

Muskegon River Management Plan

River Management Plan 04, February, 2003

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Introduction

This Plan is a companion document to the Muskegon River Watershed Assessment (O'Neal 1997). The river assessment describes physical characteristics and biological communities of the Muskegon River as well as unique resources found within the watershed. The purpose of the river assessment is to: identify opportunities and problems related to the aquatic resources and fisheries within the watershed; provide a mechanism for public comment into fisheries management decisions; and serve as a reference document for those seeking information regarding the Muskegon River watershed. The Muskegon River Watershed Assessment was drafted by Fisheries Division personnel, then went through a significant period of peer and public review and comment, and was completed in July, 1997.

Managing the health of a watershed is an activity that must be carried on continuously, and must be viewed within a long-term perspective. The physical and biological components of the Muskegon River watershed have been altered in many ways by human development over the past 150 years, and changes resulting from development will always be occurring. Restoring healthy conditions from past practices will not be accomplished for many years, and protection of resources must continue in our constantly growing and changing society. This plan provides short-term and long-term objectives. Short-term objectives will be used by Fisheries Division to guide management actions within the watershed over the next five years. It is intended that the actions identified as priorities, after being weighed against other Division priorities, will appear in annual work plans. This is a working document. Therefore it will receive review and update for progress made and tasks completed at least every five years. Long-term objectives include activities that the Division feels are vital or important to overall resource management of the watershed. Long-term objectives may be accomplished by Fisheries Division or by other agencies, universities, and interested groups.

This document, when combined with the river assessment, provides a comprehensive watershed plan that will aid Fisheries Division and partners in long-term watershed management activities. The plan provides schedules for immediate action on some management activities. It is difficult and cumbersome to attempt individual planning activities beyond a five-year schedule. However, this plan promotes management activities that form the basis for long-term watershed management. Appropriate management requires base information on features like land-use, hydrology, water quality, and channel characteristics of the watershed. Additional study is needed to evaluate these parameters and this plan provides a schedule for obtaining this base information. For example, at this time, it would be inappropriate to attempt bank erosion control on the hundreds of sites located on the mainstem upstream of Big Rapids. Many (or possibly all) of these are the result of natural channel processes. In addition, if hydrologic conditions in the watershed are unstable, bank erosion control will be less effective (or not effective) until hydrologic conditions are stabilized. So studies of channel characteristics and hydrology are objectives included in the plan. These features are also related to land use. Land-use information is presently being compiled by the Muskegon River Watershed Assembly. This plan also schedules time for representation by Fisheries Division on the Assembly. Another example is the issue of water quality problems from the numerous dams present in the watershed. It will take years to compile information before the water quality affects of all of these dams are known. The plan does provide for water quality investigations throughout the watershed. Other actions in the plan that require more study include bank erosion repair in the

hydroelectric impoundments, installation of fish passage structures at hydroelectric dams, and various individual fisheries management activities for species like walleye, lake sturgeon, and white bass.

Prioritization of Actions

The Management Options contained within the river assessment are consistent with the mission of Fisheries Division, which is to protect and enhance public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources for benefit of the people of Michigan. In particular, the Division seeks to: protect and maintain healthy aquatic environments and fish communities and rehabilitate those now degraded; provide diverse public fishing opportunities to maximize the value to anglers; and foster and contribute to public and scientific understanding of fish, fishing, and fishery management (Fisheries Division 1994). Selection of Management Actions from the Management Options list is also consistent with and is guided by the objectives found in the Fisheries Division Strategic Plan.

Both the Management Options in the river assessment and the selection of Management Actions in the Plan follow the recommendations of Dewberry (1992). Actions that protect and restore headwater streams, riparian areas, and floodplains are given priority because the reconnection of streams and floodplains is critical to the health of the entire river system. The river system is viewed as a whole, for many important elements of stream habitat are driven by whole-system processes. Actions to protect, preserve, and restore resources in an ecologically sound manner take precedence over other actions. Other approaches may be used to alter specific conditions or habitats, or to help restore whole river system functions including rehabilitation (or replacement), enhancement, mitigation, creation, and reclamation (Cairns Jr.1993; Jackson et al. 1995; Kauffman et al. 1997).

A number of mitigating factors will alter strict adherence to this order of priorities. Examples of such factors are selection of actions that may:

- 1) result in very high benefit for relatively low expenditure of effort or cost;
- 2) leverage Fisheries Division's resources by capitalizing on existing momentum and opportunities within a specific community or segment of the watershed;
- 3) reflect significant outside interest or support;
- 4) provide the Division with an opportunity to participate in partnerships;
- 5) continue an ongoing project; appear in another Fisheries Division plan (e.g., Lake Sturgeon Rehabilitation Strategy and Fishery Status Reports);
- 6) fulfill a legal requirement (e.g., FERC related actions);
- 7) involve public health concerns; or
- 8) address concerns for threatened and endangered species.

Selected Management Actions

This list was developed from the Management Options section of the Muskegon River Watershed Assessment. A copy of the Management Options section is attached as an appendix to this document. An individual action item may not address an entire Management Option, as many of the Options are broad in scope and long-term. Rather, an action item will accomplish a portion of a Management Option or take a short-term step towards accomplishing a long-term objective.

For each selected Management Action, this Plan identifies the Management Option being addressed and gives a brief explanation of the factors considered in selecting this action as a priority. Schedules are provided for up to five years for the accomplishment of the short-term action items. Schedules contain information required for completion of annual work plans. These Actions are listed in order of priority, with the highest priority listed first.

Management Action 1:

Construct a hydrologic/hydraulics model to evaluate present and historical flow patterns and channel characteristics, to identify problem areas, and to provide suitable information for planning and evaluation of alternative remedial measures. Plan and implement projects designed to maintain appropriate hydrology based on study findings.

Management option category: Geology and Hydrology

Management option: Evaluate flow stability by developing an operational discharge model for the entire river system.

Management option: Survey historical records to determine pre-settlement flow patterns.

Reasons for selection: The amounts of groundwater and surface water inflows determine aquatic community composition of the river, discharge patterns, and influence physical stability and biological production of the system. Maintaining natural discharge patterns is critical to maintaining healthy biological communities, and controlling pollution and erosion.

Several cooperating universities began initial system-wide hydrologic studies in 2000. Information from these studies will be available by 2003 and will help define more specific information and project areas.

Objective type: Short-term.

Schedule:

Year 1: Assist with information collection and evaluation.

Personnel days, by position: Fisheries Biologist-1 day.

Special needs: None.

Discretionary dollars: None.

Year 2: Assist with information collection and evaluation.

Personnel days, by position: Fisheries Biologist- 2 days.

Special needs: Unknown.

Discretionary dollars: Unknown.

Year 3: Design-implement additional projects.

Personnel days, by position: Fisheries Biologist- 3 days.

Special needs: Unknown.

Discretionary dollars: Unknown.

Management Action 2:

Conduct water temperature evaluations of the entire mainstem and principal tributaries. Collect and evaluate additional water temperature and dissolved oxygen information on dams causing water quality degradation.

Management option category: Dams and Barriers

Management option: Protect natural water temperatures by removing problem dams in the mainstream and tributaries.

Management option: Evaluate the affect of Reedsburg dam on water temperatures, and other affects on the river.

