Proposal to Establish the
Great Lakes Genomics Center

A. Proposed Name: Great Lakes Genomics Center

B. Brief Description, purpose and justification:

Remediation, restoration, protection and management of the nation’s Great Lakes and freshwaters demands highly specific knowledge of its ecology and how the biology of these complex systems interact with their environment, human imposed stresses, climate change, invasion non-indigenous species, an influx and evolution of pathogens, and the development of emerging contaminants (e.g., nano particles, hormones). Understanding these linkages is significantly hindered by our inability to identify and quantify organismal responses to these forces. Modern molecular techniques are enabling this to be achieved. The field of environmental genomics is providing the ability to understand intra- and inter-biotic interactions and the environmental conditions that shape these parameters to be understood. Our goal: unite research and educational training, to attract major research funding and high-caliber scientists and students.

The Great Lakes Genomics Center (GLGC) will serve as a focal point for collaborative research and training. The Center will build a cohesive scientific community and provide infrastructure to enable cutting edge molecular and genomic approaches to address problems in conservation, restoration and ecosystem and human health in the Great Lakes.

The thread that connects all organisms is the genetic backbone encoding all information needed for life that is passed from generation to generation. That backbone is constructed of a genetic code (genome), which is specific for individuals and can be used as a unique tag to identify organisms at various levels from populations to species, to individuals. Following the central dogma of molecular biology, the genetic code is translated to intermediate products (the transcriptome) that reflect the metabolic state of an organism under different conditions (stressed/nonstressed, polluted/nonpolluted). This can be used to indicate the health and well-being of organisms and their surrounding environments. Until recently, thorough analysis of this genetic code to uniquely identify organisms or to assess their transcriptome has been hampered by the cost and labor requirements of traditional laboratory techniques.

Recent developments in Next Generation Sequencing platforms (PacBio, Roche 454, Illumina-Solexa, ABI-SOLiD) has revolutionized the life sciences, giving researchers the ability to rapidly and economically interrogate the entire transcriptomes and genomes of any organism(s) from viruses; to sturgeon; to ecosystems. Using these new sequencing technologies and intensive bioinformatics, the GLGC will be able to provide the necessary infrastructure to:

- Generate a taxonomic genome inventory of Great Lakes aquatic organisms;
- Monitor the spread of invasive species;
• Monitor ballast water as surveillance for new invaders;
• Assess the impact of current invasive species on biogeochemical cycling and ecosystem health
• Assess urban impacts on nearshore coastal health, including non-point runoff, emerging contaminants and pathogens;
• Assess the effects of stress and the alleviation of stress in populations and the chronic, sublethal toxicity effects of pollutants at levels far below standard limits of detection;
• Employ new indicators for identifying sources of fecal pollution and waterborne pathogens;
• Utilize gene expression in aquatic sentinel and model species to evaluate potential human health effects of exposure to contaminants and other stressors
• Track indigenous populations of aquatic organisms for breeding and geographical patterns, and the potential loss or gain of biodiversity;
• Delineate fish populations as management units for commercial and recreational harvest, facilitating better stocking success and needs, setting harvest quotas, etc.;
• Elucidate roles of Lake Michigan microbes in biogeochemical cycling of carbon and other key nutrients/elements
• Monitor habitat integrity, biodiversity, and food web structure in Great Lakes ecosystems.
• Develop tools to enhance immediate monitoring of water quality measurements
• Invent and commercialize new sensor and sentinel systems for diagnosing ecosystem health, protecting water security, monitoring waterborne pathogens, and tracking restoration and mitigation strategies;

While genomics is routinely applied to marine environments for cataloging and identifying marine organisms, little work has been done to undertake an inventory of aquatic organisms over various trophic levels in the Great Lakes. If we are to assess the effect of anthropogenic impacts, invading species, pathogens, and the effects of restoration efforts on freshwater systems, it will be imperative to identify the organisms within freshwater habitats and to assess their responses on global scales. This can only be done through genomic analyses.

Development of genomic assessment techniques has significant commercial spin-off potential. Sensors and methodologies based upon molecular techniques incorporating rapidly developing nano-technologies, micro-fluidics, and genomic markers will have broad application in freshwater resource monitoring, biosecurity, and environmental remediation.

