Wisconsin Department of Natural Resources
Office of the Great Lakes
Areas of Concern Grant
2013

Summary of projects included in grant:

Project Title	AOC	Year 1 GLRI Request	Year 2 GLRI Request	Year 3 GLRI Request	Budget categories	Page #
Wildlife Population Assessment	Milwaukee Estuary	$120,000	$120,000	$65,000	Contractual - Milwaukee County Parks; Contractual - Private Contractor	2
Fish Population Assessment	Milwaukee Estuary	$149,500	$56,250	$56,250	Contractual – USGS Contractual – Ozaukee County	11
Identification and quantification of sanitary sewage contamination in the Milwaukee Estuary AOC (Bacteria Source Tracking)	Milwaukee Estuary	$235,089	$267,137	N/A	Contractual - UW-Milwaukee	14
The Little Menomonee Parkway Grassland Restoration Project	Milwaukee Estuary	$37,000	N/A	N/A	Contractual - Milwaukee County Parks	25
Assessment of Benthos and Plankton in Wisconsin's Lake Michigan Areas of Concern	Lake Michigan AOCs & comparison rivers, plus add'l Green Bay sites	$244,306	$169,951	N/A	Salary/personnel – WDNR Science Services; Contractual - USGS	28

2013 Grant total request	$785,895

Blue shading indicates projects for which incremental funding is requested (i.e., 2013 project proposal is written as a multi-year project but we are only requesting the first year of funding at this time; anticipate amending the grant in 2014 to accept subsequent years' funding).

WDNR Office of the Great Lakes AOC Grant 2013

Project Title: Milwaukee Estuary Area of Concern Wildlife Population Assessment

Project Applicant: WDNR

Organization Name: Office of the Great Lakes, Wisconsin Department of Natural Resources

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Person responsible for reporting: Marsha Burzynski

Project Location: Milwaukee Estuary AOC

Project Summary:

This proposal is for work to advance the Milwaukee Estuary AOC Fish and Wildlife Habitat Plan. The assessment is a necessary preliminary step in prioritizing habitat restoration projects in the AOC, especially for wildlife. The project area is home to a wide diversity of wildlife occupying a densely urban setting, with more than 50 species listed by the State as Endangered, Threatened, or Special Concern. This wildlife assessment will establish baseline inventories and knowledge so that future changes in biodiversity can be monitored – it will provide the needed science behind the habitat planning.

Work will build upon data mining activities begun prior to this funding, looking at historical and recent sources, new biotic surveys (e.g., mussels, fish, amphibians, reptiles, birds, mammals, etc.), species and habitat assessments, mapping and reporting. Data mining for year 2 will include collection of historical data from museum and agency records, the literature, recent surveys, and data from local naturalists that was not part of the earlier effort. Surveys will target species with sparse data, with appropriate seasons and methods for sampling, such as spring ephemeral ponds and calling frog surveys, June breeding bird surveys, late summer and fall mammal and mussel surveys, spring and fall migratory bird surveys, and invasive species surveys.

This project will lead to identification of specific projects that, once implemented, will remove the wildlife component of the Degraded Fish and Wildlife Populations impairment for the Milwaukee AOC. The Milwaukee Estuary Fish and Wildlife Technical Team is developing evaluation methods for

measuring project success, and this project is necessary to continue the development of wildlife-related goals and measures.

Project Location:
The project area is defined as the Milwaukee County portions of the Milwaukee, Menomonee, and Kinnickinnic Rivers, including Lincoln Creek, Little Menomonee River, and selected sites within the Milwaukee Estuary. The assessment work will evaluate the entire AOC, while surveys will focus on areas where baseline information is not available. The project will utilize existing data from other ongoing assessments, such as the Milwaukee River Greenway Coalition habitat planning and assessment underway from North Ave. to Silver Spring Rd. A half-mile buffer around the rivers will define the lateral limits of the study area. Using a half-mile buffer for data collection and planning purposes is necessary to evaluate species that are very mobile, such as birds, and/or those species with large habitat area requirements that may act as source populations for restorations adjacent to the rivers and be important for evaluating habitat connectivity goals. Specific restoration projects recommended for addressing Beneficial Use Impairments will have a direct ecological connection to the stream.

Problem Statement and Rationale:

> "*Much of current conservation practice is based upon anecdote and myth rather than upon the systematic appraisal of the evidence, including experience of others who have tackled the same problem.*" – Sutherland et al. 2004

Loss of fish and wildlife habitat is one of eleven Beneficial Use Impairments (BUI) identified in the Milwaukee Estuary Area of Concern (Wisconsin DNR 1991, SEH and ECT 2008). This BUI addresses Wilson's Law: "*If you save the living environment, you will automatically save the physical environment. But if you only try to save the physical environment, you will lose them both."* (Wilson 2009). E. O. Wilson, the influential scholar and two-time Pulitzer Prize winner, argues that the public clearly understands the need for addressing physical environmental problems, such as air and water quality, but that we are not making the headway we should be in preventing the destruction of ecosystems and species, the living environment, where a major mass extinction event is well underway (Leitner et al. 2008, Barnosky et al. 2011). This, despite mounting evidence that preservation of ecosystems, and interaction with nature, is essential for human health and well-being, as so eloquently articulated in Richard Louv's book *Last Child in the Woods: Saving Our Children From Nature-Deficit Disorder* (Louv 2008).
The latest International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Vié et al. 2009) reveals the extent of the ongoing global species extinction crisis, with 16,928 species threatened with extinction. The number of threatened species (as a percent of species evaluated) includes 21% of mammals, 12% of birds, 31% of reptiles, 30% of amphibians, and 37% of fishes - and that's only vertebrates. Preservation and restoration of ecosystems is essential for maintaining the life support systems and natural resources we depend upon for survival. The Wisconsin extinction crisis was addressed in the recent publication *The Vanishing Present: Wisconsin's Changing Lands, Waters, and Wildlife* (Waller and Rooney 2008). Chapters on the status of Milwaukee County amphibians, reptiles, breeding birds, and flora are directly relevant to the Milwaukee Estuary AOC impairment of wildlife habitat loss/degraded populations. These studies detail county-level species losses of 44%, 47%, 37%, and 37%, respectively, due largely to habitat loss and degradation, including the transformation of habitats by invasive species. This proposal begins to address these losses of species richness through

habitat restorations and enhancements. Subsequent repatriation of species to establish functional communities may be necessary.
To properly address the removal of this BUI, it is essential to address the ecosystem as a whole—the physical and living environment, and how they interact. Moreover, no system can be adequately evaluated without having baseline data on historical and existing conditions to first understand what has been lost, and second allow for comparisons to later restored conditions – otherwise one cannot really know what one "fixed" (Waller and Rooney 2008). Understanding how species richness is expected to change in response to restoration, with metrics on species richness and/or populations, is essential for proper planning, so that the appropriate habitats and species are addressed, as well as for documentation of success. Simply creating or enhancing habitat may or may not benefit the desired wildlife if barriers exist to colonization of new habitats from nearby source populations (Forman et al. 2008), or if habitat restorations are missing critical habitat features such as minimum area, nest sites, den sites, or other species-specific constraints (Ahlering and Faaborg 2006, Bogan et al. 2008, Ribic et al. 2009). In this regard birds, being highly mobile, are rarely impeded by barriers (but other habitat and social constraints apply), and therefore restoration planning is usually more successful when less mobile species are used to represent the full species richness of the community. The ability to colonize new habitats is directly related to the isolation of the habitat (distance to existing habitats and physical or other barriers between habitats), and the mobility of the species. Groups such as salamanders, for example, are particularly problematic in fragmented landscapes, due to their poor mobility and inability to cross many barriers (Greenwald et al. 2009). In summary, the paradigm "*if you build it they will come*" often works for birds and some insects and mammals, but not so well for less mobile species.

Funding for collection of baseline data, which can take several years, is often difficult to realize, but essential for first understanding existing conditions in order to plan for restoration of appropriate species richness. Inadequate biotic inventories can and do result in real harm, as sensitive species existing on parcels can be overlooked, populations impacted during restoration activities, and species fail to recolonize restored habitats. In urban landscapes with heavily fragmented habitats and sparse source populations, without planning for sustaining spatially connected source populations that have the ability to colonize new or enhanced habitat, restorations often fail to meet species richness expectations. **Without baseline data and an understanding of species' biological constraints, luck, rather than planning, plays a major role in which species survive to utilize restored habitats.**

This project will identify the "bookends" to understand what the system was like before (best case), how it is now (generally worst case) and what needs to be done to bring the system to an improved but feasible condition (the goal of the AOC program). Collection of baseline data is essential for project success. We propose a multi-year effort to collect comprehensive baseline data, conduct targeted wildlife surveys, and select focal species (see below) for habitat restoration planning with spatial analysis of how wildlife populations can best be recovered and persist through restoration work and/or be otherwise repatriated. This project will provide a targeted set of recommendations for restoring and protecting habitat within the study area for eventual BUI removal of wildlife habitat and populations impairments. The data and methods developed will be appropriate for monitoring wildlife responses to habitat restorations and enhancements, in order to document progress toward alleviating the BUI, and to maximize benefits to species of local conservation concern.

NOTE: By examining historical conditions in the AOC, this assessment is NOT proposing that we achieve those conditions again before removal of impairments can occur. Rather, understanding

historical conditions (i.e., best-case conditions) and worst-case conditions will help us determine what is a suitable "C-level condition" for wildlife in the AOC. **Hence, this methodology is commensurate with the remedial goals of the AOC program.**

Focal Species Concept:

In order to make the link between habitat restoration proposals and wildlife-related BUI removal, habitat restorations must be capable of supporting the wildlife species of interest, either by providing habitat sufficient to maintain or enhance viable populations, or, in the case of transient habitat use by migratory insects, birds, and bats, the habitat must offer a clear benefit to the wildlife species, such as food or shelter, during its stay in the area. This task is addressed through the use of a Focal Species Concept (Anderson and Jenkins 2006), where Focal Species are selected to represent the habitat requirements of a larger species suite, and these habitat requirements are then utilized in developing restoration proposals which can support these species (that meet the *Biological Constraints*), and therefore be reasonably expected to qualify for meeting BUI removal goals. This process follows several steps.

Steps in the Selection of Focal Species:

A. *Develop comprehensive species checklists.* These are species that could be supported in the project area. The checklist is derived from a review of all available data, including various databases, the literature (field guides, primary literature), museum data, and unpublished field notes, including surveys conducted for the project. With few exceptions, these data are treated as presence-only records, since the sampling effort necessary for surveys to rule out Type II errors (false absence) is rarely achieved. Data should be reviewed for Type I (false positives) and Type II errors as thoroughly as possible. This process is somewhat akin to a rapid ecological assessment, but restricted to species occurrence in the project area.

B. *Filter this list for Species of Local Conservation Interest (SLCI).* SLCIs are species that are at least one of the following, a) listed as either state or federally Endangered, Threatened, or Special Concern; b) species listed as Species of Greatest Conservation Need in the State Wildlife Action Plan; c) species that are considered to be locally rare or declining; or d) species that are of social value to stakeholders and considered to be desirable to the community.

C. Evaluate the SLCI to determine which species can be supported in the project area given the physical, biotic, fiscal, and social constraints on the system, and the critical habitat needs of the species.

D. Select from Step C a smaller list of Focal Species representative of habitats that can be realistically restored or enhanced in the project area. Focal Species may include keystone, umbrella, or flagship species:

Keystone species (Paine 1995) play essential roles in an ecosystem, often providing critical habitat or services without which an entire ecosystem can be disrupted and cascading extinctions result. Nitrogen fixing bacteria, for example, are keystone species whose loss would result in the extinction of most life on earth. Likewise, the American beaver creates wetland habitat, and burrowing crayfish create burrows used by many other species as refuges. Keystone species can also be disruptive, limiting other species success, such as where over-browsing by white-tailed deer eliminates many other species from a community.