Management option category: Water Quality

Management option: Survey water temperatures throughout the watershed.

Management option category: Fishery Management

Management option: Conduct evaluations to determine if Falmouth Dam is affecting water quality conditions in the Clam River.

Management option: Restore the Middle Branch River section by removing or bypassing Marion Dam to improve water quality conditions in the downstream reaches.

Management option: Improve water quality conditions in the Hersey River by removing Miller Dam.

Reasons for selection: Water temperature, dissolved oxygen, and discharge are three principal physical parameters determining types of aquatic life that will live in a river. Information on these parameters is lacking on a whole-system basis. This information is prerequisite to proper management of the river.

Information has been gathered on much of the mainstem and the principal tributaries including Cedar Creek, Bigelow Creek, Little Muskegon River, Tamarack Creek, Hersey River, and Middle Branch River. A report on the Middle Branch River is near completion. Areas that need more temperature data include the Clam River, the upper portion of the mainstem above and below Reedsburg Impoundment, and numerous smaller tributaries with dams and other problems.

Objective type: Short-term.

Schedule:

Year 1: Evaluate and report on available information.

Personnel days, by position: Fisheries Biologist-15 days.

Special needs: None.

Discretionary dollars: None.

Year 2: Evaluate and report on available information.

Personnel days, by position: Fisheries Biologist-15 days.

Special needs: None.

Discretionary dollars: None.

Year 3: Conduct monitoring, complete evaluations and reports.

Personnel days, by position: Fisheries Biologist-10 days.

Special needs: None.

Discretionary dollars: None.

Management Action 3:

Survey channel characteristics and habitat of the mainstem, and compare to expected historical parameters. Include an evaluation of the need for bank erosion repair.

Management option category: Fishery Management

Management option: Evaluate fishery habitat in the mainstem and tributaries.

Management option category: Channel Morphology

Management option: Survey historical records to determine pre-settlement channel form.

Management option: Survey the river to determine channel form.

Reasons for selection: Base information needed to evaluate and determine protection, restoration, and rehabilitation programs.

Evaluations should include a comparison of the amount of wood habitat present in the Muskegon River to other rivers of similar size. There is considerable bank erosion in the river. Studies need to determine if this erosion is at natural levels or has been accelerated by historical logging practices, or increases in river discharge resulting from watershed development.

Approximately \$100,000 would be needed to conduct these studies over a two year period.

Objective type: Long-term

Management Action 4:

Assist the Muskegon River Watershed Assembly in an advisory capacity on protection, restoration, and rehabilitation programs.

Management option category: Geology and Hydrology

Management option: Protect existing wetlands, floodplains, and natural upland drainage to maintain natural hydrologic condition of all streams in the watershed. Prevent establishment of new lake-level control structures and new agricultural and urban surface drainage.

Management option category: Channel Morphology

Management option: Protect tributaries from further ditching by allowing no new drains or developing suitable alternatives.

Management option category: Land Use Patterns

Management option: Protect lands through land-use planning and zoning guidelines that emphasize protection of critical areas and improved storm-water management.

Management option: Protect uplands by implementing USDA soil conservation practices to reduce erosion.

Management option category: Special Jurisdictions

Management option: Establish a watershed council to coordinate land and water management activities. This will protect and rehabilitate the natural river system by promoting coordinated management and planning for the future.

Management option category: Dams and Barriers

Management option: Conduct a road stream-crossing inventory to evaluate culverts, bridges, and associated problems.

Management option category: Water Quality

Management option: Survey sediment inputs to the river (agricultural and urban runoff, road crossings, and stream banks).

Management option category: Citizen Involvement

Management option: Improve and implement strategies to educate the community regarding river ecosystems.

Management option: Establish a watershed council to increase citizen involvement in watershed planning and management.

Reasons for selection: A watershed council can be instrumental in dealing with large-scale watershed issues regarding land management activities. Fisheries Division assisted in sponsoring a watershed coordinator in 1996, through the Michigan Habitat Improvement Fund. This promoted the formation of the Muskegon River Watershed Assembly in 1998, and full-time staff were acquired in 2001. Membership includes individuals, sport groups, public agencies, and municipalities throughout the watershed. Projects already started include road stream crossing inventories, stream bank erosion control below dams, development of educational materials, and upland planning activities. Many more activities are anticipated. Both Department of Natural Resources and Department of Environmental Quality representatives are advisors to the Assembly.

Objective type: Short-term.

Schedule:

Year 1: Assist as advisor to Watershed Assembly.

Personnel days, by position: Fisheries Biologist-10 days.

Special needs: None.

Discretionary dollars: None.

Year 2: Assist as advisor to Watershed Assembly.

Personnel days, by position: Fisheries Biologist-10 days.

Special needs: None.

Discretionary dollars: None.

Year 3: Assist as advisor to Watershed Assembly.

Personnel days, by position: Fisheries Biologist-10 days.

Special needs: None.

Discretionary dollars: None.

Year 4: Assist as advisor to Watershed Assembly.

Personnel days, by position: Fisheries Biologist-10 days.

Special needs: None.

Discretionary dollars: None.

Year 5: Assist as advisor to Watershed Assembly.

Personnel days, by position: Fisheries Biologist-10 days.

Special needs: None.

Discretionary dollars: None.

Management Action 5:

Evaluate present population and recruitment levels of walleye.

Management option category: Fishery Management

Management option: Evaluate current population and recruitment levels of walleye.

Reasons for selection: Information is necessary to assist in planning the ongoing restoration of walleye. In 1998, the spawning population of walleye in the Muskegon River was estimated at about one-third historical levels. Another population estimate will be complete in 2003. Five years of stocking marked fish and conducting fall electrofishing samples have shown very few naturally reproduced Age-0 or Age-1 walleye. Recruitment of walleye can vary significantly annually. Marking programs should be continued until viable natural reproduction is established. This indigenous population was self-reproducing prior to 1960. Recruitment studies should continue and be expanded to determine if there is a survival problem in the first year of life.

Larval fish studies need to be designed and completed to determine limiting factors in recruitment. Adult population estimates should be completed once every 10 years.

Approximately \$75,000 would be needed to complete larval fish studies over a three year period. These studies would be designed to evaluate egg deposition, hatching, downstream movement, and viability of fry between Croton Dam and into Muskegon Lake. Evaluations of water temperatures and other pertinent habitat features necessary for recruitment should be conducted. Marking and evaluation of stocked and natural fish (using fall fingerling evaluations) by the Department of Natural Resources should be conducted during years when larval fish are studied

Objective type: Short-term

Schedule:

Year 1: Evaluate natural reproduction using marked, stocked fish and fall electrofishing.
Personnel days, by position: Fisheries Biologist-2 days, Fisheries Technician-2 days.
Special needs: Oxytetracycline marking of fry.
Discretionary dollars: Unknown.

Year 3: Evaluate natural reproduction using marked, stocked fish and fall electrofishing.
Personnel days, by position: Biologist-2 days, Technician-2 days.
Special needs: Oxytetracycline marking of fry.
Discretionary dollars: Unknown.

Year 5: Evaluate natural reproduction using marked, stocked fish and fall electrofishing.
Personnel days, by position: Biologist-2 days, Technician-2 days.
Special needs: Oxytetracycline marking of fry.
Discretionary dollars: Unknown.