The center will use "next" and "3rd" generation sequencing capability along with enhanced computational and bioinformatics capacity of the center to enable genomic sequence data to be analyzed, archived and made web accessible to the research community and the public. The resulting data will also serve to develop hypothesis and exploratory driven grant proposals directed toward agencies such as NSF, NIH, EPA, NOAA and military based grants such as ONR DOD etc.
The Center will also serve as a training center for researchers, students, and professionals throughout the Great Lakes region. Training will be provided, not only in hands-on application of these techniques for practitioners, but also in demonstrating to resource managers how these techniques can be applied to addressing and solving management issues, setting standards, establishing quotas and targets for restoration, and informing resource policy.

C. Organizational structure, including the method of appointment and term of office for the director:

The organization of the GLGC will be as follows:

1. The GLGC will report to the Dean of the School of Freshwater Sciences (SFS), or his or her designee.
2. The GLGC Director will be appointed for two-year terms by the Dean of SFS.
3. The GLGC Director will meet with an Advisory Board consisting of the SFS Associate Dean for Research, the SFS Dean, the Provost, the Vice Chancellor for Research (or their representatives), and one faculty member from the Center (nominated from Center faculty on a rotating basis) at least once per year. The Advisory Committee will review progress and provide guidance for future development of the Center.
4. The GLGC Director will meet with a Science Advisory Board which will consist of reputable scientists in Genomics that will provide guidance to the Director for the direction of the Center and potential beneficial interactions and activities that the Center may want to initiate. This Board will also include at least one external liaison from the organizations funding research within the Center.
D. List of resources to be committed to the center, including their source:

1. Facilities and Support:
The new School of Freshwater Sciences building has dedicated space for the Center. This includes 920 sq feet of state of the art lab space that can support next generation sequencers, other molecular analysis equipment. One shared office will be available for the two technical positions. Computing resources will be through shared campus computing center, in which SFS has prioritized $300,000 towards investing in this resource. Temporary space is available in the existing WATER Institute building to house new equipment as it is purchased.

The UWM Foundation and faculty of the CGLG have also obtained $1,000,000 from the Milwaukee Metropolitan Sewerage District in support of creation of the Center and an additional $500k grant from the Fund for Lake Michigan for equipment and projects relevant to the mission of the Center and that of the Fund.

2. Personnel:

The Center will have an appointed Director with 25% effort dedicated to Center operations and coordination of research collaborations. The Center will also have two full time technical positions, one specializing in bioinformatics and one specializing in molecular biology/sequencing technologies. Salaries of the Director, Scientists and Researchers are supported by the SFS at UWM. Likewise, support functions, including operations and maintenance personnel are staff at the SFS. Salary support for personnel is estimated at $190,000.

3. Genomics Innovation Research Program. The Center will fund initial pilot projects to gain preliminary data and foster collaborations among Center faculty. Project outcomes will be integral in demonstrating the power and usefulness of genomic approaches to solving freshwater problems. The Genomics Innovation Research Program will be supported by the School.

4. Web site Development. Initial web site development will be supported by the School, with $25,000 in funds. Once established, the website will be updated by the Center faculty and maintained by the School.

5. Research Support:
Faculty and Scientists at the School of Freshwater Sciences have multiple projects that utilize genomic technologies. Below is a list of current research that would utilize the Center and support Center activities:

"Identification of new indicators of waterborne disease threats" (McLellan, PI) National Institutes of Health (NIAID). Funding Period, 7/01/11 to 6/30/15; total costs 1,538,734
"Application of Molecular-Based Methods for Investigation Sources of Fecal Pollution at Great Lakes Beaches" (McLellan, PI) University of Wisconsin Sea Grant Program. Funding period, 2/01/10 to 1/31/12; total costs: $229,975.

"Developing a State-Level Health Impact Assessment of Climate Change in Wisconsin" (Anderson, DHS, PI; McLellan, Investigator) Centers for Disease Control. Funding Period 09/30/09 to 09/29/12; total cost (McLellan) $120,000.

The unstudied majority: Microbial genetic diversity in the world's largest freshwater ecosystems (Newton, PI, McLellan Co-PI). Joint Genome Institute. Pending; total cost $450,000

"Multigenerational impacts of manufactured nanomaterials" National Science Foundation ($274,972; 2011-2014); (R. Klaper PI)

"Impact of the structure of manufactured nanomaterials on the ecologically important model species Daphnia pulex", National Science Foundation ($360,000, 2009-2012); (Klaper, PI)

Nanoparticle- Daphnia Interactions: Identifying Biomarkers, UW-Madison/UW-Milwaukee Intercampus Grant ($50,000) (Hamers PI ---Klaper Co-PI).