Umbrella species (Roberge and Angelstam 2004) are species representative of habitats and/or resources which also support a variety of other species. As a result, conservation

efforts aimed at umbrella species are likely to generate broad conservation benefits for many species. Umbrella species typically have large area requirements, specific well-defined habitat requirements, well understood life histories (ideally subject to ongoing monitoring studies), and good chances for population stability or reintroduction to areas prioritized for conservation efforts. For example, grizzly bears have been used as an umbrella species for the design of landscape connectivity in the Rocky Mountains. *Flagship species* (Veríssimo et al. 2011) are charismatic popular species that help attract public support for conservation actions (i.e. giant pandas, salmon).

Proposed Work:

1. Historical Review (year one/two)
    a. Perform a literature review of previous habitat-related studies within the study area (half mile buffer of streams)
    b. Collect all available species occurrence data
    c. Determine geographic and taxonomic data gaps
    d. Determine survey methods and locations
2. Complete a baseline assessment of species richness and biological constraints (factors affecting which species can sustain populations in the system; 3 year timeframe)
    a. Conduct targeted biotic surveys based on gap analysis (year one, beginning spring 2014)
    b. Map existing plant and animal communities
        - Include existing habitat mapping efforts in evaluation (i.e., SEWRPC, Milwaukee County Parks, DNR)
    c. Complete comprehensive species checklists of biodiversity on the study area, including global, state, and local conservation status (i.e., Nature Serve status, DNR status, county level status) (begin year one, refine year 2)
        - Include extirpated and introduced non-native species in checklists and identify these classes in status ranks
    d. Compare historic vs. existing species richness
    e. Identify broad biological constraints limiting species richness and restoration opportunities; develop a decision support chart to determine feasible restorations
    f. Determine focal species with stakeholder input; include umbrella, keystone, and flagship species concepts
    g. Identify short list of Species of Local Conservation Interest (SLCIs) and other target species with stakeholders and list their critical habitat requirements (biological constraints) for guiding habitat restorations and decision support
        - Consider a wide array of species ranging from very tolerant to very intolerant as restoration targets
3. Create goals for habitat restoration and connectivity, addressing:
    a. AOC Beneficial Use Impairments and measures of success
    b. Social constraints on restoration feasibility (i.e., land ownership, existing development extents, funding levels, etc.)
    c. Identify and prioritize specific projects that will address the BUIs of impaired wildlife habitat and populations
        - Projects will have a direct connection to the stream

- Projects will be prioritized for maximum benefit for increasing wildlife biodiversity and/or restoring or sustaining SCLIs (such as Endangered or Threatened Species).
- Projects will have measures of success identified

Collaboration with Partners:
Milwaukee County Parks is the largest owner of undeveloped property within the project area and will play a key role with wildlife habitat assessments, surveys, and planning for the project on county lands. Over 1,300 county-owned acres will be surveyed for ephemeral ponds, 800 acres for migratory birds, 120 acres for snakes, and nearly 40 acres for turtles. The wildlife subcommittee of the Milwaukee Estuary Fish and Wildlife Technical Team will serve as a steering committee, providing guidance for the project, and setting goals and priorities for project recommendations.

Deliverables and Timetable:

Description of Deliverables	**Timeline**
Historical review, data gap analysis, and focal species assessment	Years 1-2
Baseline wildlife surveys	Year 1 - areas where known data gaps exist Year 2 – continue in areas identified in gap analysis Year 3 – finish surveys in remaining target areas
Reporting	Year 1 – Interim historical review, gap analysis and survey reports. Year 2 – Final historical review, gap analysis and focal species assessment reports. Interim survey reports. Year 3 – Final survey reports. Final assessment report with restoration projects identified and ranked.
Project management and review	Throughout the project the steering committee develops goals, reviews ongoing results, holds stakeholder meetings, and identifies and prioritizes projects for BUI delisting

Project Budget:

Description	Year 1	Year 2	Year 3	Total
Milwaukee County Parks: personnel, travel, and supplies. Years 1 and 2 will focus primarily on multi-taxa surveys. Year 3 will wrap up surveys and focus primarily on participation in habitat restoration project selection and rankings. Reporting will be conducted in all years.	$45,000	$45,000	$15,000	$105,000
Contracts: personnel, travel, and supplies. Year 1 will begin multi-taxa surveys beginning spring of 2014 to fill in gaps identified in historical review and focal species development (separate project for year 1). Year 2 will finish historical reviews and focal species development, and focus primarily on surveys. Year 3 will finish surveys, and focus primarily on analysis, reporting, and restoration project selection and rankings. Reporting will be conducted in all years.	$75,000	$75,000	$50,000	$200,000
Total	$120,000	$120,000	$65,000	$305,000
Steering cmte oversight, data provisions, mapping, grant administration (DNR), etc.)	The time spent by steering committee members will be an in-kind contribution for this project			

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Project Title: ***Milwaukee Estuary Area of Concern Fish Population Assessment***

Project Applicant: WDNR

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Project Manager's name and contact info: Megan O'Shea, 414.263.8625, megan.oshea@wi.gov

Person responsible for reporting: Megan O'Shea

Project Location: Milwaukee Harbor, Milwaukee River, Kinnickinnic River, and the Menomonee River.

Problem Statement:

Relevance: The Milwaukee River and Estuary Area of Concern Beneficial Use Impairment "Degraded Fish and Wildlife Populations" was identified by the International Joint Commission in 1987. A comprehensive survey of relative population abundance of native species compared to abundances prior to 1987 will provide an understanding of the degree of improvement in fish populations. In addition, surveys will allow consideration of potential removal of this beneficial use impairment or, in the case that it is determined that conditions are not sufficient for its removal, the surveys will aid in targeting locations and species for future restoration work.

This BUI will be considered to be eligible for removal when the following have occurred:

- All contaminated sediment hotspots within the AOC have been identified, and implementation actions to remediate contaminated sites have been completed.

-A local fish and wildlife management and rehabilitation plan has been compiled for the estuary that:

- Defines the causes of all population impairments within the AOC
- Establishes site-specific local population targets for native indicator fish and wildlife species within the AOC
- Identifies all fish and wildlife population rehabilitation programs/activities within the AOC and establishes a mechanism to assure coordination among all these programs/activities, including identification of lead and coordinative agencies
- Establishes a time table, funding mechanism, and lead agency or organization responsibility for all fish and wildlife population activities needed within the AOC.
- The actions/projects necessary to accomplish the recommendations of the fish and wildlife management and restoration plan are implemented.

-Populations for native indicator fish species are statistically similar to populations in reference sites with similar habitat but little to no contamination.

For the purposes of removal of this beneficial use impairment specific native indicator species will include northern pike, greater redhorse, lake sturgeon, and walleye. Since fish population levels present in 1987 (when the BUI was designated) were unacceptable, we

will consider a 100% increase of relative density (as measured by survey wide catch per effort in Holey 1984) of these four species as central to consideration of BUI removal except in the case of lake sturgeon. Zero lake sturgeon were captured in the original survey so their presence in the proposed survey will be evidence of population increase.

Although these four species are thought to be broadly representative of fish of life histories and morphometry of various fish species, the direct correlation of their population success to those of other fish populations is not defined. As such, we also rely on two other measures of relative fish population abundance to consider removal of this BUI. As a very conservative baseline we will also require an increase in relative density of 95% of the other native species captured in the original 1985 study, regardless of magnitude. In 2014, we propose to evaluate the list of originally captured native fish species to refine the list of species and acceptable increases in relatively density based on life history, ecology, and utilization of the AOC proper. The results of this evaluation will likely result in a less conservative but more precise targets with regard to species and relative densities. The specific targets for fish populations will be refined in a separate, but related, scope of work (funded through the OGL Great Lakes Monitoring Capacity grant).

While these two measures (focal species and all native species) provide an opportunity to examine relative population density in a temporal context, a spatial comparison to reference site is also necessary. To compare the Milwaukee AOC fish populations of native indicator species to reference sites we will rely on large river IBI scores. Large river IBI scores (Lyons et al. 2001) are constructed, by definition, to represent the range of values present in similar communities (i.e. reference sites). We will have relatively intense characterization of IBI scores within the AOC in a given year (11 sites) and also between years (3 years). An overall mean value from all IBI sampling efforts of "Fair" or better (i.e. 40-69) will be considered adequate for removal of this BUI.

Objectives: Determine the current status of populations of native fish species relative to their status that led to the inclusion of the "degraded fish and wildlife populations" beneficial use impairment for the Milwaukee River and Estuary Area of Concern as outlined in Holey (1984). (Completed refined in a separate, but related, scope of work funded through the OGL Great Lakes Monitoring Capacity grant.)

Rationale: Improvements that benefit fish populations have been made in the Milwaukee Estuary Area of Concern since its designation by the International Joint Commission in 1987. In particular, the completion of the Deep Tunnel project has dramatically decreased the incidence of combined sewer overflows. Understanding the response of fish populations to the Deep Tunnel construction as well as other improvements necessitates a representative survey.

Proposed Work: Replicate monthly fyke netting and electrofishing portions of fish population monitoring completed just prior to AOC designation following Holey (1984). Total catch per effort from fyke nets and electrofishing will be used to evaluate population level recovery. Nonwadeable river indices of biotic integrity will be calculated and evaluated in order to validate relative population abundances of native fish species. Since all environmental metrics have inherent temporal variance, we will continue with electrofishing surveys for an additional two years. In

addition, related but separate work will occur in 2013/2014 to refine the species of interest and acceptable increases in relative densities of native fish species.

We are also proposing to finish the development and utilize a GIS-based tool that would help us prioritize potential sites for fish habitat/passage restoration in the AOC. This work is being completed, in part, under a grant to Ozaukee County. This specific funding would allow the tool to be used to prioritize fish habitat restoration sites in the AOC.

Collaboration with partners: MMSD, SEWRPC, Ozaukee County, Wisconsin DNR, USGS

Deliverables and Timetable: Sample collection: March 2014-October 2015. Data management, analysis, and reporting: November 2014-June 2015.
Effort: 5 electrofishing efforts x 11 sites (Years 1, 2, and 3), 10 fykenetting efforts x 21 sites (Year 1 only). Index of Biotic Integrity Scores will be available as a result of the electrofishing efforts. By the end of the third year, a ranked list of prioritized potential fish habitat restoration sites would be produced.

Project Budget: Contract to USGS

Year 1

- Surveys: 3 weeks per month, 3 person crew $7500 /week, 5 months =$112,500
- Equipment: 10 fyke nets ($1,000 ea) = $10,000
- Data management: $2000
- Fish habitat restoration prioritization using GIS-based tool = $25,000

Year 2

-Surveys: 1.5 weeks per month, 3 person crew $7500/week, 5 months = $56,250

Year 3

--Surveys: 1.5 weeks per month, 3 person crew $7500/week, 5 months = $56,250

Total: $262,000

Project Duration: January 2014-June 2017.

References

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WDNR Office of the Great Lakes AOC Capacity Grants 2013

Project Title: Identification and quantification of sanitary sewage contamination in the Milwaukee Estuary Area of Concern (AOC)

Project Applicant: Megan O'Shea, DNR

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Project Manager's name and contact info: (same as project applicant)

Person responsible for reporting: Megan O'Shea

Project Location: Milwaukee Estuary AOC

Problem Statement:
Beach closings and recreational restrictions is an impaired use in the Milwaukee Estuary AOC. Early RAP documents (DNR 1991, DNR 1994) stated that the use was impaired because of high bacteria counts and sewer overflows in the AOC that caused beach closings and recreational hazards. While sewer overflows closed beaches in the AOC, high bacteria counts from urban nonpoint pollution throughout the AOC waterways often exceeded water quality standards for recreation. Since the early 1990s, however, sewer overflows have decreased substantially, largely as a consequence of the Milwaukee Metropolitan Sewerage District's Deep Tunnel system. Before the wastewater storage tunnel became available, rain storms caused more than 50 combined sanitary and storm sewer overflows each year to local rivers and Lake Michigan. Construction of the 19.4-mile-long original tunnel was completed in 1993 and its first full year of operation was 1994. Since the Deep Tunnel system came online, there has been an average of 2.5 overflows a year from 1994 through 2011.

