# Kalamazoo River Area of Concern:

# Restoration Plan for the "Loss of Fish and Wildlife Habitat" and "Degradation of Fish and Wildlife Populations" Beneficial Use Impairments

***Photo credit: Scott Markham www.jumpinsmallie.com***


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## Summary

The Kalamazoo River Watershed Public Advisory Council (PAC), hereafter referred to by its assumed name of the Kalamazoo River Watershed Council (KRWC), developed targets for the restoration of the "Loss of Fish and Wildlife Habitat" and "Degradation of Fish and Wildlife Populations" Beneficial Use Impairments (BUIs) that were previously identified for the Kalamazoo River Watershed Area of Concern (AOC). These targets recognize that the AOC was originally listed because of extensive pollution of the river and floodplain with polychlorinated biphenyls (PCBs). Cleanup and isolation of PCBs from the river environment is regulated under federal and state law including the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, and Michigan Part 201. Targets for delisting these two impairments are proposed by the KRWC and approved by the Michigan Department of Environmental Quality (MDEQ).

In this document, the KRWC has proposed habitat and population-related restoration targets and actions of three types. The first type is **"required"** for the BUI to be considered restored and includes dam removal and subsequent return of formerly impounded areas to a free-flowing state with associated instream and riparian/floodplain habitat and population recovery. The second type is considered **"facilitative"** and includes the acknowledgement that the people involved in five ongoing processes in the Kalamazoo River Watershed (namely Superfund, Natural Resource Damage Assessment [NRDA], AOC program, point/nonpoint watershed programs, and recreation/access programs) should coordinate to integrate watershed management to the benefit of all parties. The third type is considered **"desirable"** and includes KRWC recommendations specifically directed at cleanup and restoration of the Kalamazoo River ecosystem through watershed partner implementation projects that go above and beyond "required" restoration activities. Although these "facilitative" and "desirable" projects are not considered "required" to be completed prior to delisting the Kalamazoo River AOC, they are still considered important to the overall Kalamazoo River Watershed.

The required delisting targets for the Kalamazoo River AOC are:

1. Superfund cleanup processes are completed in the AOC at the Allied Paper Inc./Portage Creek/Kalamazoo River site.

2. Dams are removed at the following sites: Plainwell (completed in 2009), Otsego City, Otsego Township, and Trowbridge.

3. High gradient river-channel habitat and its connection to the floodplain is restored at the following sites: Plainwell, Otsego City, Otsego Township, and Trowbridge.

4. Expected fish community diversity is achieved as habitat becomes restored at the dam removal sites and their upriver areas of influence.

5. "Bird or Animal Deformities or Reproductive Problems" and "Degradation of Benthos" BUIs have been removed.

Facilitative and desirable actions are included separately herein.

## I. BACKGROUND

The Kalamazoo River AOC includes the river and its floodplain from Morrow Dam to Lake Michigan as well as lower Portage Creek (Figure 1). The AOC was established because of historical polychlorinated biphenyl (PCB) contamination of sediments (Kalamazoo River PAC 1998). The KRWC has worked with the Michigan Department of Environmental Quality (MDEQ) to identify criteria for eventual removal of six BUIs. Statewide criteria for removing 6 of the 8 Kalamazoo River BUIs were proposed by MDEQ, and in February 2006 KRWC concluded that these were acceptable for the Kalamazoo River AOC. MDEQ requires that the two remaining BUIs, which relate to the physical degradation of fish and wildlife habitat and related fish and wildlife population reductions, need locality-specific targets for each AOC.

**Figure 1. Kalamazoo River Area of Concern**.

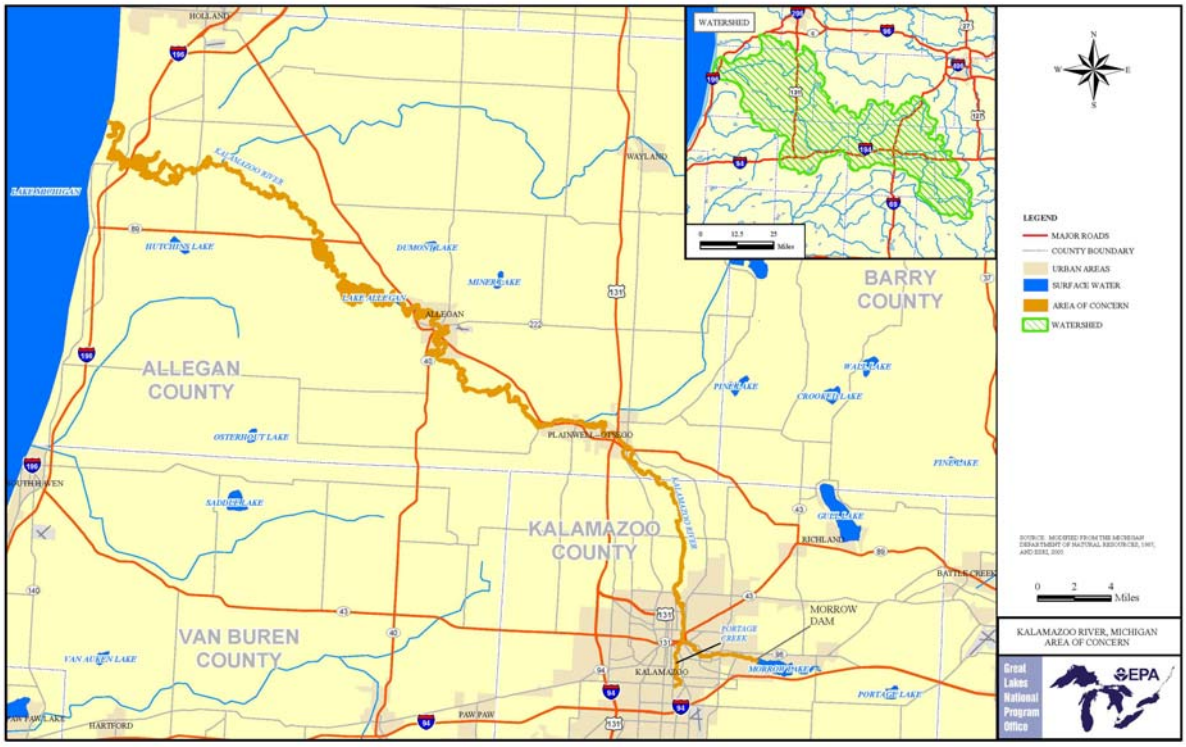



*Image Source: USEPA GLNPO AOC website, http://www.epa.gov/greatlakes/aoc/kalriv.html, last accessed February 20, 2009.*

