
Name of Organization: USGS

Type of Organization: Federal Agency

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Project Title: Use of Hexagenia as an indicator of ecosystem health

Project Category: Habitat (Ecological) Protection and Rest

Rank by Organization (if applicable): 0

Total Funding Requested (\$): 107,100 **Project Duration:** 2 Years

Abstract:

This preproposal addresses the development of a basinwide indicator of ecosystem health for Great Lakes mesotrophic waters based on Hexagenia production or biomass, as outlined in SOLEC98. The indicator will be developed so that the resulting information can be used to advise the governments of the United States and Canada, the International Joint Commission, and the interested public about progress in restoring and maintaining the Great Lakes ecosystem, as called for in the Great Lakes Water Quality Agreement. Products and expected outcomes of this proposed work will include: (1) an electronic data base referencing published and archival information on Hexagenia distribution, density, biomass, and production in the Great Lakes; (2) a simple, statistically supported protocol for monitoring Hexagenia in the Great Lakes; (3) a baseline survey of Hexagenia in Saginaw Bay, Green Bay, and western Lake Erie in 2001; (4) a written report describing the results of the survey and providing recommendations for follow-up monitoring in these habitats, and for establishing baseline surveys in other major Great Lakes mesotrophic habitats; (5) a manuscript suitable for publication in a peer-reviewed journal describing the use of Hexagenia as an indicator of ecosystem health in Great Lakes mesotrophic habitats and reviewing the status of Hexagenia populations in Green Bay, Saginaw Bay, Western Lake Erie, and the upper Great Lakes connecting channels; and (6) a public education element including appropriately attributed Federal news releases describing the status of Hexagenia in Saginaw Bay, Green Bay, western Lake Erie, and the upper Great Lakes connecting channels in 2000 and 2001.

Geographic Areas Affected by the Project

States:

<input checked="" type="checkbox"/> Illinois	<input checked="" type="checkbox"/> New York
<input checked="" type="checkbox"/> Indiana	<input checked="" type="checkbox"/> Pennsylvania
<input checked="" type="checkbox"/> Michigan	<input checked="" type="checkbox"/> Wisconsin
<input checked="" type="checkbox"/> Minnesota	<input checked="" type="checkbox"/> Ohio

Lakes:

<input type="checkbox"/> Superior	<input type="checkbox"/> Erie
<input type="checkbox"/> Huron	<input type="checkbox"/> Ontario
<input type="checkbox"/> Michigan	<input checked="" type="checkbox"/> All Lakes

Geographic Initiatives:

<input type="checkbox"/> Greater Chicago	<input type="checkbox"/> NE Ohio	<input type="checkbox"/> NW Indiana	<input type="checkbox"/> SE Michigan	<input checked="" type="checkbox"/> Lake St. Clair
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Primary Affected Area of Concern: All AOCs

Other Affected Areas of Concern: Lake Michigan LaMP
Lake Erie LaMP

For Habitat Projects Only:

Primary Affected Biodiversity Investment Area: Saginaw Bay

Other Affected Biodiversity Investment Areas: Green Bay

Problem Statement:

State of the Lakes Ecosystem Conferences (SOLEC) are hosted by the U. S. Environmental Protection Agency and Environment Canada. These conferences are held every two years on behalf of the United States and Canada in response to the binational Great Lakes Water Quality Agreement (GLWQA), to which the two countries are Parties. In 1998, SOLEC focused on the development of scientifically based indicators that would objectively represent the condition of the Great Lakes ecosystem, be easily understood by non-technical audiences, and provide a basis for reporting to the governments of the United States and Canada and the interested public concerning progress in achieving the restoration and maintenance of the chemical, physical, and biological integrity of the Great Lakes ecosystem, as called for in the GLWQA.

The burrowing mayfly *Hexagenia* has been proposed as an indicator of ecosystem health in Great Lakes mesotrophic waters by SOLEC 98 (Bertram and Salt-Statler, October 1998), where a brief rationale for its selection and application is presented., and by Edsall et al. (1999), who have proposed using the biomass and annual production of *Hexagenia* nymphs as the indicator metric of choice. *Hexagenia* has several characteristics that make it attractive to consider as an indicator of ecosystem health. It was historically abundant in unpolluted, soft-bottomed, mesotrophic habitats in the Great Lakes (Schneider et al. 1969; Cook and Johnson 1974; Mozley and LaDronka 1988) and their connecting channels (Edsall et al. 1991; Schloesser et al. 1991), until the 1940s to 1950s when major population declines occurred in all of its major, traditional Great Lakes habitats. These declines were linked to eutrophication and low dissolved oxygen in bottom waters (Britt 1955; Beeton 1961, 1969; Verduin 1964; Carr and Hiltunen 1965; Kreiger et al. 1996), and pollution of sediments by metals and petroleum products (Edsall et al., 1991; Schloesser et al., 1991). Improvements in water quality in historical *Hexagenia* habitat, which began in the 1960s were not immediately followed by the recovery of *Hexagenia* populations, but there is recent evidence of the beginnings of recovery in Green Bay, Lake Michigan (Cochran 1992) and Saginaw Bay, Lake Huron (localized mating swarm reported there in 1999), and recovery may be nearly complete in western Lake Erie (Edsall et al. 1999; Madenjian et al. 1998). Where it was abundant, *Hexagenia* was also important both as a bioturbator of sediment and as a trophic integrator that linked detrital energy resources directly to fish. For example, in western Lake Erie (Hayward and Margraf 1987), Saginaw Bay (Schaeffer 1994), and Lake St. Clair (Synnestvedt 1996) the growth rate of yellow perch *Perca flavescens*, an economically valuable species, is largely controlled by the abundance of *Hexagenia*. Thus, because *Hexagenia* is sensitive to pollution and responsive to improvements in water and sediment quality brought about by pollution control programs, and because it is also important ecologically as a trophic integrator in Great Lakes habitats that historically supported major fisheries, its use as an indicator of mesotrophic ecosystem health in the Great Lakes seems highly worthy of consideration.