Despite this substantial improvement in sewage treatment in the AOC, water quality standards for recreation are still regularly exceeded in the AOC, and pose a significant challenge to removing the beach closings and recreational restrictions impairment. The cause of these exceedances is largely attributed to contamination by urban stormwater. High levels of fecal indicator bacteria have been found in urban stormwater discharges (O'Shea and Field, 1992; Field, 1996; Haile et al., 1999; Schiff and Kinney, 2001) and are the largest contributor to water quality impairments for bacteria in Milwaukee's urban rivers (SEWPRC 2008). Complicating matters is that water quality models have shown that 60-75% of the fecal coliform loads cannot be explained by nonpoint source runoff from rooftops, parking lots, streets, and other impervious surfaces (SEWRPC, 2008), especially for the Menomonee and KK Rivers (Figure 1). The Great Lakes Water Institute's preliminary data (detailed below) demonstrates that exfiltration (leaking) from failing sanitary sewer infrastructure is a major source of fecal indicator bacteria and pathogens in urban stormwater that impacts the AOC. This means that stormwater systems are acting as conduits for conveying sewage from failing

infrastructure into surface waters used for drinking water and recreation. This sanitary waste poses a more direct threat to human health, since it is more likely to contain pathogens than urban stormwater runoff. This problem is particularly difficult to address because thousands of localized breeches within the sanitary sewage system are much more difficult to address than combined and sanitary sewage overflows, where sources and system capacities are better understood. Therefore, completing this project to identify and quantify sanitary sewage contamination of stormwater in the AOC provides a crucial, and currently missing, link in efficiently and effectively addressing the beach closings and recreational restrictions impairment.

Relevance and Rationale

The Milwaukee Estuary AOC and its constituent waterways are listed on Wisconsin's 303(d) list as impaired because they frequently do not meet the variance standard (1000 fecal coliforms/100 ml), much less the water quality standard (200 FC/100 ml), for recreation. Total Maximum Daily Load (TMDL) studies to address bacteria are underway for the three AOC tributaries and the estuary. The TMDL, however, focuses on using *E. coli* and fecal coliform bacteria indicators, which can come from a variety of sources. Some sources, namely sewage, pose a greater human health risk than other sources of fecal contamination because of extremely high concentrations of viruses, protozoa, and pathogenic bacteria associated with human waste. ***Identifying the source of contamination is integral to TMDL development because it allows for the prioritization of implementation strategies to target pathogens, which pose the greatest risk to human health.*** The risk to human health is the actual water quality impairment, and is the reason that recreation in the AOC is restricted. The lack of source information (e.g. human vs. nonhuman), therefore, hampers implementation plans that are intended to ultimately reduce pathogens and remove the recreational restrictions beneficial use impairment in the AOC.

Fortunately, the Great Lakes WATER Institute (GLWI) has been developing methods for tracking sources of fecal pollution in urban rivers, the Milwaukee Estuary, and Lake Michigan over the past several years. GLWI's previous research using source-specific indicators of fecal pollution demonstrates that sewage contamination of stormwater is common and widespread in the urban environment (Salmore 2006, McLellan 2007, Sauer 2011, Newton et al. 2011). Recent studies in their lab demonstrate that the Menomonee and Kinnickinnic (KK) Rivers are the major source of sewage (and human pathogens) to the AOC. These approaches are now being applied to studies, in partnership with Milwaukee Riverkeeper and the Milwaukee Metropolitan Sewerage District (MMSD), to map the extent of stormwater contaminated by sewage. Additionally, Dr. McLellan is already working with the TMDL effort in the three watersheds and the estuary to interface existing source identification data into the TMDL. The requested funding for this proposed project would fill critical data gaps by identifying human versus nonhuman sources, and estimating loads of sewage-derived pathogens for the two watersheds that contribute high loadings of human waste and pathogens into the AOC. The challenge is to identify, prioritize, and remediate failing sewer infrastructure systematically so that limited fiscal resources can be directed to the largest problem areas; a challenge this project would address. Specifically, the proposed project corrects the impediments to TMDL implementation by identifying the most critical infrastructure failures, and assisting decision-makers in determining their priorities for stormwater management and infrastructure investment. Based on source testing results, we will map and disseminate the locations of stormwater outfalls that are discharging sewage to the municipalities, so they can effectively direct their limited budgets toward projects that would make the greatest impact on improving water quality in the Milwaukee Estuary AOC, thus helping to bring the AOC into compliance with water quality standards.

In order to achieve this, Dr. McLellan's lab has partnered with Milwaukee Riverkeeper, who is funding a full time water quality specialist (Joe Rath) who will assist with sample collection support, GIS expertise, mapping and visualization of data for this project. This partnership increases our capabilities to extensively cover the lower Menomonee and KK watersheds that contribute significant pollutant loads to the Milwaukee Estuary AOC and to disseminate this information in a form usable to municipalities and water resource planners.

Objectives

The overall goal of our research is to delineate fecal pollution sources entering the AOC. A major part of this research is to identify unrecognized sanitary sewage contamination and determine the contribution of sewage to pathogen and fecal indicator loads to the Milwaukee Estuary. This information is necessary to direct mitigation efforts towards reducing pathogens in the AOC. The specific objectives in this proposal are critical elements in our overall research efforts and they address data needs that are not currently funded, or are only partially funded. Below are specific objectives and a brief description of each. Appendix A provides a detailed description of the overall research plan and current funding sources.

Objective 1. ***Map and sample stormwater outfalls along the lower Menomonee and Kinnickinnic and perform up the pipe investigations to identify illicit discharges.***

This objective will provide a comprehensive map of illicit discharges in two urbanized watersheds, which can be used as a resource by municipalities. Levels of human-specific indicators will be quantified and results mapped using GIS. We will determine if levels and loads are correlated to drainage area, elevations, and sewer configuration. We will specifically determine if certain variables correlate to a "high likelihood of failing infrastructure". Outfalls will be prioritized based on the concentration and load of human-specific indicators and up-the-pipe investigations conducted in collaboration with municipalities and MMSD.

Objective 2. ***Quantify amount of sewage contamination loads at two locations in the Menomonee and Kinnickinnic Rivers and at the estuary.***

Our ongoing sampling program with USGS will allow us to collect integrated water samples across the hydrograph at downstream locations in the Menomonee and Kinnickinnic Rivers. Our preliminary data (see proposed work) demonstrates there is a clear human signal from the Kinnickinnic and Menomonee watersheds in the absence of combined or sanitary sewage overflows. We will analyze baseflow and storm event samples collected in 2012 and 2014 to determine the relative contribution of sewage sources to the overall fecal coliform levels. We will use the same analytical procedures (microbiology and the sewage-indicating quantitative real time polymerase chain reaction, or qPCR, analytical method) used in Objective 1 for the outfall mapping. Importantly, this monitoring will help evaluate the effectiveness of mitigation and source reduction.

Objective 3. ***Fill data gaps and interface with TMDL efforts to prioritize implementation strategies.***

Current Great Lakes Restoration Initiative funding is supporting TMDL development for the three watersheds within the Milwaukee River Basin and estuary. This project is designed to meet a major need for TMDL implementation, i.e. identification of sources. Load calculations will be based upon fecal coliforms for the watersheds and *E. coli* for the estuary, but these general indicators DO NOT correlate to pathogens (some sources have few pathogens, but sources such as

sewage have lots of pathogens). Comprehensive mapping and river sampling will allow priority ranking of sites suspected as major contributors to sewage derived fecal coliform loads and result in more effective remediation of both local and downstream loads. For example, the area of highest fecal coliform loading in the Kinnickinnic River watershed, Holmes Avenue Creek, has few stormwater outfalls that have come back positive for human-specific indicators. These areas, however, would be identified as high priority areas for TMDL implementation activities, even though their risk to human health is relatively low. By doing this work, we ensure that the stormwater outfalls that pose the greatest risk to human health can be targeted, which increases overall effectiveness and efficiency of the TMDL. To do this, we will interface with the Center for Water Policy to disseminate research information into the policy arena. The research results will be disseminated to policy-makers, stakeholders, municipalities, and water resource managers in the form of research briefs, policy briefs, and science-based policy solutions. For example, findings from this project could improve stormwater permitting, TMDL development and implementation, as well as provide evidence for the need for municipalities to fix areas of failing infrastructure. The policy briefs will focus on identifying the most significant problem areas, and can be used for prioritizing investment in infrastructure to remediate failing sewer lines that present the most critical concerns for public health.

Proposed Work:

This project will identify unrecognized sanitary sewage contamination and determine the contribution of these sources to pathogen and fecal indicator loads in the Milwaukee Estuary. We will map sections of two urban watersheds (the lower Menomonee and Kinnickinnic River watersheds) to identify the prevalence of sewage entry into stormwater systems (e.g., local outfall scale). We will also measure overall contributions of sewage to impaired water quality in urban rivers following storm events (e.g., watershed scale). We will transfer our findings to local municipalities responsible for mitigating sanitary sewage discharges, to water resource managers working on TMDLs, and to the DNR to support their watershed-based permitting efforts.

Objective 1. *Map and sample stormwater outfalls along the lower Menomonee and Kinnickinnic and perform up the pipe investigations to identify illicit discharges.*

This objective will provide a comprehensive map of illicit discharges in the lower Menomonee and Kinnickinnic River watersheds, which can be used as a resource by municipalities. Human-specific fecal indicators will be quantified in terminal outfalls and results mapped using GIS and will include drainage areas, elevations, and sewer configuration. We will also map age of development and use these different variables to determine correlations to "high likelihood of failing infrastructure" (Figure 2). Outfalls will be prioritized based on the concentration and load of human-specific indicators and up the pipe investigations conducted in collaboration with municipalities and the Milwaukee Metropolitan Sewerage District (MMSD).

The analytical methods for the human-specific indicators Bacteroides and Lachno2 have been previously described by our laboratory (Newton et al., 2011). We are also developing methods for new assays that target non-human sources of fecal pollution and will incorporate this testing as appropriate. These new markers will continue to improve our resolution in confirming, and positively identifying other sources of fecal pollution in stormwater (e.g., urban wildlife). Concentrations determined by the analytical quantitative polymerase chain reaction (qPCR) method help to determine the extent of human sewage contamination, and can be used in conjunction with storm sewer drainage areas as a proxy for pathogen loads.

We have mapped 185 different terminal outfalls to date, which represents 70% coverage of the terminal outfalls in the lower Menomonee River (between Burleigh Ave and Hawley Ave) and 10% coverage of the Kinnickinnic watersheds. We found 80 of these terminal outfalls (>40%) have low to moderate levels of sewage contamination and 28 have very high levels of sewage contamination (15%). In this project, we would complete the mapping of the lower Menomonee and KK watersheds and conduct a minimum of 15 up-the-pipe-investigations each year, targeting areas of the highest priority, e.g. sites with the highest human fecal pollution signal and/or load. In all, we anticipate analyzing 150 terminal outfalls and 150 up-the-pipe samples using traditional microbiology and qPCR for source-specific indicators over 2013-2014. Up-the-pipe sampling is important in helping to better define the location of infrastructure failure within the storm sewer drainage area that leads to each terminal stormwater outfall at the river discharge location, and MMSD has been conducting this sampling as an in-kind contribution to this project. This effort would provide comprehensive coverage for the two most urbanized watersheds impacting the AOC.

Objective 2. *Quantify amount of sewage contamination loads at two locations in the Menomonee and Kinnickinnic Rivers and at the estuary.*

Our ongoing sampling program with USGS will allow us to collect integrated water samples across the hydrograph at downstream locations in the Menomonee and Kinnickinnic Rivers. We have been quantifying human-specific markers and general indicators at the channel leading to Lake Michigan (Figure 3). There is a clear human signal from the Kinnickinnic and Menomonee watersheds in the absence of combined or sanitary sewage overflows.

In collaboration with USGS, we will deploy ISCO sequential samplers at an estuary site (Jones Island), the Kinnickinnic River (11th and Harrison) and the Menomonee River (16th Street). The downstream river locations will provide a critical dataset for the evaluation of fecal bacteria loads just prior to the estuary and the estuary site will provide a critical dataset for calculation of bacterial loads just prior to Milwaukee's inner harbor.