### Development Process

With grant support from the MDEQ, KRWC staff convened several meetings between 2007 and 2009 of fish and wildlife contacts from the region. Invited parties included representatives from state and federal agencies connected with the Kalamazoo River Superfund cleanup, some technical representatives from the Natural Resource Damage Trustees agencies, and the KRWC Board of Directors. The purpose of these meetings was to discuss delisting targets for the fish and wildlife BUIs. A draft document was assembled and revised versions periodically were

made publicly available on the KRWC website. Steering committee participants (Attachment A) were solicited for reviews of the draft document. Feedback was incorporated into the final version.

This report documents locally-established targets for the restoration of the Loss of Fish and Wildlife Habitat and Degradation of Fish and Wildlife Populations BUIs in the Kalamazoo River Watershed AOC. These BUIs relate to the physical degradation of fish and wildlife habitat and related fish and wildlife population reductions. The targets identified in this plan will be incorporated into the Kalamazoo River AOC Remedial Action Plan (RAP), maintained and updated biennially by the Michigan Department of Environmental Quality (MDEQ). This is one step in a larger process, with the ultimate goal that all impairments (total of 8 for the Kalamazoo River AOC) will be restored and the AOC will be "delisted" from the list of the Great Lakes AOCs originally identified by the 1987 amendment to the Great Lakes Water Quality Agreement, Annex 2.

The required targets identified in this plan represent the minimum actions needed to remove the Loss of Fish and Wildlife Habitat and Degradation of Fish and Wildlife Populations BUIs. The Great Lakes AOC program is targeted at restoring degraded ecosystems to a level consistent with other, less-degraded, but otherwise comparable regional ecosystems. As such, efforts to go above and beyond the minimum restoration necessary to delist the AOC are identified in this plan as "desirable" and "facilitative" and are planned to be pursued or encouraged by the KRWC and/or various watershed partners.

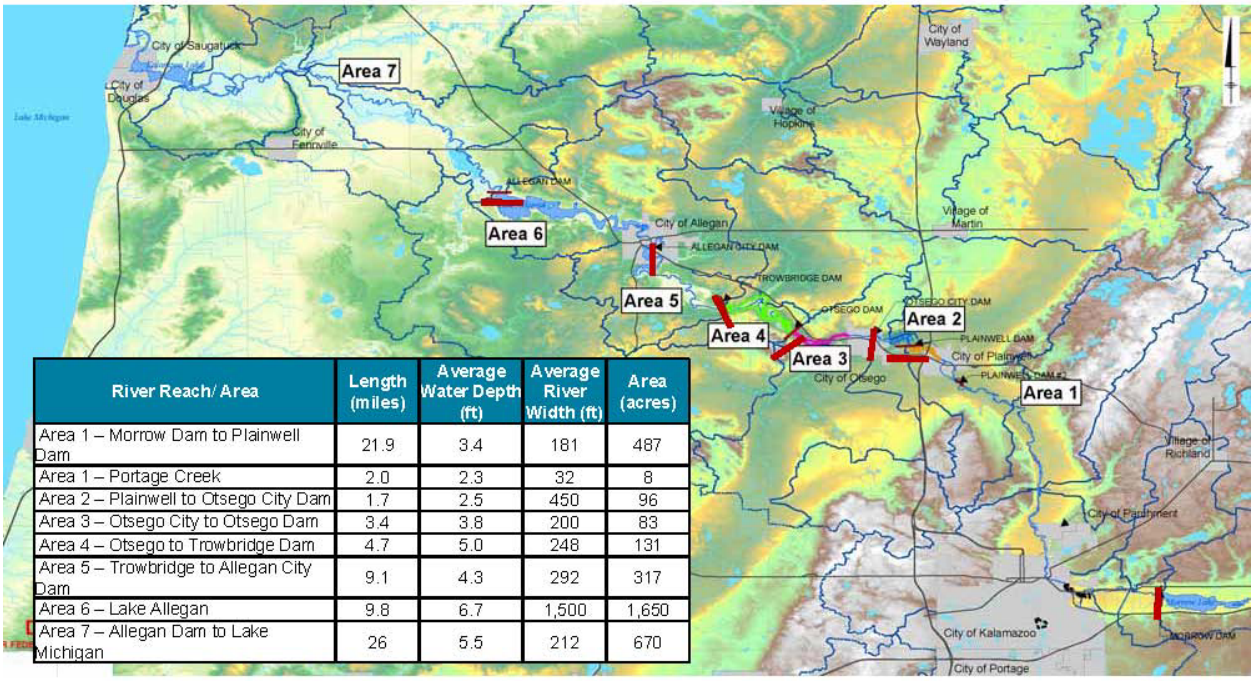
**The Future of the Kalamazoo River AOC**

The future of the Kalamazoo River AOC is heavily dependent on ongoing PCB contamination assessment, risk-based PCB cleanup level establishment, legal settlements, and PCB cleanup activities associated with the Superfund and NRDA processes. The Superfund and NRDA processes are regulatory programs with community involvement processes. These processes allow limited site specific input and influence by working groups of resource stakeholders involved in the non-regulatory programs.