Management Action 6:

Restore white bass to the Muskegon Lake fish community.

Management option category: Fishery Management

Management option: Partially restore the Muskegon Lake fish community by reintroducing white bass.

Reasons for selection: Restoration of extirpated species. During the mid-1970s and 1980s, there was an attempt to restore white bass to Lake Macatawa and White Lake. In 1983 and 1984, 2,289 adult White Bass were stocked into White Lake, from the lower Detroit River. This introduction was unsuccessful based on surveys and fishing reports. Ninety-seven adult white bass were captured in Lake Erie and transferred to Lake Macatawa (80 in 1976, 17 in 1983). In 1996, a net survey was conducted in Lake Macatawa. A total of 34 white bass and

207 white perch were collected. Samples were sent to the U.S.G.S. Laboratory in Ann Arbor to insure hybrids were not present. The results indicated no hybrids were present. Since that time both white bass and white perch have been collected in Muskegon Lake. In 2000, the U.S.G.S. Laboratory completed an analysis to determine if genetic variability of Lake Macatawa white bass were similar to Lake Erie and Lake Huron. The results indicated Lake Macatawa white bass did not have less genetic variability. The results also indicated that Lake Macatawa white bass may be genetically distinct due to a substantial polymorphism found in these fish. The results indicated Lake Macatawa white bass should be used as a source of eggs for Lake Michigan tributary stocking, rather than Lake Erie or Lake Huron white bass.

Determine if eggs can be collected from Lake Macatawa and hatched at Wolf Lake Hatchery. Rear and stock white bass with assistance from partnership group. Several days DNR time for fish collections and rearing in the hatchery is required. Volunteer assistance is needed for pond rearing activities.

Objective type: Long-term.

Management Action 7:

Use census methods to evaluate angler use and other forms of recreation throughout the watershed.

Management option category: Fishery Management

Management option: Evaluate angler use throughout the watershed.

Management option category: Recreational Use

Management option: Survey recreational use in the watershed.

Reasons for selection: Information is necessary to accurately determine recreational use, catch statistics, and base biological data for guiding fishery management programs. A fishery creel census was conducted on the Muskegon to Croton section of river from 1999 through 2001. Estimated angler-days expended in the lower river ranged from 90,000 to 115,000. A creel census will be conducted on Muskegon Lake in 2002-2003. Census on other segments of the river and impoundments will assist in fishery management programs, such as, walleye restoration, dam removal evaluations, fish passage evaluations, and stocking programs.

Approximately \$150,000 would be required to conduct one year of creel census in the three hydroelectric impoundments and in two mainstem river segments upstream of the impoundments.

Objective type: Long-term.

Management Action 8:

Construct and test a barrier fence to prevent the extensive annual motor vehicle losses of turtles in the Muskegon River marsh at the U.S. 31 crossing.

Management option category: Biological Communities.

Management option: Protect and preserve adequate river corridor forest, especially sensitive plant and animal communities. River-corridor forest management includes maintenance of old growth forest corridors, prevention of wetland loss, protection of sensitive habitats, and protection from over-development and intensive recreational use.

Reasons for selection: Protection of sensitive and threatened species. The U.S. 31 highway spans the entire floodplain of the Muskegon River in Muskegon County. The floodplain is approximately two miles wide at the highway crossing, and is predominantly submerged wetlands. The north and south highway sections were constructed on fill deposited directly into the wetlands. Two bridges over the north and south branch river sections provide the only water corridors joining the wetlands. The wetlands serve as the primary migration route for turtles in the river. Numerous mature turtles are killed by motor vehicles each year while crossing the highway. Turtle deaths are highest during the spring egg-laying season but occur throughout summer and fall. Initial evaluations indicate approximately 10 miles of barrier protection is needed at this site, and Michigan Department of Transportation will support such a project.

Activities needed include obtaining funding and working with interested group to conduct demonstration project in a small portion of this site. Determine effectiveness of barrier using appropriate study methods. Continue with project when appropriate barrier has been designed. Initial review indicates metal fencing should form an appropriate barrier.

Approximately \$20,000 is needed to purchase fencing materials and posts for four miles of fence for a demonstration project. Volunteers would be needed for placement or additional funding to hire personnel.

Objective type: Long-term.

Management Action 9:

Continue to manage the Middle Branch River, a Blue Ribbon Trout Stream, as a high quality coldwater stream. Restore natural river conditions and improve habitat in the Middle Branch River by removing Marion Dam, or separating the river from Marion Impoundment.

Management option category: Fishery Management

Management option: Manage the Middle Branch River as a high quality trout fishery.

Management option: Restore the Middle Branch River section by removing or bypassing Marion Dam to improve water quality conditions in the downstream reaches.

Reasons for selection: Marion dam is degrading water temperatures in the Middle Branch River. Removal or bypass is necessary to reconnect fragmented river sections and restore habitat to natural conditions. Water temperature, discharge, fisheries, and invertebrate studies were conducted from 1998 through 2001. Evaluation of this information is near completion. Discussions with the Village of Marion regarding possible separation of the river from the impoundment began in 1999. The Village of Marion contracted engineering studies to determine appropriate river restoration and mill pond cultural and aesthetic preservation plans. Plans incorporate recreational improvements for coldwater fisheries, warmwater pond fisheries, waterfowl use, swimming, boating, hiking, and nature viewing. Efforts to secure funding sources to complete engineering studies and separation of the river from the mill pond are ongoing. Approximately \$4,300,000 is required to complete this objective.

Studies to evaluate water temperatures and fisheries should be conducted following restoration projects.

Objective type: Short-term.

Schedule:

Year 1: Assist in acquiring funds and other activities needed to complete project .

Personnel days, by position: Fisheries Biologist-5 days.

Special needs: None.

Discretionary dollars: None.

Year 2: Assist in acquiring funds and other activities needed to complete project.

Personnel days, by position: Fisheries Biologist-5 days.

Special needs: None.

Discretionary dollars: None.

Year 3: Assist in acquiring funds and other activities needed to complete project.

Personnel days, by position: Fisheries Biologist-5 days.

Special needs: Unknown.

Discretionary dollars: Unknown.

Management Action 10:

Continue to manage the Hersey River as a coldwater stream. Conduct additional evaluations of the effects of Miller Dam and Hersey Dam on river resources.

Management option category: Fishery Management

Management option: Manage the Hersey River for brook and brown trout.

Management option: Improve water quality conditions in the Hersey River by removing Miller Dam.

Reasons for selection: Protection and restoration of coldwater habitat. The dams are degrading water temperatures in the Hersey River. Dam removal or bypass is necessary to reconnect fragmented river sections and restore habitat to natural conditions. Whole river water temperature, discharge, and fisheries surveys of the Hersey River began in 1999. Evaluation and reports need to be completed. Initial discussions regarding dam removal with the Village of Hersey have been conducted. Contaminant studies of the impoundment by The Department of Environmental Quality will be completed in the near future. Planning can continue following completion of the contaminant studies. Removal of Miller Dam needs to be pursued. Approximately \$1,000,000 is required to complete removal or bypass of each of these dams.

Objective type: Short-term.