As sewage-contaminated waters are closely associated with human pathogens, the cause of the beach closings and recreational restrictions impairment, we will analyze baseflow and storm event samples collected from 2012 through 2014 to determine the relative contribution of sewage sources to the overall fecal coliform levels. We will use the same analytical procedures (microbiology and qPCR) used for outfall sampling to differentiate the two forms of pollution.

Objective 3. *Fill data gaps and interface with TMDL efforts to prioritize implementation strategies.*

Current Great Lakes Restoration Initiative funding is supporting TMDL development for the three watersheds within the Milwaukee River Basin and estuary. This project is designed to meet a major need for TMDLs, i.e. identification of sources.

For the TMDLs, load calculations will be based upon fecal coliforms for the watersheds and *E. coli* for the estuary. However, unrecognized sanitary inputs contribute additional fecal coliforms and *E. coli* beyond what is estimated from land use and runoff calculations. Comprehensive mapping and river sampling will allow priority ranking of sites suspected as major contributors to sewage derived TMDLs and result in more effective remediation of both local and downstream loads,

ultimately targeting the pathogens that give rise to one of the estuary's beneficial use impairments.

Historically, concentrations of fecal coliform bacteria in the estuary portions of the Kinnickinnic, Menomonee, and Milwaukee Rivers regularly exceeded the estuary variance standard of 1,000 CFU/100 ml. According to MMSD datasets, between 1975 and 2004 the median concentration of fecal coliform bacteria in the Milwaukee Harbor estuary was about 930 CFU/100 ml. Fecal coliform counts in the estuary varied over seven orders of magnitude during this period (from 1 CFU/100 ml to 2,400,000 CFU/ 100 ml), regularly exceeding the variance standard and almost always exceeding the standard for full recreational use (200 CFU/100 ml). From 2000-2002, MMSD levels of *E. coli* in the estuary varied over six orders of magnitude, ranging from 0.5 CFU/100 ml to 240,000CFU/100 ml.

Current MMSD data illustrates the substantial and ongoing contamination problems in the AOC. In 2012 during June, July, and August, 53% of MMSD samples collected in the estuary (n=30) had fecal coliform levels greater than 200 CFU/100 ml and 10% had levels greater than 1000 CFU/100 ml. The *E. coli* levels were greater than 235 CFU/100 ml in 20% of the samples and 7% were greater than 1000 CFU/100 ml, USEPA standards for water quality advisories and beach closings respectively. Importantly, 2012 was during an extreme drought, thereby representing a "best case" scenario for storm-driven pollution levels.

MMSDs comprehensive sampling program provides ongoing data for the AOC and the upstream rivers that impact the AOC. This sampling program is the primary data source for developing the TMDLs and sites correspond to assessment points used in the TMDL. As the McLellan lab became engaged in the TMDL project, they requested split samples from MMSD's monitoring program in the Kinnickinnic and lower Menomonee rivers, whereby MMSD took 2 sets of samples—one for their lab and one for the McLellan lab. This has enabled the McLellan lab to archive an entire sampling season with minimal budget investment so that these samples would be immediately available for analysis during winter of 2012/2013. As a result, more than 200 samples have been analyzed for *E. coli* and enterococci by culture methods and archived by freezing samples for later qPCR testing. We will obtain river samples from MMSD in 2013 and each year analyze the most relevant samples by qPCR. We estimate that we will use qPCR to analyze a max of 200 in-stream samples over the three year time frame.

<u>*Center for Water Policy*</u>
The second part of this objective is to interface with the Center for Water Policy to disseminate our findings to inform policy. We will dedicate one Master's student to these efforts, who can help translate our research findings into information useful in other efforts in our region. The research results will be translated into research briefs and policy briefs designed to be useful for decision makers, stakeholders, municipalities, and water resource managers. The articulation and communication needs will be assessed for targeted groups. The results will be disseminated through stakeholder meetings, links to research briefs, and direct access to policy briefs, providing for feedback loops.

Collaboration with partners:
This project builds upon an existing and longstanding collaboration between the Great Lakes WATER Institute (GLWI), School of Freshwater Sciences, Riverkeeper, and MMSD. This group meets monthly to implement an overall strategy to map stormwater outfalls. "On the ground" interaction is ongoing and includes GIS information sharing between MMSD and Riverkeeper.

Riverkeeper has an extensive collection of stormwater samples, which are analyzed by GLWI, and results mapped by Riverkeeper. Up the pipe investigations are jointly formulated by the group and then sampled by MMSD, analyzed by GLWI, and mapped by Riverkeeper. At the GLWI, there is a research specialist and one Master's student dedicated to our stormwater and AOC work. These are just a few examples of the ongoing and longstanding collaboration of this group.

In addition, Dr. McLellan and Cheryl Nenn, MS, work closely with the Southeastern Wisconsin Watersheds Trust (Sweet Water) and municipalities to disseminate mapping of sewage contamination in outfalls for further investigation and remediation and cooperate with the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in their efforts to facilitate watershed-based stormwater permits. The draft watershed-based stormwater permit for Menomonee River municipalities incorporates improved monitoring requirements (e.g., to test all size outfalls and test outfalls suspected of human sewage contamination multiple times during dry and wet weather) and requires the municipalities to develop a watershed-wide strategy to identify and eliminate human-specific bacteria sources in response to our joint monitoring efforts by spring 2013.

Deliverables and Timetable:
See Appendix A for comprehensive timetable and activities.

Deliverables include:
Analysis of 150 terminal outfall samples by culture and qPCR
Analysis of 150 up the pipe samples by culture and qPCR
Analysis of 200 watershed samples collected with ISCO samplers
Analysis of 200 river samples (collected by MMSD) by culture and qPCR
Update comprehensive stormwater reports and maps for 2013 and 2014
Develop research briefs and policy briefs to disseminate to stakeholders and target groups

Project Budget:
Project Duration: January 1, 2014 to December 31, 2015

<u>Year one:</u>

Personnel costs:	$103,941
Graduate student tuition costs:	$8,984
Supplies and equipment:	$46,000
Travel:	$500
Subcontract to Riverkeeper for sampling/mapping collaboration:	$25,000
Subcontract to USGS for sample support and expertise:	$20,000
University overhead:	$30,663
Total:	$235,089

<u>Year two:</u>

Personnel costs:	$110,865
Graduate student tuition costs:	$17,948
Supplies:	$32,080
Travel (include scientific meetings):	$3400
Publication costs (peer reviewed journals):	$3000
Center for Water Policy dissemination materials and meetings	$5000

Subcontract to Riverkeeper for sampling/mapping collaboration:	$50,000
Subcontract to USGS for sample support and expertise:	$10,000
University overhead:	$34,844
Total:	$267,137
Grand total:	**$502,226**

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Schiff, K., and Kinney, P. (2001) Tracking sources of bacterial contamination in stormwater discharges to Mission Bay, California. *Water Environ Res* **73**: 534-542.

SEWRPC (2008) Regional Water Quality Plan Update, Technical Report 39.

USEPA (2009) National Water Quality Inventory: Report to Congress, 2004 Reporting Cycle.

Figure 1. Predicted fecal coliform levels from water quality modeling of nonpoint source runoff (orange lines) compared with observed values (open circles; ±1SD is represented by the blue dashed line). The lower Menomonee River had observed fecal coliform values one order of magnitude greater than model predictions suggesting major contributions of fecal coliforms from unrecognized sources.

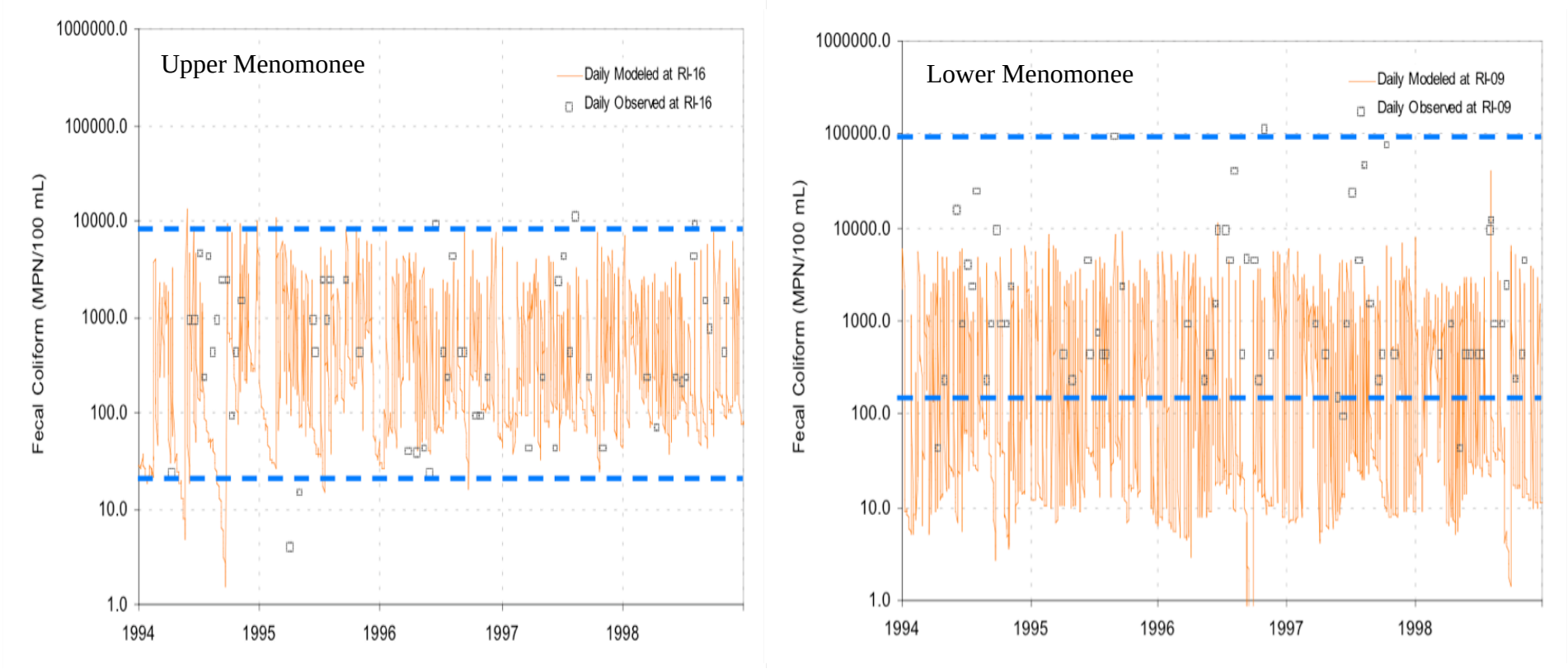
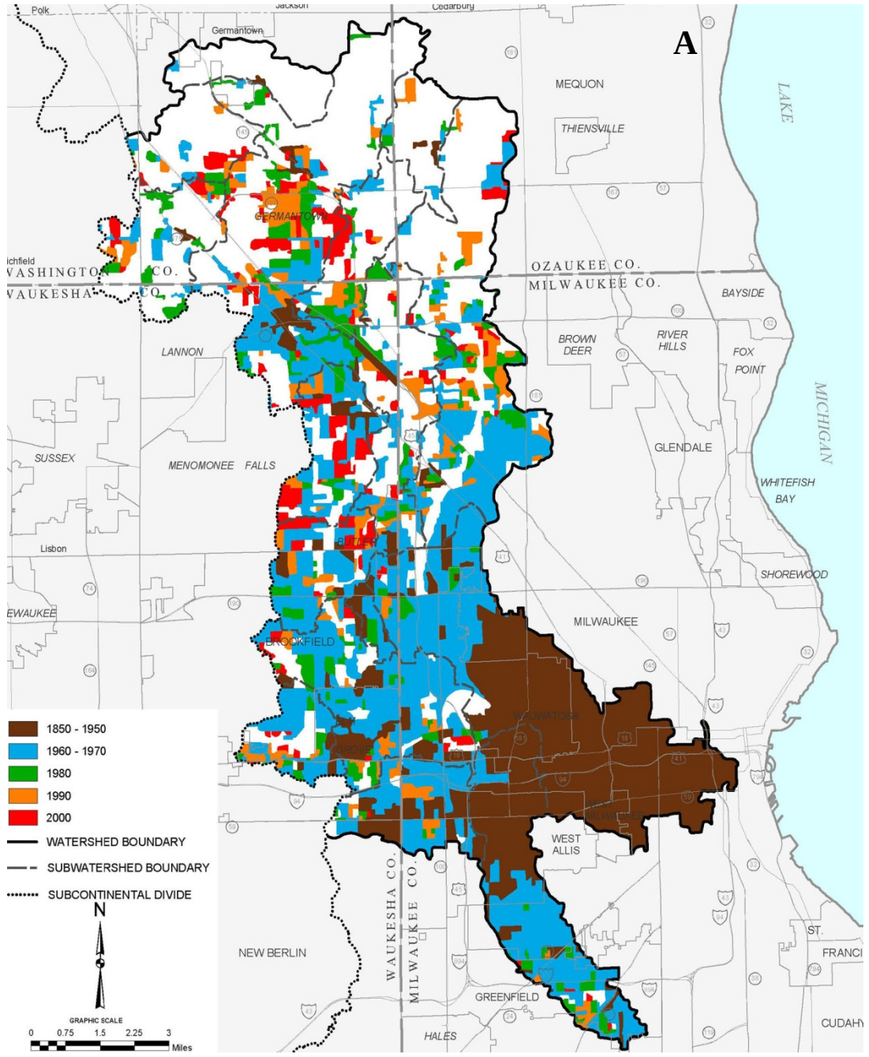