Superfund parties are developing site-specific cleanup criteria, settling legal and financial issues, and implementing engineered cleanups at numerous operable units in the Kalamazoo River AOC. Many issues are unresolved, thus the amount of PCB contaminated material that will be isolated, removed, or left untouched is largely unknown. Work has proceeded in several Operable Units and a proposed schedule for remaining seven areas (see figure 2) of the mainstem of the Kalamazoo River and Portage Creek, or Operable Unit 5, was released in late 2008.

In light of this considerable uncertainty about how much uncontrolled PCB-contaminated material will be removed, consolidated and capped, or left untouched, the steering committee agreed that delisting targets presented in this document have to be general.

**Figure 2. The Seven Areas of Operable Unit 5 (The River and Portage Creek).**




| River Reach/ Area | Length (miles) | Average Water Depth (ft) | Average River Width (ft) | Area (acres) |
|---|---|---|---|---|
| Area 1 – Morrow Dam to Plainwell Dam | 21.9 | 3.4 | 181 | 487 |
| Area 1 – Portage Creek | 2.0 | 2.3 | 32 | 8 |
| Area 2 – Plainwell to Otsego City Dam | 1.7 | 2.5 | 450 | 96 |
| Area 3 – Otsego City to Otsego Dam | 3.4 | 3.8 | 200 | 83 |
| Area 4 – Otsego to Trowbridge Dam | 4.7 | 5.0 | 248 | 131 |
| Area 5 – Trowbridge to Allegan City Dam | 9.1 | 4.3 | 292 | 317 |
| Area 6 – Lake Allegan | 9.8 | 6.7 | 1,500 | 1,650 |
| Area 7 – Allegan Dam to Lake Michigan | 26 | 5.5 | 212 | 670 |

*Image Source: USEPA public presentation "Supplemental Remedial Investigations / Feasibility Studies" September 23, 2008, http://www.epa.gov/Region5/sites/kalproject/, website last accessed date February 20, 2009.*

## II. DELISTING TARGETS

The remnant dams along the river mainstem are the overriding issue with respect to fish and wildlife populations and habitat and are directly related to the PCB contamination and thus to the AOC. These dams have not been completely removed only because of concerns about the potential for remobilization of stored sediments and the PCBs contained in their impoundments (Wesley 2005). Three of these dams – Otsego City, Otsego Township, and Trowbridge – have been partly demolished and serve no function now. The removal of these mainstem dams is our primary action deemed "required" to meet our habitat and population restoration targets.

Removal of the three dams is achievable and is thus a reasonable target that will recover significant in-stream, high gradient habitat lost due to damming and impoundment sedimentation. This has been demonstrated recently with the removal of the Plainwell Dam concurrent with instream and floodplain Superfund contamination cleanup actions.

**Therefore, the fish and wildlife habitat and population BUIs will be removed when the following targets are achieved:**

1. Superfund cleanup processes are completed in the AOC at the Allied Paper Inc./Portage Creek/Kalamazoo River site.

2. Dams are removed at the following sites: Plainwell (completed in 2009), Otsego City, Otsego Township, and Trowbridge (removal of these dams is linked to the PCB contamination because of the need to deal with contaminated sediments behind them).

3. High gradient river-channel habitat and its connection to the floodplain is restored at the following sites: Plainwell, Otsego City, Otsego Township, and Trowbridge (this would be achieved through removal of the aforementioned dams and restoration of the associated habitat).

4. Expected fish community diversity is achieved as habitat becomes restored at the dam removal sites and their upriver areas of influence (see model in Attachment B.).

5. "Bird or Animal Deformities or Reproductive Problems" and "Degradation of Benthos" BUIs have been removed. See the *Guidance for Delisting Michigan's Great Lakes Areas of Concern* (MDEQ, 2008) for details.

Removal of the Loss of Fish and Wildlife Habitat and Degradation of Fish and Wildlife Populations BUIs will be based on achievement of full implementation of regulatory and non-regulatory remedial actions, including monitoring conducted according to site plans, and showing consistent improvement in quantity or quality of habitat or populations addressed in the targets. Habitat values and populations need not be fully restored prior to delisting, as some may take many years to recover after actions are complete.

The continued presence of the three dams targeted for removal degrades fish and wildlife habitat and populations in several ways. MDNR's Kalamazoo River Assessment (Wesley 2005) describes how the impoundments behind these dams inundate reaches that originally had relatively high gradients and groundwater inputs. A coupled hydrological-ecological model that predicts conditions for fish habitat showed how restoration of a free-flowing river in these reaches would create favorable habitat for a natural fish community, including a number of species that were historically present in the river but are now uncommon or absent (Attachment B).

Remedial actions coupled with dam removals will lead to the removal of two additional Kalamazoo River BUIs: 1) Bird or Animal Deformities or Reproductive Problems; and, 2) Degradation of Benthos. When the targets for removal of these BUIs have been met, terrestrial and riparian wildlife community health is expected to improve as food chain contamination declines. See "*Guidance for Delisting Michigan's Great Lakes Areas of Concern* (MDEQ, 2008) for BUI removal guidelines, and see "*The Michigan Department of Environmental Quality Biennial Remedial Action Plan Update for the Kalamazoo River Area of Concern* (MDEQ, 2009) to track progress toward all Kalamazoo AOC BUI removals.

A free-flowing river in these reaches also could serve as a spawning habitat for sturgeon that inhabit Lake Michigan (gravid females would have to be translocated or provided passage through a fish ladder from the lower reaches of the river because they could not ascend beyond Calkins Dam, Allegan City Dam, or likely the Plainwell Diversion and Mill Race Dams). Numerous other fish and wildlife species would benefit from a restored river, including river otters, bald eagles, and mussels. We consider that in this case the fish and wildlife population and habitat BUIs can be addressed as a single problem with a joint solution; once habitat is restored, populations should be able to recover.