Schedule:

Year 1: Complete evaluation and report of water temperatures, discharge, and fish surveys.

Continue discussions and planning with the Village of Hersey. Pursue Miller Dam removal.

Personnel days, by position: Fisheries Biologist-10 days.

Special needs: None.

Discretionary dollars: None

Year 2: Continue habitat evaluation, protection, restoration, and rehabilitation measures.

Continue discussions and planning with the Village of Hersey. Pursue Miller Dam removal.

Personnel days, by position: Fisheries Biologist-5 days.

Special needs: None.

Discretionary dollars: None.

Year 3: Continue habitat evaluation, protection, restoration, and rehabilitation measures.
Continue discussions and planning with the Village of Hersey. Pursue Miller Dam removal.
Personnel days, by position: Fisheries Biologist-5 days.
Special needs: Unknown.
Discretionary dollars: Unknown.

Management Action 11:

Assess lake sturgeon, river redhorse, and lake trout spawning.

Management option category: Fishery Management

Management option: Assess lake sturgeon, river redhorse, and lake trout spawning.

Reasons for selection: Assess present distribution and spawning of rare, indigenous species. Information on these species is needed for preparing restoration plans. A few adult river redhorse were collected in the pre-licensing dam studies. Incidental lake trout catches have been made at various locations in the river and angler reports indicate they move upstream to Croton Dam during the fall. Six adult lake sturgeon (50"-60") were collected incidental to steelhead sampling during 1997. Sturgeon population and movement studies will be completed in 2002-2003 by university researchers.

Individual studies need to be designed and conducted to determine the relative number and distribution of adults in the river, and if recruitment is occurring. Lake sturgeon and river redhorse studies are presently ongoing. Approximately \$50,000 is required to conduct lake trout spawning and larval fish studies.

Objective type: Long-term.

Management Action 12:

Evaluate the potential for reintroduction of Great Lakes muskellunge.

Management option category: Fishery Management

Management option: Evaluate the potential for reintroduction of Great Lakes muskellunge.

Reasons for selection: Great Lakes muskellunge were an indigenous species to the Muskegon River watershed. Evaluation needs to determine appropriate locations in the system where reintroduction should occur. Completion of this program is dependant on successful egg collection and rearing of this species from Michigan broodstock.

Objective type: Long-term.

Management Action 13:

Improve river and impoundment aquatic habitat by improving discharges from Rogers, Hardy, and Croton hydroelectric dams.

Management option category: Geology and Hydrology

Management option: Restore or rehabilitate natural flow patterns at hydroelectric dams by removal or require operation in non-peaking mode. (Provisions for flow improvement at Rogers, Hardy, and Croton dams were made in the Settlement Agreement, part 6)

Management option category: Water Quality

Management option: Optimize oxygen and water temperature levels below dams.

Management option category: Fisheries Management

Management option: Improve water quality conditions in Croton Impoundment by maintaining proper dissolved oxygen concentrations in the discharge from Hardy Dam.

Management option: Improve fisheries below Croton by mitigating the negative effects caused by the hydroelectric dams. (Provisions for mitigation of negative effects at Croton Dam were made in the Settlement Agreement.)

Reasons for selection: Rehabilitate or mitigate habitat loss resulting from water quality problems. These are provisions of the Settlement Agreement (Refer to part 6). A three-year water quality study of the dams and impoundments began in 1999. The results of these studies will be used to determine if water quality improvements can be made. Based on information from the water quality studies, determine and implement methods to improve water quality conditions. Funding is provided in the Settlement Agreement to complete this objective.

Objective type: Long-term

Management Action 14:

Manage the river section covered by Rogers, Hardy, and Croton impoundments for impoundment fisheries. Protect and improve the fisheries of the impoundments by installing barrier screens at the intakes.

Management option category: Dams and Barriers

Management option: Where feasible, protect fishery resources by screening turbine intakes at hydroelectric dams.

Management option category: Fisheries Management

Management option: Retain Rogers, Hardy, and Croton Impoundments and manage for impoundment fisheries.

Management option: Where feasible, install barrier screens at all three hydroelectric dams to reduce fish entrainment.

Reasons for selection: Rehabilitate fisheries in the impounded portion of the river. This is part of the Settlement Agreement. These impoundments have had limited fisheries since they were constructed in the early 1900s. Poor fisheries are at least partly the result of entrainment losses as demonstrated by walleye tagging studies conducted by Fisheries Division. Numerous attempts to improve fisheries in the impoundments have occurred in the past. The impoundments are large and generally unproductive, have water fluctuations that affect habitat, and entrainment. There are presently no obvious solutions to improving fisheries. There may be some potential to attempt trout stocking, but this cannot be accomplished without fish screening of the turbine intakes.

Barrier screen studies are ongoing at representative dams in Michigan. These studies will be used to determine if barriers can be used in a cost-effective manner at individual dams. Barrier funding is provided in the Settlement Agreement.

Objective type: Long-term.

Management Action 15:

Determine the effects of bank erosion on habitat in the hydroelectric impoundments.

Management option category: Fishery Management

Management option: Evaluate habitat in the impoundments.

Management option: Evaluate the effects of bank erosion in the impoundments on habitat.

Reasons for selection: Status: Review of impoundment bank erosion and aquatic plant information from the pre-licensing studies does not indicate a correlation between the two variables. However, impoundment bank erosion repair projects have been completed and proposed to benefit resources. Additional evaluation is needed to determine the affect of bank erosion on aquatic vegetation in the impoundments, prior to allocation of additional funding. Approximately \$25,000 is required to complete evaluations. Attempting to reduce bank erosion in the impoundments may have little, if any, resource benefits.

Objective type: Long-term.

Management Action 16:

Install fish passage devices at Rogers, Hardy, Croton, Reedsburg, Houghton Lake, and Higgins Lake dams.

Management option category: Biological Communities

Management option: Restore and rehabilitate populations of potamodromous fish above Croton by dam removal or fish passage.

Management option category: Fisheries Management

Management option: Restore and rehabilitate potamodromous fish runs above the hydroelectric dams. Install fish passage devices at Rogers, Hardy, and Croton dams.

Management option: Evaluate effects of fish passage on interacting avian and mammal species.

Reasons for selection: To reduce habitat fragmentation in the mainstem, and improve the health and genetics of fish populations. Restore indigenous fish populations upstream of the dams. Rehabilitate fisheries upstream of the dams by passing naturalized species. The design, construction, operation, and maintenance of fish passage structures is to be provided by Consumers Energy under specific conditions specified in Part 9 of the Settlement Agreement. Determine specific objectives, goals, and schedules for fish passage at each dam, in concert with appropriate management agencies, and obtain approvals in accordance with the Settlement Agreement, Part 9 specifications.

Objective type: Short-term.

Schedule:

Year 1: Continue habitat protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist- 2 days.

Special needs: None.

Discretionary dollars: None.

Year 2: Continue habitat protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist- 2 days.

Special needs: None.

Discretionary dollars: None.

Year 3: Continue habitat protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist- 2 days.

Special needs: None.

Discretionary dollars: None.

Management Action 17

Use environmental permit review activities, agency and interagency plan reviews, land acquisitions, and partnerships to protect and restore floodplains, wetlands, upland drainage, and control non-point source pollution.