Figure 2: The Menomonee and Kinnickinnic watersheds. The stormwater outfall results for sewage contamination will be correlated to age of development, pipe elevations, ground elevations and other available data to develop a risk index to help target actual investigations.



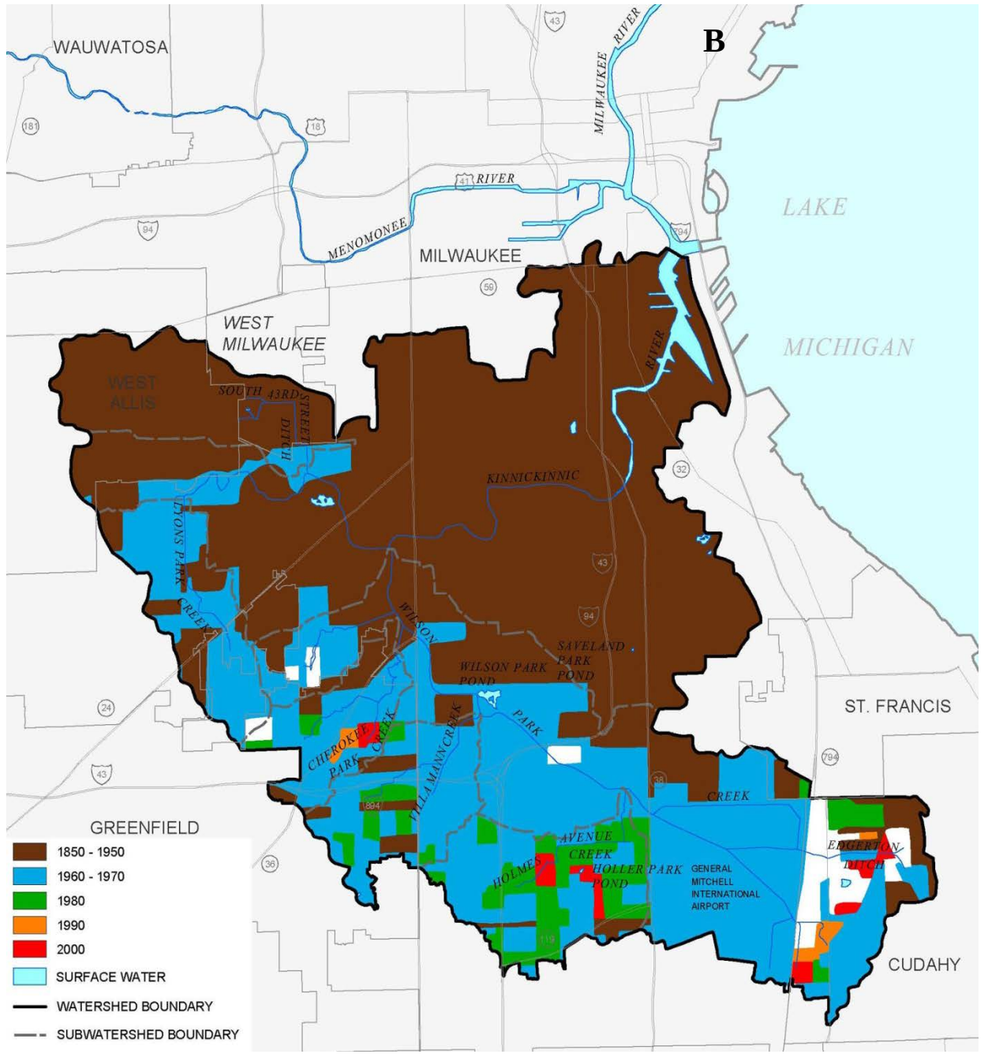
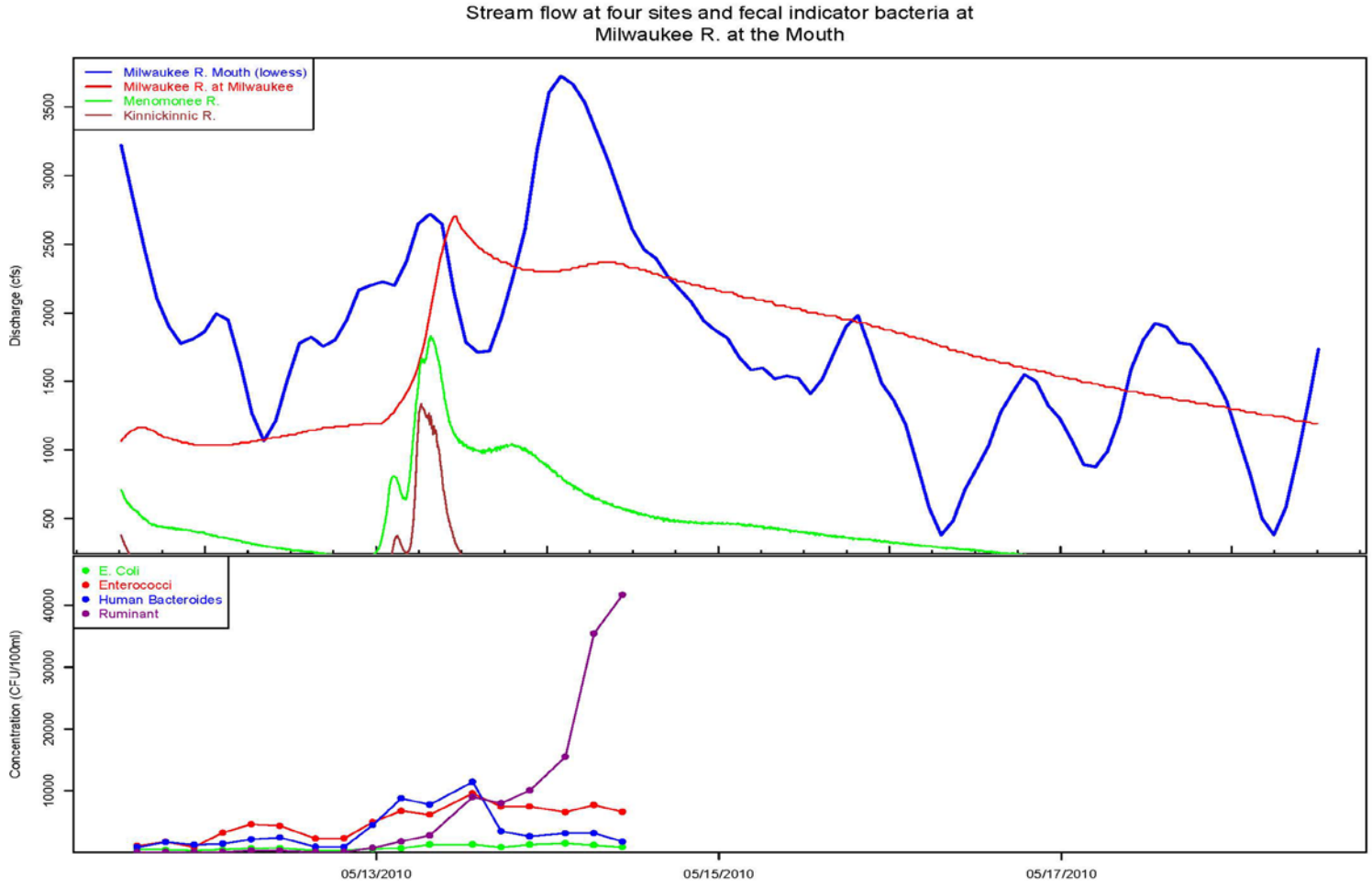


Figure 3. *Top panel,* hydrograph of three AOC rivers; blue line indicates the discharge to Lake Michigan from the estuary. Bottom panel, **human-specific indicators** and **ruminant-specific indicators** measured at the estuary across the hydrograph during rain events **5/13/10.** Human fecal indicators, *Bacteroides* and *Lachnospiraceae* (i.e., Lachno2), are detected at high concentrations at the peak of the discharge for the two urban rivers, while the flow peak later in the hydrograph for the estuary is correlated with higher contributions of bacteria from ruminants.



WDNR Office of the Great Lakes AOC Grant 2013

Project Title: The Little Menomonee Parkway Grassland Restoration Project

Project Applicant: Megan O'Shea, DNR

Street/Mailing Address: 2300 N. Dr. Martin Luther King Jr. Dr., Milwaukee, WI 53212

Phone number: 414.263.8625

E-mail address: megan.oshea@wi.gov

Project Manager's name and contact info: (same as project applicant)

Person responsible for reporting: Megan O'Shea

Project Location: The Little Menomonee River section of the Milwaukee Estuary AOC.

Managing Agency: Milwaukee County Department of Parks, Recreation, and Culture (DPRC)

Landowner: Milwaukee County Department of Parks, Recreation, and Culture

Problem Statement and Project Summary

This project will enhance/expand the grassland habitat in the AOC, and will improve breeding opportunities for grassland species that are designated as state and/or local species of concern. Currently, there is a lack of grassland habitat areas of any significant size elsewhere within the AOC.

The objectives of this project are to:

- Restore native grassland habitat on the site
- Improve breeding and migratory habitat for bird and invertebrate while also providing breeding habitat for herptile grassland species of local concern
- Reduce erosion from the site to the Little Menomonee River and its 100-year floodplain.

Currently, large stands of common buckthorn (non-native invasive species) are encroaching on the existing grassland. These invasives provide little to no groundcover due to the dense shade it generates. Common buckthorn populations are degrading habitat through the reduction of native species diversity (negative impacts on habitat and food resources) and the creation of edge habitat which leads to increased predation and parasitism. In addition, the lack of groundcover under the buckthorn makes these areas susceptible to continuous soil erosion during rainfall events. These eroded sediments, along with run off from nearby subdivisions, flow into culverts that drain directly into the Little Menomonee River. By converting the degraded areas (32.5 acres) into grassland through this restoration project, erosion issues would be dramatically reduced and absorption of run-off would increase, thereby decreasing the amount of potentially harmful pollutants entering the Little Menomonee River. The removal of the invasive species will also provide critical, improved habitat conditions for breeding and migratory wildlife within a regionally designated environmental corridor (SE WI Regional Planning Commission). This grassland restoration is the largest potential upland grassland restoration site in the Milwaukee County portion of the Little Menomonee River section of the AOC. In addition, there is a Butlers

Gartersnake (Wisconsin listed threatened species) population in the area that would benefit greatly from improved grassland habitat conditions.