Removal of these impoundments would bring other benefits as well. Reid and Hamilton (2007) provided evidence that they allow algae to reach high abundances by increasing water residence time, and this exacerbates the problems with excessive algal growth downstream in Lake Allegan, which has necessitated a phosphorus Total Maximum Daily Load reduction effort. Free-flowing reaches upstream of Plainwell actually removed algae from the water, most likely through the action of invertebrate consumers that filter algae from the river water. Occasional problems with ice dams and property damage from flooding in the City of Allegan also likely are related to the presence of impounded areas upstream that generate large amounts of ice. Ongoing risk of dam failure, coupled with an increase in storm runoff intensity due to climate change, will be addressed through removal of these documented, "at risk" dams. Finally, removal of these impoundments would improve the safety of the river environment for increasing numbers of boaters and anglers rediscovering the recreational values of the river.

Three significant impoundments would remain in the Kalamazoo River AOC: 1) Allegan City Dam, which is owned by the city; 2) Morrow Dam, which forms a lake that is not part of the AOC or Superfund Site; and 3) Calkins Dam, which forms Lake Allegan and generates a modest amount of hydroelectricity. The latter two are not thought to be "on the table" for removal. Removal of Allegan City Dam entails the same contaminated sediment challenges and would bring the same kind of ecological benefits, but that dam is considered desirable by the local community to maintain a ponded area along the downtown waterfront, and there is ongoing discussion about retrofitting that dam to generate hydropower. Lake Allegan is a much larger reservoir that has trapped most of the PCBs that are in the river system, and it is valued for riparian lakefront property and recreational uses, all of which make its removal unlikely even if the hydroelectric facility no longer functioned. Another small dam in the AOC is the Plainwell Diversion Dam, but it does not create much impounded backwater, nor is it likely to have accumulated much sediment, though sampling is underway in the impounded area as a part of the Operable Unit 5 (OU5), Area 1, Superfund supplemental sampling efforts.

## Scope of Work

Table 1 provides a general scope of work for the proposed delisting targets. Considering the uncertainties involved in decision making processes and timetable, many of the details are unknown and will be updated as the work progresses.

**Table 1. Kalamazoo River Area of Concern Fish and Wildlife Beneficial Use Impairment Removal Targets**

| Delisting Target | Timetable | Funding | Parties with Interest | Indicators and Monitoring | Evaluation Process | Public Involvement |
|---|---|---|---|---|---|---|
| #1) CERCLA (Superfund) risk assessments and cleanup processes are completed at the site | Unknown | PRPs | All | Decisions and actions taken | River "Areas" and Operable Units delisted from CERCLA | CERCLA public involvement |
| #2) Dams are removed at the following sites: Plainwell, Otsego City, Otsego Township, and Trowbridge | Dam removal is complete at Plainwell; others should be removed during or following CERCLA contaminant removal actions | PRPs, NRDA, MDEQ, MDNR, AOC programs | EPA, MDEQ, MDNR, NRDA Trustees, &/or Dam Owner | Dam removed | Observation and target #4 | CERCLA public involvement; KRWC network; AOC program |
| #3) High gradient habitat is restored instream at these sites | Restoration work will follow dam removal; work is nearly complete at Plainwell | PRPs, NRDA, MDEQ, MDNR, AOC programs | USEPA, MDEQ, MDNR, NRDA Trustees | Construction complete | Observation and MDEQ Procedure 51, if applicable | CERCLA public involvement; KRWC network; AOC program |
| #4) Expected fish community diversity is achieved at dam removal sites | Monitoring will occur pre- and post dam removal and habitat restoration and continue until expected diversity achieved | PRPs, NRDA, MDEQ, MDNR, AOC programs | USEPA, MDEQ, MDNR, NRDA Trustees | See Attachment B | See Attachment B | CERCLA public involvement; KRWC network; AOC program |
| #5) "Bird or Animal Deformities or Reproductive Problems" and "Degradation of Benthos" BUIs have been removed | As determined by Agencies | MDEQ, USEPA | All | See DEQ Guidance (MDEQ, 2008) | See DEQ Guidance (MDEQ, 2008) | AOC program |

## Future Assumptions

The KRWC fully expects that the ongoing Superfund process will result in the removal or isolation of PCBs from the river environment and food chain. We expect that the Superfund process will reduce water column, sediment, floodplain, and food chain PCB concentrations below state and federal actionable levels to the extent that the Kalamazoo River will again be fishable and will not inhibit wildlife reproduction and development any more than an average Michigan river. We also expect that long-term monitoring will occur associated with these cleanup programs and data will be available to KRWC and the public at reasonable intervals. In addition we expect that the NRDA Trustees will work to integrate their stated restoration principles into ongoing remedial efforts. Finally, we expect that all naturalized riparian lands currently held by the State of Michigan will remain in the public trust with uses restricted by deed depending on the degree of contamination and anticipated land use.

Removal of the fish and wildlife BUIs will be considered complete when the natural conditions (hydrology and geomorphology) are restored by removal of the dams, and the restoration of the riparian zone has been implemented to create the conditions amenable to natural ecological succession towards riparian, wetland and floodplain vegetation. Channel geomorphology should become restored in time by natural fluvial dynamic processes. Ultimately, the desired goal is restoration of aquatic and riparian habitat and fish and wildlife populations, but we recognize that this may take many years after the habitat restoration trajectory is established, and we propose that delisting need not await full ecological restoration. Fish community diversity is a good metric for restoration of in-stream habitat. Coupled hydrological-ecological models can demonstrate the target (reference) condition for in-stream fish habitat in a particular reach.

## Progress to Date

KRWC feels that several important things happened in the midst of this target setting exercise. First, the Plainwell Dam was removed. Second, NRDA Trustees are communicating their activities with the public to the extent they are able and encouraging feedback from stakeholders. Further progress will be reported in future RAP updates.