Management option category: Biological Communities

Management option: Protect and preserve adequate river corridor forest, especially sensitive plant and animal communities. River-corridor forest management includes maintenance of old growth forest corridors, prevention of wetland loss, protection of sensitive habitats, and protection from over-development and intensive recreational use.

Management option category: Geology and Hydrology

Management option: Protect existing wetlands, floodplains, and natural upland drainage to maintain natural hydrologic condition of all streams in the watershed. Prevent establishment of new lake-level control structures and new agricultural and urban surface drainage.

Management option: Restore and rehabilitate natural hydrologic conditions of streams by requiring proper operation or modifications of existing lake-level control structures, improving flow patterns in established county drains, eliminating unneeded drainage and restoring wetlands and floodplains.

Management option category: Channel Morphology

Management option: Restore woody habitat by establishing natural woody buffer zones along the river and reducing high flood flows.

Management option category: Special Jurisdictions

Management option: Advocate all agencies incorporate recommended river protection measures in their land and water management programs.

Management option category: Fishery Management

Management option: Manage the river above the confluence with the Middle Branch River for northern pike. Protect and restore wetland and floodplain habitat for northern pike fisheries.

Management option category: Water Quality

Management option: Control nutrient and sediment inputs using non-point source control measures.

Reasons for selection: These are ongoing activities conducted by fisheries biologists. Permits submitted for development activities to the Department of Environmental Quality are reviewed for resource effects. Reviews of agency resource planning activities are also conducted, such as, Department of Natural Resources Forest Compartment Plans, U.S. Forest Service and U.S. Fish and Wildlife Land and Water Plans. Fisheries Division acquires lands along the river when needed for resource protection or recreation.

Objective type: Short-term.

Schedule:

Year 1: Continue habitat protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist-15 days.

Special needs: None.

Discretionary dollars: None.

Year 2: Continue habitat protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist-15 days.

Special needs: None.

Discretionary dollars: None.

Year 3: Continue habitat protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist-15 days.

Special needs: None.

Discretionary dollars: None.

Year 4: Continue habitat protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist-15 days.

Special needs: None.

Discretionary dollars: None.

Year 5: Continue habitat protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist-15 days.

Special needs: None.

Discretionary dollars: None.

Management Action 18

Use environmental permit review activities, agency and interagency plan reviews, and partnerships to reconnect fragmented river segments and mitigate negative effects of dams.

Management option category: Biological Communities

Management option: Restore and rehabilitate migrations of river fish by removing dams or installing fish passage devices.

Management option category: Recreational Use

Management option: Restore and rehabilitate fish communities by establishing fish passage at hydroelectric dams.

Management option: Restore and create more river fishing by removing tributary dams.

Management option category: Dams and Barriers

Management option: Protect the biological communities of the river by providing fish passage at dams to mitigate for habitat fragmentation.

Management option: Rectify or mitigate the numerous problems associated with hydroelectric and non-power dams.

Reasons for selection: To restore river habitat, reduce habitat fragmentation, and improve health of aquatic communities. Construction, repair, and replacement of dams require permits through the Department of Environmental Quality. Review of these permits is an ongoing activity for fisheries biologists. Special efforts should be made to provide information on the

resource effects of these activities, and request adequate mitigation or removal of these structures.

Objective type: Short-term.

Schedule:

Year 1: Continue evaluation, protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist-3 days.

Special needs: None.

Discretionary dollars: None.

Year 2: Continue evaluation, protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist-3 days.

Special needs: Unknown.

Discretionary dollars: Unknown.

Year 3: Continue evaluation, protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist-3 days.

Special needs: Unknown.

Discretionary dollars: Unknown.

Year 4: Continue evaluation, protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist-3 days.

Special needs: Unknown.

Discretionary dollars: Unknown.

Year 5: Continue evaluation, protection, restoration, and rehabilitation measures.

Personnel days, by position: Fisheries Biologist-3 days.

Special needs: Unknown.

Discretionary dollars: Unknown.

Management Action 19:

Stock brown and rainbow trout in the Evart to Big Rapids section of river. Evaluate fish community.

Management option category: Fishery Management

Management option: Between the confluence with the Middle Branch River and Big Rapids, manage resident walleye, smallmouth bass, brown trout, and rainbow trout. Evaluate the potential for stocking these species.

Reasons for selection: Stock trout for fishery rehabilitation. Attempt to create an urban fishery in the City of Big Rapids. Rainbow and brown trout were stocked in Big Rapids beginning in 1998 and will continue through 2003. Evaluations of the fish community in this river segment will be conducted in 2000-2002, along with studies of the Big Rapids Dam removal and University of Michigan studies.

Objective type: Short-term

Schedule:

Year 1: Evaluate results of survey, write summary report.

Personnel days, by position: Fisheries Biologist-3 days.

Special needs: None.

Discretionary dollars: None.

Management Action 20:

Continue management practices for existing fisheries in the Muskegon to Croton river section. Continue habitat protection, restoration and rehabilitation through environmental permit evaluations, Settlement Agreement provisions, and by working with the Muskegon River Watershed Council. Attempt to determine limiting factors for self-sustaining populations.

Management option category: Fishery Management

Management option: Manage the river fishery below Croton Dam for self-sustaining populations of the following species: walleye, smallmouth bass, river herring, chinook salmon, steelhead, brown trout, rainbow trout, and lake sturgeon.

Reasons for selection: This segment of the river has very good, diverse fisheries. Creel census estimates from 1999 through 2001 indicate from 90,000 to 115,000 angler-days/year were expended on this river segment. Approximately \$250,000 annually is spent stocking steelhead, walleye, and non-migratory brown and rainbow trout. Walleye, lake sturgeon, chinook salmon, and steelhead recruitment studies have begun. Evaluations of non-migratory rainbow and brown trout have been conducted. The cost and importance of management in this segment of river requires continued management activities.

Fishery management programs in this river segment will continue and adapt as additional information is gathered. Continue to assist in gathering appropriate information to aid in fishery management decisions.

Objective type: Long-term.

Management Action 21:

Continue management of existing fisheries in Muskegon Lake, Houghton Lake, and Higgins Lake. Protect, restore, and rehabilitate habitat through environmental permit evaluations and by working with interested watershed groups. Develop management plans for these lakes.

Management option category: Fishery Management

Management option: Manage Muskegon Lake for warmwater and coolwater fish. Primary species include walleye, northern pike, smallmouth bass, largemouth bass, panfish, yellow perch, flathead catfish; and seasonally chinook salmon, brown trout, steelhead, lake trout, and lake sturgeon. Protect wetlands, shallow water habitat, and aquatic plants required by these species.

Reasons for selection: Houghton and Higgins lakes are two of the largest lakes in Michigan and support significant fisheries. Muskegon Lake is one of the best fishing lakes in west Michigan, and contains the primary walleye fishery for central Lake Michigan. All of these lakes have significant development and resource related issues. Lake management plans should be developed to form a basis for sound long-term management. A preliminary study of the types and densities of aquatic vegetation in Muskegon Lake was completed by Grand Valley State University (Luttenton 1995). An update of this study needs to be conducted to measure trends in the plant community. In addition, whole-lake quantitative information needs to be gathered and an historical reconstruction of littoral habitat and wetlands should be completed for all three lakes. This information is needed to determine historical habitat alterations and if present levels of vegetation are sufficient to maintain the aquatic community.