Restoration activities in the first year of the project will use a forestry (fecon) mower and chainsaws to remove the stands of non-native invasive woody species. Vegetation removed by chainsaws will be stump-cut treated with herbicide to prevent regrowth. Vegetation removed with the forestry mower will receive a secondary treatment with herbicides after it regenerates during the following growing season. The proposed timeframe to begin woody vegetation removal is November 2013 through March 2014, which allows for minimal soil disturbance and reduces negative impacts on desirable plants species and breeding wildlife.

This restoration project will consist of removing 20 acres of woody vegetation (mainly invasive species) using a forestry mower and chainsaws. One full year of invasive species control must be conducted after forestry mowing prior to planting native grassland/prairie species. Invasive species control will consist of foliar application and cut-stump treatments. The final phase of the project will take place at the end of 2014 and include planting 20 acres of the site to native prairie. Additional invasive species control on the entire 32.5 acres will be required by the Parks Department which is committed to the long-term maintenance of this project site.

This restoration project is a component of a larger 169-acre Milwaukee County Parks restoration and management (R&M) plan for this section of the Little Menomonee River. The R&M plan is a ten-year project that encompasses all short and long term goals/activities such as invasive species control, wildlife habitat management, hiking trail maintenance, natural resource inventories, and public use activities. All R&M plans are developed by DPRC Natural Areas staff, reviewed and approved by the DPRC Chief of Operations and the Parks Director. Once a restoration & management plan is approved by the Director, Natural Areas staff begins implementation.

The Milwaukee County Department of Parks Recreation and Culture (landowner) will be the managing agency that will oversee all project activities. The County's restoration plan account for all invasives species control for the 10-yr term of the plan. Any site where aggressive invasives control has been done in the Park System is put in the annual plan of work for additional control as needed so that the gains that are achieved aren't lost.

BUIs Addressed & How Project Addresses Each BUI

1. **Degradation of fish and wildlife populations:** Restoration of terrestrial vegetation and removal of invasive species will provide more suitable grassland habitat and assist in the restoration of terrestrial biodiversity at the site and in the AOC.
2. **Loss of fish and wildlife habitat:** This project will increase suitable buffer habitat, and provides additional areas of existing critical habitat enhanced in the AOC by the reduction in acreage of invasive species. This grassland restoration is the largest potential upland grassland restoration point in the Milwaukee County portion of the Little Menomonee section of the AOC. There is also a Butlers Gartersnake (a Wisconsin listed threatened species) population in the area that would benefit greatly from improved grassland habitat.
3. **Degradation of benthos:** Benthic organisms on the adjacent Little Menomonee River will benefit from the reduction in polluted runoff resulting from this project.

Goals and Metrics Used

Wildlife Habitat Goal	Metric Used to Evaluate Environmental Outcomes
Enhance/improve terrestrial habitat by expanding buffer width to a minimum of 75 feet, or expanding the buffer width to 400' to 1,000' to meet core or habitat area needs	• Area of native upland suitable habitat reconstructed • Area of native species restored • Area of exotic invasive species removed
Enhance/improve terrestrial habitat by identifying and enhancing existing potentially restorable habitat areas through fish and wildlife assessments (for portions of the LMR, this process is already underway from a 2011 wildlife assessment)	• Area of native upland suitable habitat reconstructed • Number of native species restored • Area of exotic invasive species removed • Area of native species restored

Timeline:
The proposed timeframe to begin woody vegetation removal is November 2013 through March 2014 and during the following growing season, July 2014 through October 2014 (dependent on the timing of funding dispersal). The second component of the project will be the dormant seeding of native prairie vegetation in October/November of 2014. The site will continue to be maintained over a 10-year period by the County, as specified in the Milwaukee County Parks restoration and management (R&M) plan for this section of the Little Menomonee River. After the initial 10-year maintenance period a subsequent 10-year plan will be developed to continue monitoring and maintenance of the site.

Permits Necessary: Due to the single entity ownership and the fact that this is predominantly an upland site, no permits will be necessary to undertake management activities.

Project Budget: The total estimated cost for project implementation would be a contract to the landowner (Milwaukee County Parks Department) in the amount of $37,000 for materials, equipment rental/purchase, and labor costs.

Great Lakes Restoration Initiative Proposal

1. **Funding Opportunity Number:**
   Focus Area: I.A. Toxic Substances and Areas of Concern
   Program: 1. Coordinated Implementation of Remedial Action Plan Programs & Processes

2. **Name of Proposal:** Assessment of Benthos and Plankton in Wisconsin's Lake Michigan Areas of Concern

3. **Points of contact:** Andrew Fayram Ph.D., Wisconsin Department of Natural Resources
   Monitoring Coordinator, Office of the Great Lakes
   101 S. Webster St., Madison, WI 53703
   Phone: (608) 267-7654
   Fax: (608) 267-2800
   E-mail: Andrew.Fayram@wisconsin.gov
   DUNS # 809-611-247

   Barbara Eikenberry, US Geological Survey
   8505 Research Way, Middleton, WI 53562
   Phone: 608-821-3832
   Fax: 608-821-3817
   E-mail: beikenberry@usgs.gov

4. **Type of Organization:** State Agencies

5. **Proposed Funding Request:** $ 414,300

6. **Brief Project Description:** Benthos (benthic invertebrate) and plankton (zooplankton/ phytoplankton) communities in Wisconsin's four Lake Michigan Areas of Concern (AOCs; Menominee River, Lower Green Bay and Fox River, Sheboygan River, and Milwaukee Estuary) and six non-AOCs were sampled in 2012 and quantified. The weather during the summer of 2012, however, was quite uncharacteristic with an early spring and record-breaking high temperatures with record drought conditions in summer. These conditions are likely to have negatively impacted the aquatic communities with extreme high water temperatures and extreme low water levels. Community analyses of the 2012 samples are in progress and may show poor community values for both AOCs and non-AOC in part due to the unusual weather conditions. Additionally, three of the four AOCs had active dredging during sampling (Fox, Sheboygan, and Menominee) that may have adversely affected measurements of the aquatic communities. In light of weather extremes during the 2012 sampling year in the Midwest, we propose that the current project be extended for two additional years, including sampling in 2014, with subsequent data analysis and interpretation in 2015 to further quantify benthos and plankton communities at these sites. The community data within and between the AOCs and non-AOCs will be analyzed in comparison with 2012 results, and the differences and similarities will assist in determining the status of the communities and, when appropriate, support delisting of the "Degraded Benthos" and "Degradation of phytoplankton/zooplankton populations" beneficial use impairment (BUI, hereafter) in each AOC. This project would be a cooperative agreement between the Wisconsin Department of Natural Resources (WDNR) and the US Geological Survey (USGS).

7. **Project Location:** Sample sites include Wisconsin AOCs and non-AOCs for potential comparison along Lake Michigan's western shore. All 10 sites that were sampled in 2012, including four AOCs and six non-AOCs, will be sampled again in 2014. A map of the

approximate sampling locations in each area is available at:
http://maps.google.com/maps/ms?ie=UTF8&hl=en&oe=UTF8&msa=0&msid=102008844605005406045.0004790db30557e1a6328

Table 1. List of AOCs and non-AOCs with latitude/longitude.

Wisconsin's Lake Michigan Areas of Concern (AOCs)	Approximate Decimal Longitude-Latitude of Harbor/River mouth	Drainage area from USGS gages (square miles)
Menominee River	-87.592264, 45.093712	3930 (Menominee at McAllister)
Lower Green Bay and Fox River	-88.004528, 44.539139	6330 (Fox at mouth)
Sheboygan River	-87.703243, 43.748877	418 (Sheboygan at Sheboygan)
Milwaukee Estuary	-87.895958, 43.025215	872 (Milwaukee at mouth)
Non-AOCs (comparison sites)		
Escanaba River/Little Bay de Noc	-87.023391, 45.718166	870 (Escanaba River at Cornell)
Oconto River	-87.830544, 44.894127	966 (Oconto River near Oconto)
Ahnapee River	-87.433056, 44.608866	Not Gaged
Kewaunee River	-87.499389, 44.459425	127 (Kewaunee near Kewaunee)
Manitowoc River	-87.651565, 44.092347	526 (Manitowoc at Manitowoc)
Root River	-87.779949, 42.732715	190 (Root River at Racine)

8. Full Project Description: The WDNR will enter into a cooperative agreement with the USGS to quantify benthic invertebrate (benthos, hereafter) and phytoplankton / zooplankton (plankton, hereafter) communities of Wisconsin's four Lake Michigan AOCs. Benthos and plankton communities at the AOCs will be compared with communities at non-AOCs along the Lake Michigan shoreline that will be used as comparison or reference sites for data analysis; use of the term "reference" in this case does not imply "pristine." The non-AOC sites were selected by Amanda Bell (USGS), and other USGS and WDNR personnel, based on similar characteristics to the AOCs such as climate, geology, soils, land-use, and geography. The inclusion of non-AOC sites will allow comparison of AOC sites to less-impacted control sites with natural physical and chemical characteristics that are as close as possible to that of the AOCs. Comparison to less-impacted control sites as site pairs and as a group is consistent with the approaches used by other Great Lakes states, such as Michigan and Ohio (Michigan Department of Environmental Quality, 2008; Ohio EPA, 2008).

This project will answer the following questions:

1. What are the current states of benthos and plankton communities in Wisconsin's Lake Michigan AOCs?
2. How do the benthos and plankton communities in these AOCs differ from selected comparison rivers and harbors that are not considered AOCs?
3. What community measures (richness, abundance, diversity, and tolerance) can be used as guides for determining benthos and plankton impairment in the AOCs?
4. Do the answers to the above questions differ between 2012 and 2014 and in what ways?

The null hypothesis is that the benthos and plankton communities in each AOC are not degraded in comparison to non-AOCs. To test the hypothesis, benthos and plankton samples in the river mouths and harbors of the four Lake Michigan AOCs and six non-AOCs along the western

shoreline of Lake Michigan will be collected to provide community data. Community-based metrics for each site will be calculated for statistical analyses. Statistical analyses will be used to detect any significant differences between paired AOC and non-AOC sites, as well as an overall AOC to non-AOC group comparison. In order to disprove the null hypothesis for each AOC, the benthos and plankton communities in each of the AOCs must be statistically different, with 90% confidence, from selected non-AOCs using a weight of evidence approach. If there is no statistically significant difference between the sampled communities from an AOC and a comparable non-AOC site, the data may be used to support delisting of that BUI once all other components of the delisting target have been met. Differences and similarities will assist the WDNR and USEPA in determining whether or not the "Degraded Benthos" and "Degraded Plankton" BUIs are still valid for each AOC. If statistically significant differences do exist between AOC and non-AOC sites, future examination of the potential causes of the impairment will be required. Characterization of current benthos and plankton populations is a critical first step that must occur before these BUIs can be considered for delisting. The Milwaukee Harbor and Green Bay are large and far more complex systems than any other harbors or rivers along the western Lake Michigan shoreline. Comparing these AOCs to the non-AOCs is not plausible and, therefore, the information gained from these systems will provide a baseline community assessment for future comparisons within those systems with regard to the BUIs.

9. Timeline: The project would encompass two years of work, with data collection in Year 1 and data analysis and report writing in Year 2.

Year 1 – Data Collection
Sample collection and data analysis will begin in the first year. Artificial substrates would be set out 4-6 weeks before the initial sampling. Sampling will be conducted three times per sampling year during the growing season: the spring sample will be collected in May/June; the summer sample will be collected in July/August; and the fall sample would be collected in September/October. The sampling events will be separated by at least 4 weeks, but preferably 6 weeks to ensure adequate recolonization of artificial sampling devices.

As in 2012, only non-wadable portions of the sites will be sampled to simplify comparisons between AOCs and non-AOCs, and to minimize the variability associated with benthos in complex river/stream systems. Data collected will include parameters to characterize the sites, and the benthos and plankton communities. Details of all data to be collected and associated methods follow below under Methods.