## The Benefits of Collaboration

The KRWC intends to work to bring together available state and federal agency input to enhance or take the next steps beyond remedial actions implemented by the Superfund parties. We will also work to commit community funders to dam removal projects to further encourage Superfund parties to invest settlement dollars in coupled dam removal and impoundment cleanup at an accelerating rate. Examples of potential AOC specific monies include, but are not limited to:

- State bond monies (current or future CMI)
- Great Lakes Legacy Act funding under USEPA
- United States Army Corps of Engineers AOC programs
- National Oceanic and Atmospheric Administration, United States Fish and Wildlife Service, and other AOC habitat programs

- Great Lakes Regional Collaboration (or Initiative) Implementation funding
- United States Environmental Protection Agency Great Lakes National Program Office funding for AOCs

## III. BEYOND DELISTING TARGETS

Additional habitat actions need implementation in the river valley and watershed that go beyond the minimum for BUI removal. Actions include: 1) naturalized corridor recovery to replace that lost to permanent disposal facilities; 2) improved public involvement strategies; and, 3) other site specific projects.

The KRWC highly recommends naturalized corridor recovery as a preferred habitat recovery action. PCBs at or near paper mills, landfills, riverside lagoons, and in the paper mill waste stream left both consolidated, managed concentrations of waste and dispersed waste across floodplains and in existing sediment. The Superfund process has already produced several final decisions at Operable Units along the mainstem of the Kalamazoo River where contaminated materials will be stored and managed in perpetuity. Despite the intention of landowners and oversight agencies to manage these facilities as naturally as possible, the KRWC believes these areas will never serve as fully functional, connected river corridor riparian zones, floodplain or wetland. Thus, the KRWC identified a potential investment opportunity that could serve to recapture lost floodplain functions (see Table 2.). KRWC advocates that permanent acreage lost to floodplain landfills should be replaced by permanently acquired or protected functional floodplain or wetland at a suggested ratio of 1 acre floodplain or wetland lost to landfill to 2 acres acquired or protected (e.g., conservation easement). The basis for the 1:2 ratio is the use in state wetland mitigation as described at http://www.michigan.gov/deq/0,1607,7-135-3313_3687-86447--,00.html.

**Table 2. Naturalized corridor recovery strategy to replace that already lost to (or threatened by) permanent waste storage facilities in the 100 year floodplain of the Kalamazoo River Valley.**

| Permanent storage facility | Acreage lost (footprint) | Habitat loss to replacement ratio; and acreage replaced to date |
|---|---|---|
| A-Site | 22 acres[1] | 1:2; none |
| Willow Blvd | 11 acres[1] | 1:2; none |
| Allied Site | 89 acres total; 22 acres capped[2] | 1:2; none |
| King Highway | 23.2 acres[1] | 1:2; none |
| 12th Street | 6.5 acres[1] | 1:2; none |
| Plainwell Mill | unknown | 1:2; none |
| Future 100-y floodplain site | none | 1:5; none |

**[1]Site Record of Decision, approximate acreage**
**[2]Remedial Investigation**

The second facilitative action beyond fish and wildlife targets is to ensure necessary public and Watershed Council involvement, given the watershed communities' reliance on ongoing negotiations, settlements, and decisions made by Superfund parties and the integrated NRDA processes (Table 3). Work on the river is accelerating now, but will likely take years to decades, thus better defined pathways for public involvement and information exchange are necessary so that all parties can communicate restoration expectations, opportunities, goals, and available funding sources. There are numerous groups working in the watershed on restoration and protection issues, and we feel that this should be recognized, and that the KRWC can assist in serving as a conduit of information between parties including the public, subwatershed work groups, municipal partners, advocacy groups, and pollution prevention and cleanup agencies (including Superfund and NRDA Trustees).

Additional projects identified in the planning process are listed in Table 3; these were considered desirable but may not be achievable directly through the Superfund or NRDA processes.

**Table 3. Kalamazoo River Area of Concern Fish and Wildlife Habitat Facilitative and Desirable Habitat Actions (listed in random order)**

| **Facilitative Actions** | **Brief Description** | **Benefit; additional benefit** |
|---|---|---|
| *1) Watershed Stakeholder Liaison Organization* | Kalamazoo River Watershed Council recognized public advisory liaison; scheduled information exchange with all parties about potential Area of Concern investments and cost share opportunities (e.g., Operable Unit 5 Task Force) | Improved public involvement |
| *2) Kalamazoo River Watershed Trust Fund - Habitat Component* | Settlement monies held in trust for future habitat related watershed investments. Funds could provide local match for outside grants | Sustainable funds for annual improvements |
| *3) Integrated Habitat and Trails Plan* | Plan needed to balance preserved natural corridor areas with paved land trails and recreational water trails | Balanced public access and undisturbed natural areas |
| | | |
| **Desirable Actions** | **Brief Description** | **Benefit; additional benefit** |
| *1) Disposal Site Footprint Mitigation* | Replace riparian habitat lost to permanent riverside disposal facilities by securing uncontaminated corridor habitat (See Table 2) | Continuous river/genetic riparian corridor consistent with MDNR and Trustee goals |
| *2) Performance Paper Site* | Remove concrete armoring, contamination, and debris for stream restoration | Improved benthic habitat; provide passage to paddlers |
| *3) Bryant Millpond Dam* | Remove remaining dam sill and restore channel under road culvert | Improved benthic habitat, recovered high gradient stream habitat, and provide fish passage over partial barrier; provide passage to paddlers |
| *4) Monarch Millpond Dam* | Remove dam and manage reservoir sediment, restore channel through drained impoundment | Recovered high gradient stream habitat; provide passage to paddlers |
| *5) Milham Park Dam Removal* | Remove dam and associated sedimentation; restore channel through drained impoundment | same |
| *6) Portage Creek/Milham* | Remove reported low head barrier | same |
| *7) Allegan City Dam* | Prefer dam removal; minimally create safe recreational and ecological passage; city interests in hydro and elevation noted | same |
| *8) Calkins Dam* | Create fish passage structure or program; establish removal trust fund | Fish passage; sustainable dam removal or repair funding |
| *9) Plainwell Diversion Dam* | Prefer dam removal; minimally create safe recreational and ecological passage; city interests in mill race hydro and elevation noted | Recovered high gradient stream habitat; provide passage to paddlers if removed |