Non-Invasive Sex Identification of Lake Sturgeon ($74,000; 2011-2013)(R. Klaper PI)

USEPA Great Lakes Restoration Initiative, Cheryl Murphy (Michigan State University, PI), Michael Carvan (Investigator, PI of UWM subaward), "Scaling the subtle effects of MeHg to perch population dynamics", 8/1/2010-7/31/2013, GL00E00496-1 $515,000 total costs (UWM subaward $252,791).


National Science Foundation, Istvan Laulco (UWM Mathematical Sciences, lead PI), Michael J. Carvan and others (PI), "UBM-Group: Integrated Undergraduate Research Experiences in Aquatic Biology and Mathematical Sciences at the University of Wisconsin Milwaukee", NIEHS Marine & Freshwater Biomedical Sciences Center, Pilot Project Program, University of Wisconsin-Milwaukee, Michael J. Carvan (PI), "High throughput screening of zebrafish
DUE-0827217, 10/01/2011-9/30/2016, $754,546 total costs.
mutants: identification of genes with environmental health relevance", 06/01/2010-08/31/2011, no cost extension, $20,000 direct costs.


UW-Madison-Milwaukee intercampus collaborative grant - Young EB and Graham LE (co-ils) Freshwater algal communities used for wastewater bioremediation and bioenergy production: characterization of algal and microbial community dynamics. $49,252. 07/10 - 12/11.

"Collaborative Research: Causes and mechanisms of cell death in freshwater phytoplankton" (Berges, PI) National Science Foundation. Funding Period, 09/01/11 to 08/31/14; $417,666 to UWM.

E. List of individuals to be associated with the Center:

1. Scientists and Researchers:

Sandra McLellan, Associate Professor and Senior Scientist
Rebecca Klaper, Associate Professor
Matt Smith, Assistant Professor
Woo-Jin Chang, Assistant Professor, CEAS
Michael Carvan, Associate Professor
Fred Binkowski - Senior Scientist
J. Val Klump Senior Scientist, Professor
Erica Young, Associate Professor, Biological Sciences and SFS affiliate
John Berges, Associate Professor, Biological Sciences and SFS affiliate
Todd Miller, Assistant Professor, Public Health
Jerry Raster, Associate Professor
Filipe Alberto, Biological Sciences

2. GLGC Staff

a. Bioinformatics specialist, 12 mo. appointment, permanent staff, reports to the Director
Life Sciences Researcher and Sequencer Specialist, 12 mo. Appointment, permanent staff, reports to the Director
Center Postdoctoral Fellows (supported from Grants)
Graduate Research Assistants (supported from Grants and Traineeships)

3. Collaborators:

NIEHS Marine & Freshwater Biomedical Sciences Center, Pilot Project Program, University of Wisconsin-Milwaukee, Michael J. Carvan (PI), "High throughput screening of zebrafish
WI DNR Fisheries Management staff
UW Sea Grant Institute
USDA ARS staff:
University of Toledo, Lake Erie Center staff
NOAA Mill Center of Excellence  
US EPA  
Children's Environmental Health Sciences Core Center (funded by NIEHS)

F. The long term future and long range plan for the Center:
Research programs headed by SFS and other affiliated faculty align closely with the Center capabilities; therefore, this Center is anticipated to be central to supporting collaborations among investigators and advancing individual research program capabilities over the long term. Because sequencing technologies and bioinformatic analysis is a large component of several of the faculty's research, the Center will provide a training platform for graduate students and post docs within SFS and other affiliated Departments. Further, the Center has an opportunity to become a resource for scientists and researchers across the greater scientific community to provide access to technologies that are cost prohibitive to establish at separate institutions. This will enhance research opportunities and expertise to the SFS by enabling collaborative efforts with regional and international partners. This will lead to new and novel funding opportunities and will highlight the SFS as a world leader in aquatic biotechnology. As sequencing technologies are rapidly evolving and the Center will keep pace with these technologies by updating sequencers through traditional funding stream (e.g., NSF or NIH), industry partners or awards from philanthropic foundations. The majority of the work performed within the center could be applied to each of those potential streams of funding.

Fundraising efforts in support of the Great Lakes Genomics Center are ongoing. We have a $1 million proposal in support of nextgen sequencer equipment under consideration with one source and have received $500k in matching funding from the Fund for Lake Michigan. In total, SFS' current fundraising efforts to support the Center total $2 million in potential gifts, with significant opportunities for additional fundraising once the Center is established.