Year 2 – Analysis and Report Writing
The second year will consist of finalizing the data analysis and report writing. A USGS Digital Data Series report will be prepared and an article detailing the methods, data, and results of this project will be submitted to a peer-reviewed journal for publication. Progress reports will be prepared and submitted to WDNR and the U.S. Environmental Protection Agency (USEPA) in January and July for each of the years that the project is continuing. All reporting required by USEPA will be completed by the USGS and WDNR.

The above timeline is based on awarding of funds on or before March 1, 2014 or 90 days prior to the spring sampling, due to the time required for project and personnel planning, QAPP preparation/approval, and equipment/supplies requisition. If the award is not received on or before March 1, 2014, the first sampling would not occur until summer. If the award is not received on or before June 1, 2014, the first sampling would not occur until the following spring. In addition, all milestones and the completion date of the project would shift accordingly, based award timing.

Table 2. Project timeline (dependent on timing of GLRI award)

Date	Milestone
Spring 2014	GLRI grant award
	Plankton and benthos collections begin
Fall 2014	Plankton and benthos collections complete
Winter 2014	Data received from laboratories reviewed and data analysis begins
Summer 2015	Data analysis completed and report/journal article submitted for review and publication
Winter 2015	Final report submitted to WDNR and USEPA

10. Approach/Methods: All methods for sample collection are based on (1) reports published or methods used by the USEPA for large rivers and lakes or on (2) peer-reviewed papers publicly available. All sample collections will be performed by boat, so that towing and retrieval speed can be calculated. Coordinates of each sampling location will be recorded on a GPS unit. To assess the degradation of the communities, multiple sample types will be collected three times in one year. Two types of composite benthos samples will be collected for sampling invertebrates: one using a Ponar dredge and the other using artificial substrates (Hester-Dendy multi-plate samplers). Two types of composite plankton samples will be collected: one using a tow net for sampling zooplankton and the other using a water depth-profile sampler for sampling phytoplankton.

Ancillary field measurements to be taken at each sampling event include water temperature, dissolved oxygen, pH, and specific conductance using a water-quality sonde. Sediment samples will be collected from each of five Ponar dredges to be composited for particle-size analysis and loss-on-ignition, to determine substrate size and type and estimate organic matter content at each location.

The Milwaukee Estuary and Lower Green Bay/Fox River AOCs each have unique characteristics that must be studied in a slightly different manner and, therefore, the data collected for those AOCs will be used as baseline data for future analysis. Because three separate and unique river systems converge to create the Milwaukee Inner Harbor, one sample will be collected within each of the three river systems and an additional sample will be collected in the Inner Harbor. These separate samples will be used to determine if the benthos and plankton communities in each of those systems are degraded or if a particular system is more degraded and requires more remediation for these BUIs than the other systems. The Lower Green Bay/Fox River AOC is unique because there is extensive remediation occurring in the river, and the bay is different from any other system in the Great Lakes with regard to size, connection/separation to the lake, and a shift from highly eutrophic in the lower bay to highly oligotrophic in the upper bay. For this AOC, two separate sampling locations within the area will be sampled: one in the lower Fox River and one in Lower Green Bay. The Fox River sampling location has historical benthos data from the Green Bay Metropolitan Sewerage District (GBMSD) and every effort will be made to maintain spatial consistency with the historical location; samples from the GBMSD site will be similar to the other AOCs in that both benthos and plankton communities will be sampled. Benthos and plankton communities will be sampled in lower Green Bay but, due to depth and wave action in the bay, artificial samplers will not be deployed for benthos in the bay.

Sampling will be conducted three times per year during the growing season and the overall sample collection structure for each trip is provided in Table 3. Details of each of the collection methods follow.

Table 3. Sample structure to be repeated during each of the three sampling events. Sites are listed from north to south, and sites highlighted in blue are AOCs.

Location (Sampling site)		Replicate	Ponar Dredge	Artificial Substrate	Plankton Tow	Plankton Depth Profile
1. Escanaba River			X	X	X	X
2. Lower Menominee River			X	X	X	X
3. Oconto River			X	X	X	X
4. Lower Green Bay and Fox River	Fox River (near Fox Point)		X	X	X	X
	Lower Green Bay		X		X	X
5. Ahnapee River			X	X	X	X
6. Kewaunee River			X	X	X	X
7. Manitowoc River		X	X	X	X	X
8. Sheboygan River		X	X	X	X	X
9. Milwaukee Estuary	9A. Milwaukee River		X	X	X	X
	9B. Menomonee River		X	X	X	X
	9C. Inner Harbor		X	X	X	X
10. Root River			X	X	X	X

Benthos Collection

The two methods for benthos collection are based on the USEPA's Assessment and Remediation of Contaminated Sediments (ARCS) Program Assessment Guidance Document, Chapter 7—Assessment of Benthos Community Structure (EPA 905-B94-002): one using a Ponar dredge for natural/in-situ substrates and one using artificial-substrate samplers.

A Ponar dredge will be used to collect benthos samples at each site during each sampling event. Depending on substrate types, three to five subsamples will be collected with the Ponar dredge and composited into a single sample per site each trip. To minimize costs of analyzing multiple benthos samples for each location, compositing the subsamples into a single sample will produce a more comprehensive taxa list for the locations and will then be more comparable between sites. Although USEPA's ARCS does not require more than one sample per location, the investigators feel that a composite sample will more accurately reflect the communities within the AOCs and non-AOCs (http://www.epa.gov/reg3hscd/risk/eco/faqs/composite.htm). A small amount of sediment will be collected from each Ponar dredge subsample to be composited for particle-size analysis and loss-on-ignition to determine substrate size, type, and organic matter content. The

sediment particle size samples will be sent to WSLH and loss-on-ignition analyses will be conducted by the USGS. Each grab sample will be elutriated to remove debris, larger sand and inorganic particles and rinsed to remove finer sediment through a 500 µm wash frame. The 5 individual Ponar samples will be composited, transferred into a collection bottle, and preserved with formalin solution before sending to Dr. Schmude at the University of Wisconsin–Superior for identification and enumeration.

Four tandem artificial-substrate samplers will be deployed at each site, two each attached to a single concrete block, and anchored to immobile structures. These artificial substrate samplers will be deployed four to six weeks prior to the first sampling event to allow adequate time for colonization. The invertebrates that have colonized the samplers will be scraped into sample bottles and the artificial samplers will be re-deployed for the next sampling event. Artificial samplers will be deployed at one location at each site, GPS locations captured, allowed to colonize for 30 days, retrieved, rinsed through a 500µm wash frame, transferred into a collection bottle, and preserved with formalin solution before sending to Dr. Schmude at the University of Wisconsin-Superior for identification and enumeration.

Table 3. Summary of benthos sample types, analysis laboratories, and information gained.

Sample type	Disposition	Information gained
Ponar grab	University of Wisconsin–Superior	Community assessment of benthos
	USGS	Loss-on-ignition estimate of organic matter content
	WSLH	Sediment particle size distribution
Artificial substrate	University of Wisconsin–Superior	Community assessment of benthos

Plankton Collection

Two types of plankton samples will be collected: one using a tow net and the other using a water depth-profile sampler.

One tow-net sample is collected at each station from 20 meters below the water surface to the surface using a 63µm net. If the station depth is less than the specified depth, the tow is taken from about 0.5 meters above the bottom to the surface. The tow net, with a screened sample bucket attached at the bottom, is lowered to the desired depth, and raised at 0.5 meters/second to collect zooplankton from the water column. After lifting the net from the water it is sprayed with water from a garden hose to wash organisms down into the bucket. The sample is concentrated into the sample bucket and is transferred to a sample storage bottle. The organisms are narcotized with soda water and preserved with glutaraldehyde before being sent to the analysis laboratory. The methods for zooplankton collection are based on the USEPA's Standard Operating Procedures (SOPs) for zooplankton sample collection and preservation for Great Lakes National Program Office's (GLNPO) Water Quality Survey (WQS) (LG402, Revision 10, March 2005); however, because the samples will be collected in the harbors, bays and rivers, the deeper water sample will not be collected.

Using a Van-Dorn style water depth-profile sampler, 1 liter of water from each meter of depth will be collected and composited for a maximum of 20 liters of water. Using a standard water splitter, several aliquots will be taken from this composited whole water sample. Two aliquots

will be filtered for chlorophyll a and ash-free dry mass analysis and immediately frozen on dry ice for shipment to the WSLH. Two additional one-liter aliquots will be preserved with glutaraldehyde; one will be sent to Dawn Perkins at WSLH for soft algae phytoplankton identification and enumeration, and one will be sent to Paul Garrison at the WDNR for diatom phytoplankton identification and enumeration. Taxonomic identification of plankton will be to the lowest practical level.

Table 4. Summary of plankton sample types, analysis laboratories, and information gained.

Sample Type	Disposition	Information gained
Tow net	WDNR	Community assessment of zooplankton
Depth-profile Sampler	WSLH	Chlorophyll a concentration
	WSLH	Ash-free dry mass
	WSLH	Community assessment of soft algae phytoplankton
	WDNR	Community assessment of diatom phytoplankton

Quality Assurance

The Quality Assurance Project Plan for the 2012 study will be amended as needed for the 2014 study to document quality assurance methods. Triplicate zooplankton tows and benthos samples will be collected at one location for each sampling event for a total of 20% sampling replicate. These co-located replicate samples will be collected within a 100-m^2 area at each station. The data collected from the replicate samples will be compared to original samples to determine sampling and laboratory efficiency. If it is determined that the replicate samples are within 7% of the original sample data for each data type collected, the original sample will be used for further data analysis. If the replicate samples are greater than 7% of the original sample data for each data type collected, then values of the three replicate samples will be averaged and that value will be used for further data analysis.

To minimize disturbance of the different sampling substrates, samples will be collected in the following order: water quality data, plankton tows, depth-profile samples, Ponar grab samples, and deployment or retrieval of artificial samplers. Because no other water or sediment samples are included in this proposal, the samples for this proposal will be collected without regard to other samples.

Data Analysis

Multivariate, multi-metric, and correlation methods will be used to analyze the data. Software designed to incorporate the non-normality of ecological data will be used to analyze variability in the biological community data from the sampled AOCs and non-AOCs. Using non-parametric multivariate statistical analyses in the PRIMER statistical program (Clarke and Gorley, 2006) and observed-over-expected (O/E) methods developed by Meador et al. (2008), the community data will be compared amongst the sites and differences between taxa richness, composition, and abundance will be determined for benthos and plankton communities. Routines to be used in PRIMER will likely include nMDS (non-metric Multi-Dimensional Scaling) to derive plankton and benthos community site scores; PCA (Principal Components Analysis) to derive environmental site scores; and ANOSIM (ANalysis Of SIMilarity) to determine the extent plankton and benthos communities vary across sites. Probability values are based on 1,000

random permutations that are used to develop a nonparametric probability distribution. Site-specific scores based on similarities between communities will be used to determine whether a given site is statistically different from the others. Location specific differences such as drainage area, substrate, soil type, latitude/longitude, land cover, and climate will be incorporated as well. This information will be used to determine if the BUIs in the AOCs are impaired when compared with the non-AOC site pairs and group, and if there are no differences to support delisting of beneficial use impairments for delisting the AOCs.

11. Relevance to the Great Lakes, Existing Comprehensive Plans & Great Lakes Restoration Efforts

Great Lakes Areas of Concern (AOCs) are severely degraded areas within the Great Lakes Basin where beneficial uses have been identified as impaired. This proposal seeks the funds necessary to evaluate the status of two use impairments (Degraded Benthos and Degraded Phytoplankton / Zooplankton Populations) in Wisconsin's four Lake Michigan AOCs. It builds upon ongoing work by Amanda Bell and others of the USGS. Delisting beneficial use impairments is a high priority referenced by the following programs and documents:

Great Lakes Restoration Initiative Action Plan (http://greatlakesrestoration.us/pdfs/glri_actionplan.pdf) —The Great Lakes Restoration Initiative Action Plan (USEPA 12/3/09) lists "comprehensive monitoring and assessment" as a principle action for Focus Area 1 (Toxic Substances and Areas of Concern). This project will assess the status of seven beneficial use impairments: degraded benthos in four AOCs and degraded plankton populations in three (Menominee not impaired). If the uses are not impaired (compared to non-AOC sites), the data will provide the supporting documentation for delisting and contribute to achieving measure of Progress 2, number of "AOC BUIs removed" (p. 19, USEPA 2009).