**Table 3 cont**

| **Desirable Action Item** | **Brief Description** | **Benefit; additional benefit** |
|---|---|---|
| *10) A-site Sheet Pile* | Re-engineer sheet pile wall for soft engineered riparian connection; reduce footer sheer; increase floodplain connectivity for riparian species | Improved fish and wildlife habitat |
| *11) Willow Blvd. Perimeter Barrier* | Bioengineer barrier and prevent footer sheer | Improved fish and wildlife habitat |
| *12) King Highway Sheet Pile* | Re-engineer sheet pile wall for soft engineered riparian connection; reduce footer sheer; increase floodplain | Improved fish and wildlife habitat |
| *13) Mill Creek Reservoir Area* | Remedial investigation of suspected sediment contamination | Determine if contamination settled in former backwater area |
| *14) Kalamazoo Lake, River Mouth* | Secure AOC designated dollars for contaminant assessment | Accelerated decision making and sediment remediation |
| *15) Relocate Mussels - All Active Remediation Sites* | Relocate mussel populations pre- or post remedial activities | Prevent local catastrophic losses associated with river remediation |

## REFERENCES

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Michigan Department of Environmental Quality. 2008. *Guidance for Delisting Michigan's Great Lakes Areas of Concern*. Report MI/DEQ/WB-06/001.

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## Attachment A: Steering Committee

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## Attachment B: Modeling Exercise – Fish Community Targets and Monitoring Recommendations

Specific targets, monitoring, and evaluation processes for delisting impairments to fish and wildlife populations are needed. The conclusions and recommendations as requested by the stakeholders are provided here for fish and freshwater mussels, with notes on aquatic insects as resources for fish.

To make informed decisions regarding the repair, removal, or modification of dams that are publicly owned, river managers and public stakeholders require information on the effects that these structures may have on river ecosystems. Dams alter riverine environments by converting lotic habitat to lentic (Martinez et al. 1994), creating physical barriers (Winston et al. 1991), altering temperature and flow regimes (Bain et al. 1988), and disrupting sediment transport and nutrient cycling processes (Ward and Stanford 1983). Consequently, dams change the fish species composition, limit the distributions of species, and block fish migrations. Where dams degrade riverine habitats through fragmentation, sedimentation, and reduced water quality, dam removal would result in reconnected habitats, restored substrates, and improved water quality. Sensitive riverine taxa would replace tolerant habitat generalists in formerly impounded reaches. Reconnected upstream and downstream reaches allow species to expand their upstream spatial distributions at the valley segment scale.

*Modeling to predict habitat restoration targets*

Decision support tools that include quantitative fish density and optimal habitat conditions are useful to establish reference fish population targets. Habitat suitability index models relating fish density to habitat have been synthesized for Lower Michigan streams (Zorn et al. 2006). The spreadsheet model for characterizing suitability of sites for species included three variables. Catchment area (or CA) was used as a correlate of discharge and an index of stream size rather than stream order or width. The use of catchment area is well known in the literature for distinctions between biotic zones in streams that have been attributed to various factors often changing predictably in a downstream direction (Hynes 1970). Low-flow yield, defined as 90% exceedence flow divided by catchment area, is a measure of groundwater contribution to streams and an index of important parameters such as stream temperature, hydrologic stability, and current velocity. It is a measure of the level of groundwater loading to the stream, reaching its highest levels in basins with highly permeable soils and steep topography (Hendrickson and Doonan 1972). Summer temperature (July mean) is one of the major factors affecting growth (Brett 1979), survival (Smale and Rabeni 1995a), and distribution of fish (Magnuson et al. 1979; Smale and Rabeni 1995b; Lyons 1996; Wehrly et al. 2003; Zorn et al. 2004) throughout the Midwest. Zorn et al. (2006) developed a spreadsheet model that describes how close conditions of a site are to what is optimal for 68 common fishes in Michigan Rivers. Fish density data by species were standardized (Z-distribution, mean = 0, SD = 1). Sites were selected where a fish species was relatively abundant (z-score > 0.75), hereafter referring to them as “optimal” sites, and the mean and standard deviation were computed for their LFY, CA, and mean July temperature values. The spreadsheet model assigns a score to a site based upon variance-based comparisons of the site’s LFY, CA, and July temperature average conditions with “optimal” LFY, CA, and mean July temperature values for each species. The site receives a 4, 3, 2, or 1 score if its values are within 0.5, 1.0, 1.5, or 2.0 standard deviations of the optimal values for a

species; a 0 score is given if the site's value is more than 2.0 standard deviations from the species' optimal value.

The spreadsheet model provides a simple tool with many potential uses. Managers having the requisite physical data can use it to predict the type of fish assemblage that might be expected at a site. Such predictions might be useful when little or no fish survey data are available, and would provide benchmarks for comparison with future surveys. Managers can also explore how the fish assemblage at a site might change by management actions by changing values for key parameters such as temperature. For example, rough projections of effects of dam removals (i.e., increased LFY and/or decreased temperature) on a particular site's suitability for different fishes could be assessed this way. Changing catchment area values can provide managers with some sense of how the fish assemblage may change at locations upstream or downstream of a site.

*Restoration of fish habitat in the lower Kalamazoo River*

The Kalamazoo River reach (Morrow Dam downstream to Allegan Dam, Figure 1) represents a large stream size with catchment area ranging from 1,000 to 1,500 $mi^2$, moderate low flow yields from 0.38 to 0.49 cubic feet per second per square mile ($cfs/mi^2$), and warm July mean temperatures from 73.0 to 79.5 $^oF$ with the higher average temperatures influenced by the effects of impounded water (Table 1). Free-flowing areas in the Kalamazoo River have higher species richness, substantially higher overall and harvestable-sized sport fish abundance, and more sucker species. Impounded areas have higher Centrarchid species abundance and notably lower species richness and assemblage structure. While much of the Kalamazoo River fish assemblage remains similar to earliest historical records (Wesley 2005, Table 2), the loss of the lake sturgeon *Acipenser fulvescens* is a notable change resulting from habitat loss and fragmentation. Additional localized absences of northern hogsucker *Hypentelium nigricans*, channel catfish *Ictalurus punctatus*, stonecat *Noturus flavus*, several redhorse *Moxostoma* species, and other migratory fishes have occurred in the impounded reaches upstream of dams.