Approximately \$50,000 is required for each lake to complete aquatic habitat studies in each of these lakes.

Objective type: Long-term.

Management Action 22:

Continue to manage a portion of the Clam River for coldwater fisheries. Continue habitat protection measures and attempt to resolve habitat degradation caused by inappropriate operation of the lake-level control structure at Lake Cadillac. Evaluate the resource effects of Falmouth Dam.

Management option category: Fishery Management

Management option: Manage the Clam River as a high quality trout fishery.

Management option: Protect the Clam River by operating the lake-level control structure from Lake Cadillac so water quality conditions in the river are not degraded.

Management option: Conduct evaluations to determine if Falmouth Dam is affecting water quality conditions in the Clam River.

Reasons for selection: Water temperature evaluations were started on the Clam River in 1999. Additional water temperature, discharge, gradient, and fisheries information will be needed to manage this river.

Objective type: Long-term.

Management Action 23:

Continue to manage Bigelow Creek for self-sustaining brook and brown trout populations. Protect, restore, and rehabilitate habitat through environmental permit evaluations and by working with interested watershed groups and the U.S. Forest Service.

Management option category: Fisheries Management

Management option: Manage Bigelow Creek, Newaygo County, for a self-sustaining brook and brown trout fishery.

Reasons for selection: Whole river water temperature surveys and fisheries surveys have been completed on Bigelow Creek. Salmonid recruitment studies began in 1997. In-stream habitat improvement work (log-structure and erosion control) has been ongoing through various partnerships throughout the 1990s. Public access land purchase at the mouth of Bigelow Creek was completed in 1999. Continued management is necessary to protect coldwater fisheries.

Objective type: Long-term.

Management Action 24:

Evaluate habitat conditions in Brooks Creek to determine if the stream can be managed for a brown trout fishery. Protect, restore, and rehabilitate habitat through environmental permit evaluations and by working with interested watershed groups.

Management option category: Fishery Management

Management option: Manage Brooks Creek, Newaygo County, for a brown trout fishery. Reduce sediment erosion and agricultural drainage to improve water quality conditions.

Reasons for selection: Brooks Creek was stocked with brown trout for several years during the mid-1980s, with limited success. The watershed has substantial agricultural development and some non-point erosion control work was conducted during the early 1990's. Water

temperatures, in-stream habitat, and discharge needs to be evaluated prior to additional attempts at trout management in this system.

Objective type: Long-term.

Management Action 25:

Continue to manage Cedar Creek for self-sustaining brook trout and steelhead populations. Continue to protect, restore, and rehabilitate habitat through environmental permit evaluations and by working with the Cedar Creek Partnership, Muskegon River Watershed Assembly, and U.S. Forest Service.

Management option category: Fishery Management

Management option: Manage Cedar Creek, Muskegon County, for a self-sustaining brook trout and steelhead fishery. Reduce sediment erosion and agricultural drainage to improve water quality conditions.

Reasons for selection: Cedar Creek has excellent naturalized brook trout and steelhead populations. Considerable in-stream habitat work has been completed by partner groups in this watershed. The headwater segment of this stream is mostly agriculture with artificial drainage. The middle segment of the stream is owned mostly by the U.S. Forest Service. Appropriate upland and drain management in the headwaters is needed to restore this area and protect downstream areas from water quality degradation.

Objective type: Long-term.

Management Action 26

Continue to manage Mosquito Creek for a self-sustaining brook trout population. Evaluate ditched headwaters and work with Wildlife Division and other property owners on protection, restoration, and rehabilitation of the stream.

Management option category: Fishery Management

Management option: Manage Mosquito Creek, Muskegon County, for a self-sustaining brook trout fishery. Return ditched headwater sections to natural stream conditions to improve water quality.

Reasons for selection: Mosquito Creek has a self-reproducing naturalized brook trout population. The headwaters was partially in agricultural development, and some portions of the stream were ditched. Wildlife Division owns much of this property now and there is opportunity to restore natural stream conditions.

Objective type: Long-term.

Management Action 27:

Acquire access sites and upgrade existing sites for barrier-free access.

Management option category: Recreational Use

Management option: Improve existing sites and equip new sites for barrier-free access.

Management option: Purchase or lease access sites where necessary.

Reasons for selection: Access to the river is limiting recreational use in some areas. Access sites should be barrier-free when possible to allow use by all people. Some access site improvements are part of the Settlement Agreement. In 1998, a new access site was acquired

on the river at the mouth of Bigelow Creek near Newaygo. Recent improvements to access sites at the hydroelectric facilities include: Rogers facility (Rogers Heights Boat Launch, Ulrich Park, Rogers Tailrace Fishing Access), Hardy facility (U.S.-31 Public Access Site, Brower Park, Hardy Dam Park), Croton facility (Croton Township Boat Launch, Croton Tailrace East and West Sides).

Several additional boat access sites are needed in the river segment downstream of Croton Dam. The cost would likely be several million dollars for land purchase and development. Limited boat access is available upstream of the impoundments. Evaluations of access and use of the upper river segments need to be evaluated.

Objective type: Long-term.

Management Action 28:

Evaluate the effect of water discharge stabilization on the invertebrate community below Croton Dam.

Management option category: Biological Communities

Management option: Survey the distribution and status of fish, aquatic invertebrates, reptiles, amphibians, and mussels.

Reasons for selection: To determine if there have been changes in the invertebrate community or abundance associated with the more stable flow regimes below the hydroelectric dams. Consumers Power Company began stabilizing discharges from the dams between 1988 and 1992. The Settlement Agreement was reached in 1994, and re-regulation or near run-of-river discharge patterns have been ongoing since that time. Evaluation of changes in invertebrate communities would be beneficial to future dam licensing efforts, and provide additional biological data for management purposes.

Approximately \$50,000 is required to complete this evaluation.

Objective type: Long-term.

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Management Unit Supervisor

Date

Basin Coordinator

Date

River Assessment Program Manager

Date

Chief, Fisheries Division

Date

APPENDIX

The following is a copy of the Management Options section of the Muskegon River Watershed Assessment, Michigan Department of Natural Resources, Fisheries Division, Special Report 19, Ann Arbor, Michigan.

MANAGEMENT OPTIONS

This section lists possible management options for various sections of the Muskegon River and primary tributaries. The management options listed below are related principally to aquatic communities, but wildlife, botanical, and social factors are noted where they directly affect aquatic community management. Some of the management options are simple, especially when related to smaller tributaries. Most options are complex, sometimes involving entire watershed management, and can take many years to accomplish. For example, preserving the hydrology of the watershed is critical to management of aquatic communities. To accomplish this option, all uplands, lowlands, and agricultural and urban drainage in the watershed needs to be managed properly. The social, political, and legal implications are very complex because of the size of the watershed and the many communities and special jurisdictions involved. Natural resource agencies often do not have the legal authority to accomplish the necessary changes. For example, the drain code gives direct authority for establishment of drains to county drain commissioners. Establishment of drains is usually in direct conflict with preserving watershed hydrology. There are many other problems, similar in nature, related to preserving watershed hydrology.