USEPA's Strategic Plan 2006-2011 (http://www.epa.gov/ocfo/plan/plan.htm)—Subobjective 4.3.3 (Improve the Health of Great Lakes Ecosystems) strategic targets include "By 2010, restore and delist a cumulative total of at least 8 Areas of Concern" (p 98, USEPA 2006). This proposed evaluation of seven use impairments will be a critical step in identifying whether or not the benthos and plankton communities in four Wisconsin AOCs are impaired compared with non-AOCs sites. This step was identified in the AOC delisting targets and must be completed before the use impairments can be considered for delisting.

Lake Michigan Lakewide Management Plan 2008 (http://epa.gov/greatlakes/lamp/lm_2008/index.html) —Results of this project will help answer the question posed by Subgoal 4 of the Lake Michigan LaMP: "Are all habitats healthy, naturally diverse, and sufficient to sustain viable biological communities?" (USEPA 2008) for the four AOCs.

Great Lakes Regional Collaboration (GLRC) Strategy to Protect and Restore the Great Lakes (http://www.glrc.us/strategy.html) —A recommended action to address obstacles to restoring the AOCs is "providing for the program capacity needed to develop measurable endpoints, design and implement remedial actions, and measure results" (p 37 GLRC 2005). The strategy further states that the "research, remediation and monitoring needed to achieve these restoration targets must be identified, funded, and implemented" (p 37 GLRC 2005). This proposal seeks the funds necessary to conduct the research and monitoring needed to assess and possibly demonstrate the ability to delist these use impairments.

Wisconsin's Great Lakes Strategy (http://dnr.wi.gov/topic/greatlakes/documents/GLStrategy2009Final.pdf) —This proposal addresses a key point in Wisconsin's strategy by requesting the funds needed to "Evaluate and delist BUIs when monitoring demonstrates that targets have been met" for Wisconsin's four Lake Michigan AOCs (p 28, WDNR 2009).

Area of Concern Beneficial Use Impairment Delisting Targets (http://dnr.wi.gov/topic/greatlakes/aoc.html) —WDNR developed delisting targets for the four Lake Michigan AOCs. Evaluation of the status of the benthos and plankton communities relative to reference conditions is a critical step in determining whether or not the beneficial uses are currently impaired and is mentioned in the delisting targets documents for the Milwaukee Estuary, Lower Green Bay and Fox River, and the Sheboygan River (WDNR 2011a, 2011b, and 2011c).

Area of Concern Stage 2 Remedial Action Plan (RAP) Updates —

- Milwaukee Estuary (http://dnr.wi.gov/topic/greatlakes/documents/Stage2RAPMilwaukee.pdf)
- Lower Green Bay and Fox River (http://dnr.wi.gov/topic/greatlakes/documents/Stage2RAPGreenBay.pdf)
- Sheboygan River (http://dnr.wi.gov/topic/greatlakes/documents/Stage2RAPSheboygan.pdf)
- Menominee River (http://dnr.wi.gov/topic/greatlakes/documents/stage2RAPLowerMenominee.pdf)

12. Facilitation of USEPA oversight & administration: The level of USEPA oversight and administration necessary to successfully implement this project is minimal. Assessment of two use impairments at four AOCs have been combined in a single proposal to minimize the reporting requirements associated with this grant proposal.

WDNR and USGS have over 40 years of cooperative history collecting and analyzing data and publishing their findings in USGS and WDNR reports and peer-reviewed journals.

13. Education/outreach plan to disseminate results: USGS and WDNR will present the results to each AOC Citizen Advisory Committee. USGS will coordinate with WDNR to ensure a sampling event is captured by photo and/or video for inclusion in AOC education and outreach materials. Final results of the data and analysis will be published as a USGS Digital Data Series report, and an interpretive report will be submitted to a peer-reviewed scientific journal for publication.

14. Potential for transferability: The results of this project will assist other AOCs with Degraded Benthos and Degraded Phytoplankton/Zooplankton populations determine appropriate levels of monitoring to characterize AOCs. Non-AOC reference site data may be useful for comparison with other AOCs, if they have similar physical, chemical, and biological characteristics. For example, the St. Louis River Estuary is Wisconsin's only other AOC and is located on Lake Superior. The results of this project will be useful when determining the study design necessary to evaluate that AOC's "Degraded Benthos" beneficial use impairment.

15. Outcomes, Outputs, and Expected Results: This project will definitively determine the status of and result in measurable progress towards delisting up to 7 beneficial use impairments.

Data will be collected and analyzed to re-evaluate these existing beneficial use impairments to determine if they are still applicable, an expected result from projects in this program (EPA GLRI RFP p I-2). The results will also help identify further actions needed to restore beneficial uses.

The expected outcomes of this study are to determine the baseline conditions of two beneficial use impairments in four AOCs along Wisconsin's Lake Michigan shoreline. Species/taxa lists for each of the sample types (Ponar, plankton, and artificial substrate) will be provided from the analytical laboratories. These community data will be summarized based on metrics such as nutrient, oxygen, and pollution tolerance, functional feeding groups, substrate preference, and family/taxonomic groupings from Barbour et al. (1999), and Porter et al. (2008), among others. By determining the taxonomic differences between the AOCs and non-AOC sites, the beneficial use impairments can be quantified for the sites in question. Data from the non-AOC sites will be used to determine a preferred taxonomic composition for each AOC which then may be re-evaluated for the zooplankton and benthos Beneficial Use Impairments.

Table 5. Summary of Project Results, Output, and Outcome, 2011-2015

Description of Project Result	Output	Outcome
Compilation of historic benthos and plankton community data for AOC and non-AOC locations	Endnote Library created and available literature brought to common location.	Compiling the abundant relevant agency reports and publications on benthos and plankton communities in one location will allow for new interpretation of historic results. Authors of future RAP updates will be able to easily access relevant data.
	Listing and/or map of historic sample sites at each location.	List may be used to inform decisions about where to sample at each location.
Quantification of Benthos communities	Baseline: unknown BUI status in 4 AOCs Output: definitive determination of BUI status in 4 AOCs. Metrics such as taxonomic richness, pollution tolerance, and functional feeding group generated for 4 AOCs and 6 non-AOCs.	Data will be used to characterize current benthos populations and determine appropriate metric for evaluating impairment.
Quantification of Phytoplankton / Zooplankton communities	Baseline: unknown BUI status in 3 AOCs Output: definitive determination of BUI status in 3 AOCs. Metrics such as taxonomic richness, diversity, and pollution tolerance generated for 4 AOCs and 6	Data will be used to characterize current phytoplankton / zooplankton populations and determine appropriate metric for evaluating impairment.

Description of Project Result	Output	Outcome
	non-AOCs.	
Comparison of AOC and non-AOC benthos and plankton communities	Baseline: • 4 Degraded Benthos BUIs • 3 Degraded Phyto/Zooplankton BUIs Output: • Potential delisting of up to 7 BUIs	Evaluation is a necessary step to re-evaluate if the BUIs are still applicable. All other relevant criteria in delisting target documents for these BUIs will have to be met.
Final Report and Peer-reviewed journal article	Publication of results in a widely accessible format.	Scientific peer review will lend additional credibility to decisions made based on data.
Coordination with AOC citizen committees (e.g. CAC, PAC, or STAC)	• Consultation with AOC groups prior to sampling • Presentation of results to AOC groups	Inclusion of AOC groups as project is developed and executed will increase public understanding and support for decisions about delisting based on the results of this project.
WDNR photographs and/or video of sampling event	Photos and/or video of sampling equipment and methods.	AOC community outreach and education materials will make the results accessible to the public in an understandable manner.

16. Collaboration, Partnerships, and Overarching Plans: The WDNR will collaborate with the USGS in Middleton, WI to perform necessary data collection, sampling, data analysis and reporting. All phases of the project will be coordinated with AOC site managers and LaMP coordinators. Where feasible, effort will be made to coordinate with other ongoing studies at these sites by the WDNR, USGS (J Larson and others), other agencies, and universities with regard to sampling timing, specific location within each AOC or non-AOC, and data sharing. Additional collaboration with analytical laboratories to perform taxonomic identification of the samples includes:

- Paul Garrison from the WDNR will identify zooplankton and diatom phytoplankton
- Dawn Perkins from the WSLH will identify the soft-bodied phytoplankton
- Dr. Kurt Schmude at UW Superior will identify benthic invertebrates (http://www.uwsuper.edu/acaddept/naturalsciences/employees/kurt-schmude_employee77608)
- WSLH will also analyze sediment particle size distribution in benthos samples, chlorophyll a, and ash-free dry mass

AOC public stakeholder groups will be consulted prior to initiation of sampling, and results of the sampling will also be presented to them. Inclusion of AOC groups as the project is developed and executed will increase public understanding and support for decisions about delisting based on the results of this project.

Relevant overarching plans to this project include the AOC delisting targets, RAPs, Wisconsin's Great Lakes Strategy, and the Great Lakes Regional Collaboration Strategy (project relevance to each previously described in Section 8 of this proposal, see p 7 and 8).

17. Programmatic Capability and Past Performance: The WDNR has had the opportunity to be a USEPA grant recipient for the past three decades and has been able to consistently demonstrate grant performance accountability. WDNR grant management is a joint effort that consists of multiple mechanisms to ensure expected outcomes and deliverables have been satisfactorily met.

Internal GPO's (Grant Project Officer's) are dedicated to each project to provide oversight and coordination. WDNR project officers have been able to satisfactorily meet reporting requirements as outlined in the grants programmatic and administrative conditions (annual, and/or semiannual, and final) for all grants received to date. Project Officers are responsible for meeting technical reporting and periodic project status requirements conveyed though reporting updates or communication/correspondence with USEPA.

Financial accountability has been demonstrated through systematic tracking by our staff grant accountants and financial accountants. State budgetary information systems track project activity and project related expenditures in order to provide accurate fiscal reporting. State procurement policies and processes provide guidelines to ensure funds are managed appropriately. Financial reporting is completed on a quarterly basis as required in programmatic terms and conditions to include a Final Federal Financial Reports (SF-425). Our financial representation has also established credibility for providing additional final reporting requirements; MBE/WBE reporting, Property Reports, Disclosure of Inventions, etc.

Historically, the WDNR has been successful in meeting grant recipient requirements and expectations. We appreciate the opportunity to continue to demonstrate our high performance standards and anticipate these to strengthen in the near future.

17. Budget: The following table outlines the total cost of the proposed project, which is a cooperative agreement between WDNR and the USGS. WDNR will use the grant funds to pay for analytical costs to minimize costs. Contractual category includes salary, fringe, supply, and travel costs for USGS, WSLH, WDNR, and UW Superior. The contractual costs are mostly associated with laboratory costs. One of the laboratories is run by WDNR so no competitive sourcing is necessary. WSLH is a state-owned lab that has contractual services with the WDNR and USGS for discounted prices. The other laboratory is a university that specializes in the types of samples being collected (benthos). No other laboratories in the Midwest were able to process the samples with the expertise of the selected labs with regard to the Great Lakes benthos fauna.

Summary	
Personnel/Salaries	$0
Fringe Benefits	$0
Travel	$0
Equipment	$0
Supplies	$0
Contract Costs	
UW—Superior	$37,650
WDNR	$18,000
WSLH	$10,350
USGS	$345,800
Total	$411,800
Construction Costs	$0
Other Costs	$2,500
Total Direct Charges	$414,300
Indirect Charges	$0
Total Cost	**$ 414,300**

18. References

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Meador, M.R., Carlisle, D.M., and Coles, J.F., 2008, Use of tolerance values to diagnose water-quality stressors to aquatic biota in New England streams: Ecological Indicators, v. 8, no. 5, p. 718-728.

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