Freshwater Mussels are an important ecological component to the Kalamazoo River. Tailwater areas and free-flowing sites have higher relative abundance and extant species richness and lower percent missing species than impounded sites. In addition to the rehabilitation of fish species, it has been noted that freshwater mussel distribution may also be limited by the lack of fish passage at dams. Freshwater mussels require fish hosts for the dispersal of juvenile life stages and the lack of upstream fish passage has significantly reduced the diversity of mussel species above each dam when compared to mussel diversity below each dam. The provision of free fish passage should increase mussel diversity in the Kalamazoo River.

Mussel beds in the tailwater areas could be subjected to high mortality during dam removal projects from the transport and deposition of impoundment sediments. Therefore, while benefits of the dam removal will include fish passage and restoration of lotic habitats in the upstream reaches, these habitat changes will come about at some cost to the local mussel community. Pre-removal assessments of potential ecological impacts of dam removal and appropriate mitigation efforts should be included in the dam removal process to reduce short-term negative ecological effects of this restoration action.

*Indicators and evaluation process for Kalamazoo River habitat restoration*

The Kalamazoo River within the Area of Concern is not designated as a coldwater trout stream and it is not expected to produce a trout fishery with removal of dams. Fish community assemblage as predicted by the habitat suitability model for the Kalamazoo River at Plainwell is given in a species optima table. Low composite scores for individual fish species were observed because this area of the Kalamazoo River has lower temperatures and higher low-flow yields than other Michigan rivers with similar catchment size.

Within 2 years of habitat restoration, fish and macro-invertebrate assemblages in formerly impounded reaches should not significantly differ from those in either the upstream reference site or in other un-impounded reaches below the dam site. All un-impounded sites should be characterized by lotic taxa such as net-spinning caddisflies and heptageniid mayflies regardless of their impoundment history. All un-impounded sites should be characterized by fish species diversity values ranging from 22 to 26 or higher at downstream sites with larger catchment size. Adfluvial fish species should not be included in the total number of species taxa representing the community structure. Fish assemblage structure should have representative species as identified in Table 3 from each of the group associations. Freshwater mussels should maintain extant species richness numbers compared to tailwater area conditions prior to dam removal. Fish community surveys following MDNR-Fisheries Division non-wadable stream protocol should be conducted every 2 and 5 years as an assessment tool to measure progress toward delisting. This protocol includes a single pass using a boat electrofisher along the same river bank for a distance of 0.5 mile. Coarse scale assemblage metrics to consider include IBI, species richness, percentage of tolerant species, and number of species per guild type. Changes to these metrics should be compared to changes observed at a reference site.

Within 5 years of habitat restoration sportfish standing crop (number per acre) should be similar to reference estimates within free flowing reaches of the river. Sport fish should have a stable declining size structure. Freshwater mussel distribution should indicate higher relative abundance of mussels within the former impounded areas or at optimal habitat suitability sites upstream from former dam location. Ecological restoration may take many years (>10 years) after the habitat restoration trajectory is established and we propose that delisting need not await full ecological restoration.

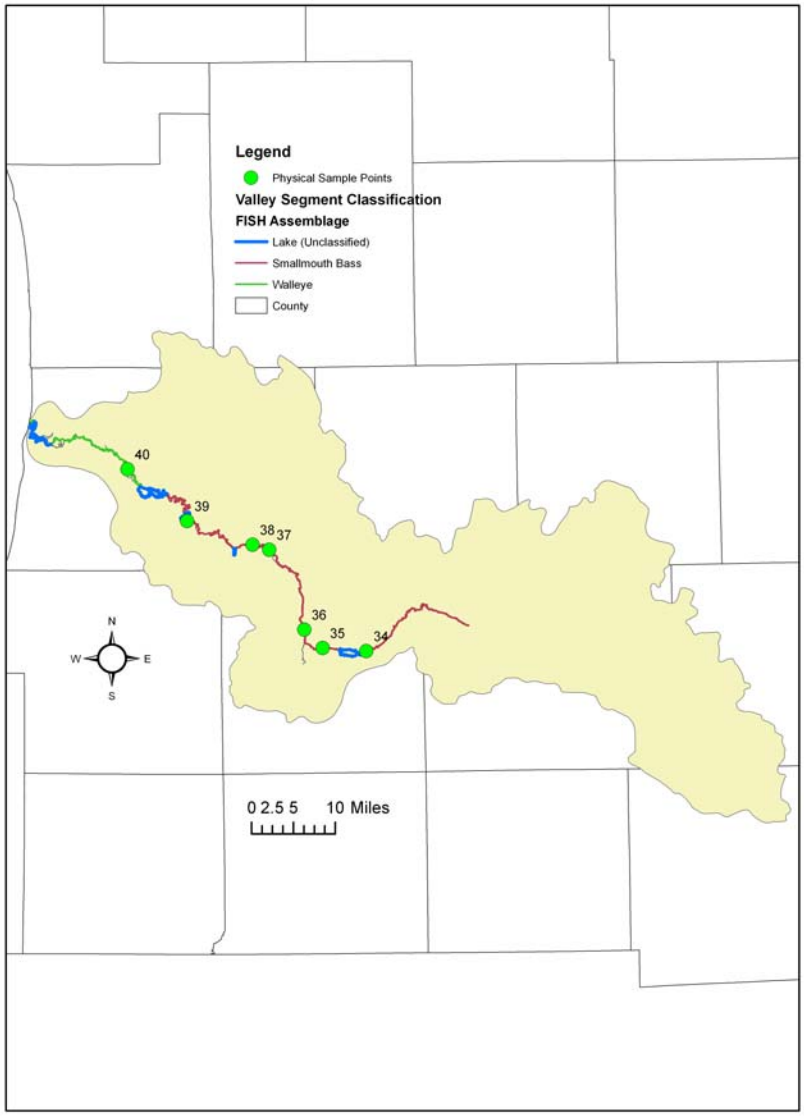


**Figure 1. Valley Segment classification and fish assemblage structure of the Kalamazoo River Area of Concern. Details of the physical sample points are provided in Table 1.**