Regardless of the complexity, it is necessary to list important management options available to protect and manage aquatic communities in the Muskegon River watershed. This will provide a basis for discussion, public review, and proper choices of management options. Selection of options will provide management agencies with both long and short term management direction.

These options follow the recommendations of Dewberry (1992), who outlines measures necessary to protect the health of the nation's public riverine ecosystems. Dewberry stresses the protection and rehabilitation of headwater streams, riparian areas, and floodplains. Streams and floodplains need to be reconnected where possible. We must view the river system as a whole, for it is the entire system that must be managed, not fragmented pieces.

The identified options are consistent with the mission statement of the MDNR Fisheries Division. This mission is to protect and enhance the public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources. In particular, the division seeks to: protect and maintain healthy aquatic environments and fish communities and rehabilitate those now degraded; provide diverse public fishing opportunities to maximize the value to anglers; and foster and contribute to public and scientific understanding of fish, fishing, and fishery management.

Options convey four approaches to correcting problems in the watershed. These include options to protect and preserve existing resources, options requiring additional information, opportunities for rehabilitation of degraded resources, and opportunities to improve an area or resources above and beyond the original condition.

Biological Communities

Limited information is readily available on the original aquatic communities in the Muskegon River watershed. The extirpation of the Arctic grayling, from the Hersey River, is the one documented piece of information showing a severe decline in a riverine stock of fish. It is also probable that a riverine stock of Great Lakes muskellunge was extirpated. Severe declines in potamodromous stocks have also occurred for walleye, sauger, white bass, lake sturgeon, and probably lake trout, lake herring, round whitefish, and lake whitefish. Declines of these stocks were influenced by changes in Lake Michigan and Muskegon Lake, as well as the Muskegon River watershed.

Recent fish community information is not sufficient to accurately document the distribution of most species within the watershed. Fish diversity and biomass are similar to other large Michigan rivers. The fish community of the mainstem is intermediate in composition between Michigan warmwater and coldwater streams. Warmwater-coolwater species dominate the fish community but coldwater-coolwater fish are present throughout the mainstem. Populations of some species exhibit lack of recruitment. Hydroelectric dams are negatively affecting aquatic communities below Croton. A number of important pest species are present.

Numerous animal and plant species are threatened or endangered and the watershed contains many game species used extensively for recreation.

- Option: Protect and preserve adequate river corridor forest, especially sensitive plant and animal communities. River-corridor forest management includes maintenance of old growth forest corridors, prevention of wetland loss, protection of sensitive habitats, and protection from over-development and intensive recreational use.
- Option: Survey the distribution and status of fish, aquatic invertebrates, reptiles, amphibians and mussels.
- Option: Survey the historic record to determine the pre-settlement fauna in the watershed.
- Option: Rehabilitate populations of potamodromous fish above Croton by dam removal or fish passage.
- Option: Rehabilitate migrations of river fish by removing dams or installing fish passage devices.
- Option: Rehabilitate aquatic communities by controlling pest species. Species included are sea lamprey, rusty crayfish, carp, alewife, chestnut lamprey, zebra mussels, purple loosestrife, Eurasian water milfoil, mute swans, gypsy moth, forest tent caterpillars, and jack pine and spruce budworms.

Geology and Hydrology

In Michigan, the most productive aquatic communities are found in streams with stable discharge patterns. Stable stream discharge is supported by permeable geology's. Geologic landforms in the watershed are moderate to high in permeability, which is reflected by intermediate stability in mainstem discharge. The upper river appears to have the most unstable high flows. Hardy Impoundment is moderating high flows below Croton. Hydroelectric dams were destabilizing low flows below Croton. Flow regulation by hydroelectric dams substantially reduced fishery habitat below Croton. Flows in some tributary streams are less stable because of improper operation of lake-

level control structures and many are affected by increased surface runoff from agricultural and urban development.

- Option: Protect existing wetlands, floodplains, and natural upland drainage to maintain natural hydrologic condition of all streams in the watershed. Prevent establishment of new lake-level control structures and new agricultural and urban surface drainage.
- Option: Survey historical records to determine pre-settlement flow patterns.
- Option: Evaluate flow stability by developing an operational discharge model for the entire river system.
- Option: Rehabilitate natural hydrologic conditions of streams by requiring proper operation or modifications of existing lake-level control structures, improving flow patterns in established county drains, eliminating unneeded drainage and restoring wetlands and floodplains.
- Option: Rehabilitate natural flow patterns at hydroelectric dams by removal or require operation in non-peaking mode. (Provisions for flow improvement at Rogers, Hardy, and Croton dams were made in the Settlement Agreement, Appendix 3.)

Channel Morphology

The channel of the Muskegon River has been adversely altered. Most of the moderate and high gradient reaches have been impounded. High gradients produce high diversity stream channels favorable to aquatic communities. Removal of riparian vegetation has reduced the introduction of important woody habitat in the channel. Many tributaries have been dredged and straightened.

- Option: Protect tributaries from further ditching by allowing no new drains or developing suitable alternatives.
- Option: Survey historical records to determine pre-settlement channel form.
- Option: Survey the river to determine channel form.
- Option: Rehabilitate moderate and high gradient stream sections by removing hydroelectric dams.
- Option: Rehabilitate woody habitat by establishing natural woody buffer zones along the river and reducing high flood flows.

Land Use Patterns

Agricultural and urban development are moderate. Erosion of sediment into streams from uplands is significant. Drainage systems are established on many tributary streams. Irrigation is not significant in the mainstem but may be causing problems in the tributaries. Floodplain use is substantial in many areas. The entire watershed has been logged of virgin timber but secondary timber growth is extensive.

Option: Protect lands through land-use planning and zoning guidelines that emphasize protection of critical areas and improved stormwater management.

Option: Protect uplands by implementing USDA soil conservation practices to reduce erosion.

Special Jurisdictions

Numerous agencies have regulatory responsibilities that affect the river system. These range from small local governments to large federal bureaucracies. The Federal Energy Regulatory Commission has authority over hydroelectric dams. The US Fish and Wildlife Service, US Forest Service, US Natural Resources Conservation Service and US Environmental Protection Agency have responsibilities for land and natural resources management. The Michigan Department of Natural Resources manages many natural resource activities and the Michigan Department of Environmental Quality is responsible for regulatory protection of the environment. Local agencies conduct zoning and other land management activities. County drain commissioners have responsibility for legally designated drains and some lake-level control structures.

Option: Establish a watershed council to coordinate land and water management activities. This will protect and rehabilitate the natural river system by promoting coordinated management and planning for the future.

Option: Advocate all agencies incorporate recommended river protection measures in their land and water management programs.

Recreational Use

Outdoor recreation is extensive in the watershed. Fishing is limited over most of the mainstem because of fish blockage by hydroelectric dams. The impoundments cover most of the high gradient river sections and limit river boating recreation and fishing. Access is limited in several areas of the mainstem and tributaries, as are handicap accessible fishing locations.

Option: Survey recreational use in the watershed.

Option: Rehabilitate fish communities by establishing fish passage at hydroelectric dams.

Option: Rehabilitate and create more mainstem river fishing and boating recreation by removing the hydroelectric dams.

Option: Rehabilitate and create more river fishing by removing tributary dams.

Option: Improve existing sites and equip new sites for access for barrier-free access.

Option: Purchase or lease access sites where necessary.

Dams and Barriers

Numerous dams and impoundments exist in the watershed. Five major impoundments are on the mainstem. Three of these are operating hydroelectric dams located midway in the river. One is a retired and partially removed hydroelectric dam at Big Rapids. The last mainstem dam is a wildlife flooding located at the headwaters. Most of the tributary dams are non-hydropower used for aesthetics, swimming, or for wildfowl. These dams are detrimental to the river because they impound most high gradient habitat, reduce river habitat, create water flow fluctuations, trap wood habitat, kill fish, fragment habitat and reduce genetic viability of fish populations, and block potamodromous fishes from much of the river.

- Option: Protect the biological communities of the river by providing fish passage at dams to mitigate for habitat fragmentation.
- Option: Protect fishery resources by screening turbine intakes at hydroelectric dams.
- Option: Protect natural water temperatures by removing problem dams in the mainstream and tributaries.
- Option: Conduct a road stream crossing inventory to evaluate culverts, bridges, and associated problems.
- Option: Evaluate the affect of Reedsburg dam on water temperatures, and other affects on the river.
- Option: Rehabilitate free-flowing river conditions by removing dams that are no longer economically feasible such as Big Rapids.
- Option: Rectify or mitigate the numerous problems associated with hydroelectric and non-power dams.

Water Quality

Water quality is good in most parts of the watershed. The mainstem is affected by moderate nutrient enrichment and excessive sediment bedload. Localized water quality problems exist near metropolitan sites and below dams.

- Option: Control nutrient and sediment inputs using non-point source control measures.
- Option: Control localized contaminant problems by cleaning up contaminated sites.
- Option: Control oxygen and water temperature problems below dams.
- Option: Survey water temperatures throughout the watershed.
- Option: Survey sediment inputs to the river (agricultural and urban runoff, road crossings, stream banks).

Fishery Management

Fishing is good between Lake Michigan and Croton Dam. Fishing is moderate to poor in the mainstem upstream of Croton. The hydroelectric dams are affecting the fisheries downstream of Croton, are impounding most moderate and high gradient river reaches, and are blocking migrations of potamodromous species. Many small dams are reducing water quality for fisheries. Fisheries are affected by sediment erosion from improper land use and bank erosion.

- Option: Protect the Clam River by operating the lake-level control structure from Lake Cadillac so water quality conditions in the river are not degraded.
- Option: Conduct evaluations to determine if Falmouth Dam is affecting water quality conditions in the Clam River.
- Option: Assess lake sturgeon, river redhorse and lake trout spawning.
- Option: Evaluate habitat in the impoundments.
- Option: Evaluate the effects of bank erosion in the impoundments on habitat.
- Option: Evaluate current population and recruitment levels of walleye.
- Option: Evaluate the potential for reintroduction of Great Lakes muskellunge.
- Option: Evaluate fishery habitat in the mainstem and tributaries.
- Option: Evaluate alternative control programs for sea lamprey.
- Option: Evaluate effects of fish passage on interacting avian and mammal species.
- Option: Evaluate angler use throughout the watershed.
- Option: Inventory the entire river system to determine species abundance and fish distribution.
- Option: Rehabilitate the Middle Branch River section by removing Marion Dam to improve water quality conditions in the downstream reaches.
- Option: Rehabilitate the Hersey River by cleaning up the contaminated creosote site in Reed City, thereby reducing fish contamination.
- Option: Rehabilitate the West Branch River by removing abandoned beaver dams in the headwaters which will improve water quality in the downstream river section.
- Option: Rehabilitate Muskegon Lake fish community by reintroducing white bass.
- Option: Rehabilitate potamodromous fish runs above the hydroelectric dams. Install fish passage devices at Rogers, Hardy, and Croton dams.

- Option: Manage the river above the confluence with the Middle Branch River for northern pike. Protect and rehabilitate wetland and floodplain habitat for northern pike fisheries.
- Option: Between the confluence with the Middle Branch River and Big Rapids, manage resident walleye, smallmouth bass, brown trout, and rainbow trout. Evaluate the potential for stocking these species.
- Option: Manage the Hersey River for brook and brown trout.
- Option: Manage the Clam River as a high quality trout fishery.
- Option: Manage the Middle Branch River as a high quality trout fishery.
- Option: Manage the West Branch of the Muskegon River as high quality trout stream.
- Option: Manage the river fishery below Croton Dam for self-sustaining populations of the following species: walleye, smallmouth bass, river redhorse, chinook salmon, steelhead, brown trout, rainbow trout, and lake sturgeon.
- Option: Manage Mosquito Creek, Muskegon County, for a self-sustaining brook trout fishery. Return ditched headwater sections to natural stream conditions to improve water quality.
- Option: Manage Cedar Creek, Muskegon County, for a self-sustaining brook trout fishery. Reduce sediment erosion and agricultural drainage to improve water quality conditions. Acquire more access.
- Option: Manage Bigelow Creek, Newaygo County, for a self-sustaining brook and brown trout fishery. Reduce sediment erosion to improve habitat quality. Acquire more access.
- Option: Manage Brooks Creek, Newaygo County, for a brown trout fishery. Reduce sediment erosion and agricultural drainage to improve water quality conditions. Acquire more access.
- Option: Manage Muskegon Lake for warmwater and coolwater fish. Primary species include walleye, northern pike, smallmouth bass, largemouth bass, panfish, yellow perch, flathead catfish; and seasonally chinook salmon, brown trout, steelhead, lake trout, and lake sturgeon. Protect wetlands and shallow water habitat required by these species.
- Option: Retain Rogers, Hardy, and Croton Impoundments and manage for impoundment fisheries.
- Option: Remove Rogers, Hardy, and Croton impoundments and manage this river section for walleye, smallmouth bass, lake sturgeon, rainbow trout, brown trout, and potamodromous fish.
- Option: Install barrier screens at all three hydroelectric dams to reduce fish entrainment.
- Option: Improve water quality conditions in the Hersey River by removing Miller Dam.

- Option: Improve shallow littoral zone habitat in Hardy Impoundment by stopping winter drawdown.
- Option: Improve water quality conditions in Croton Impoundment by maintaining proper dissolved oxygen concentrations in the discharge from Hardy Dam.
- Option: Improve sport fisheries in Hardy and Croton impoundments by stocking rainbow trout.
- Option: Improve fisheries below Croton by mitigating the negative effects caused by the hydroelectric dams. (Provisions for mitigation of negative effects at Croton Dam were made in the Settlement Agreement, Appendix 3.)

Citizen Involvement

There are numerous local government interests, from counties, villages, towns, and cities within this watershed. Interest from organized recreational groups is widespread. There are many local hunting and fishing groups in the basin. The river also draws interest from Lake Michigan fishing groups because of migratory fish species using the river. A few environmental groups are locally active in the Muskegon area because of local contamination problems.

- Option: Improve and implement strategies to educate the community regarding river ecosystems.
- Option: Establish a watershed council to increase citizen involvement in watershed planning and management.