**Table 1. Location, catchment area, low-flow yield, and July temperature data for sites with fish density estimates in the Kalamazoo River Area of Concern.**

| SITE | WATERSHED | STREAM | LOCATION | LAT. | LONG. | CA ($mi^2$) | LFY ($cfs/mi^2$) | July Mean (F) | July range (F) |
|---|---|---|---|---|---|---|---|---|---|
| 34 | Kalamazoo | Kalamazoo | Galesburg | 42.2802 | -85.4294 | 991.1 | 0.4554 | 76.1 | 8.7 |
| 35 | Kalamazoo | Kalamazoo | SprinkleRd | 42.2858 | -85.5307 | 1035.9 | 0.3882 | 79.5 | 7.6 |
| 36 | Kalamazoo | Kalamazoo | MoselAve | 42.3178 | -85.573 | 1137.4 | 0.4748 | 77.5 | 9 |
| 37 | Kalamazoo | Kalamazoo | Hwy131 | 42.4544 | -85.6538 | 1241.3 | 0.4985 | 74.5 | 5 |
| 38 | Kalamazoo | Kalamazoo | OtsegoDam | 42.4633 | -85.6922 | 1466 | 0.4872 | 77.5 | 9.8 |
| 39 | Kalamazoo | Kalamazoo | BridgeSt | 42.5046 | -85.8446 | 1528.5 | 0.4475 | 72.9 | 10.4 |
| 40 | Kalamazoo | Kalamazoo | M89 | 42.5937 | -85.9834 | 1630.8 | 0.4332 | 76.1 | 9.9 |
| 41 | Kalamazoo | Kalamazoo | 57thSt | 42.6513 | -85.1066 | 1951.7 | 0.363 | 75 | 7.9 |

**Table 2. Fish assemblage, taxonomic group, and species diversity of the Kalamazoo River Area of Concern. Asterisks by the species name indicates optimal fish species targets within the AOC.**

| Group # | Taxonomic group | Species | Scientific name |
|---|---|---|---|
| 1 | Cyprinids | Spotfin shiner * | *Cyprinella spiloptera* |
| | | Common shiner * | *Luxilis cornutus* |
| | | Striped shiner * | *Luxilis chrysocephalus* |
| | | Redfin shiner | *Lythrurus umbratilis* |
| | | Golden shiner | *Notemigonus crysoleucas* |
| | | Rosyface shiner* | *Notropis rubellus* |
| 2 | Minnows | Bluntnose minnow * | *Pimephales notatus* |
| 3 | chubs and stoneroller | Central stoneroller | *Campostoma anomalum* |
| | | Creek chub * | *Semotilus atromaculatus* |
| | | Hornyhead chub * | *Nocomis biguttatus* |
| 4 | Carp and goldfishes | Common carp | *Cyprinus carpio* |
| 5 | suckers and redhorses | Quillback | *Carpoides cyprinus* |
| | | White sucker * | *Catostomus commersoni* |
| | | Northern hog sucker* | *Hypentelium nigricans* |
| | | Spotted sucker | *Minytrema melanops* |
| | | Silver redhorse * | *Moxostoma anisurum* |
| | | Black redhorse * | *Moxostoma duquesnei* |
| | | Golden redhorse * | *Moxostoma erythrurum* |
| | | Shorthead redhorse * | *Moxostoma macrolepidotum* |
| | | Greater redhorse * | *Moxostoma valenciennesi* |
| 6 | catfishes | Yellow bullhead | *Ameiurus natalis* |
| | | Channel catfish * | *Ictalurus punctatus* |
| | | Stonecat * | *Noturus flavus* |
| | | Tadpole madtom * | *Noturus gyrinus* |
| 7 | pikes | Grass pickerel | *Esox americanus* |
| | | Northern pike * | *Esox lucius* |
| 8 | Centrarchids | Rock bass * | *Ambloplites rupestris* |
| | | Green sunfish | *Lepomis cyanellus* |
| | | Bluegill | *Lepomis macrochirus* |
| | | Smallmouth bass * | *Micropterus dolomieu* |
| | | Largemouth bass | *Micropterus salmoides* |
| | | Pumpkinseed | *Lepomis gibbosus* |
| | | Black crappie | *Pomoxis nigromaculatus* |
| 9 | Percids | Walleye * | *Stizostedion vitreum* |
| | | Logperch * | *Percina caprodes* |
| | | Blackside darter * | *Percina maculata* |
| | | Greenside darter * | *Etheostoma blennioides* |
| | | Rainbow darter * | *Etheostoma caeruleum* |
| | | Johnny darter * | *Etheostoma nigrum* |

**Table 3. Statistical fish species associations represented in the Kalamazoo River Area of Concern. Names in bold are the dominant species represented in the group association.**

| | | | |
|---|---|---|---|
| 1 | **smallmouth bass**<br>black redhorse<br>striped shiner<br>river chub<br>northern hog sucker<br>Stonecat<br>greenside darter | **rosyface shiner**<br>yellow perch | **logperch**<br>brook silversides<br>mimic shiner<br>sand shiner<br>shorthead redhorse |
| 2 | **Walleye**<br>channel catfish<br>spotfin shiner | **golden redhorse**<br>greater redhorse<br>silver redhorse | **freshwater drum**<br>quillback carpsucker<br>qizzard chad |
| 3 | **tadpole madtom**<br>spotted sucker<br>Bowfin<br>common carp<br>flathead catfish<br>black crappie | | |