Proposed Work Outcome:

This preproposal addresses the development of a basinwide indicator of ecosystem health for Great Lakes mesotrophic waters based on *Hexagenia* production and biomass. The indicator will be developed so that the resulting information could

be used to advise the governments of the United States and Canada and the interested public about progress in restoring and maintaining the Great Lakes ecosystem.

Typically annual production (P) is estimated for Hexagenia from mean annual biomass (B) data, which are collected by sampling the Hexagenia population monthly during one 12-month period (Edsall et al. 1991). Lakebed sediment and Hexagenia nymphs are collected with a Ponar grab. The sediment is washed through a fine screen (0.65-mm mesh) and the nymphs remaining on the screen are taken to the laboratory where they are extracted manually, measured and weighed. Annual production is calculated from B by the size-frequency method. Although this approach provides reliable estimates of B and P , sample processing is exceptionally labor intensive, which effectively precludes use of the approach for routine lake-wide or basin-wide assessment and monitoring. However, recently completed research at the Great Lakes Science Center (Edsall et al. unpublished manuscript) showed that (1) reliable estimates of B and P could be easily obtained by adopting an approach based on the observation that most of the B and P in the nymphal population occurs in May and June, among nymphs 16 mm and larger, which emerge in July as winged adults, and (2) that the biomass of large nymphs in May-June (B_{mj}) can be used to estimate B ($R^2 = 0.81$) and P ($R^2 = 0.71$). Thus, sampling need only be conducted once during the year and B_{mj} can be used in place of B , both as a direct index of the status of the Hexagenia populations in Great Lakes waters, and as an estimator of P in these populations. In this approach sediment samples will be collected in the usual manner, but will be washed on a coarse screen (about 2-mm mesh). This will greatly reduce sample processing effort because sediment and plant detritus and small nymphs will pass quickly through the coarse screen. The large nymphs that are about to emerge as winged adults will be retained on the screen where they will be easily extracted manually. Sample processing in the laboratory will then only require processing the large nymphs.

To ensure appropriate geographic distribution of sampling effort, we propose to establish a sampling gridwork on Green Bay, Saginaw Bay, and western Lake Erie similar to that used in the upper Great Lakes connecting channels study (EC & EPA 1988; Bertram et al. 1991). Grid cells will be about 7 km square and one sampling location (station) will be located in each grid cell. Three or more Ponar grab samples will be taken at each station during a single visit to the station in 2001. Sampling will be conducted in late May or early to middle June, before the annual emergence, which would normally occur during the first week of July. Hexagenia will be extracted from each sample, preserved in a vial labeled with the station and sample number, and taken to the Great Lakes Science Center. A mean dry weight biomass (B_{mj}) and a measure of variance will be determined in the laboratory for each station and B , and P will be estimated for the station by the equations in Edsall et al. (unpublished manuscript).

Sport fishing groups and local newspapers will be contacted in spring 2000 and 2001 to alert them to the possible presence of Hexagenia mating swarms in Saginaw Bay and Green Bay and to request them to report occurrences to us. A 1999 national news release on the recovery of Hexagenia in western Lake Erie based on Edsall et al. (1999) was prepared by USGS, Reston VA (and subsequently featured by GLNPO in one of their weekly reports to Washington). Similar press coverage can be anticipated from the proposed work, featuring Lake Erie as the success story and Saginaw Bay and Green Bay as works in progress.

Products and expected outcomes of this proposed work will include:

1. An electronic data base referencing published and archival information on Hexagenia distribution, density, biomass, and production in the Great Lakes.
2. A simple, statistically supported protocol for monitoring Hexagenia in the Great Lakes.
3. A baseline survey of Hexagenia in Saginaw Bay, Green Bay, and western Lake Erie in 2001.
4. A written report describing the results of the survey and providing recommendations for follow-up monitoring in these habitats and for establishing baseline surveys in other major Great Lakes mesotrophic habitats.
5. A manuscript suitable for publication in a peer-reviewed journal reviewing the status of Hexagenia populations in Green Bay, Saginaw Bay, Western Lake Erie, and the upper Great Lakes connecting channels, and describing the use of Hexagenia as an indicator of ecosystem health in Great Lakes mesotrophic habitats.
6. A public education element including appropriately attributed Federal news releases describing the status of Hexagenia in Saginaw Bay, Green Bay, western Lake Erie, and the upper Great Lakes connecting channels in 2000 and 2001, and explaining the significance of Hexagenia as an indication of ecosystem health.

Project Milestones:	Dates:
Project Start	08/2000
Generate electronic data base	10/2000
Document sampling protocol	03/2001
Begin sampling	05/2001
End sampling	06/2001
Complete sample & data processing	02/2002
Submit draft final report	05/2002
Project End	07/2002

Project Addresses Environmental Justice

If So, Description of How:

Project Addresses Education/Outreach

If So, Description of How:

One outreach component of the project are news releases and personal contacts with area residents and other segments of society that recreate in or otherwise frequent the Great Lakes environment to make them aware of SOLEC and the environmental significance of Hexagenia mating swarms as indicators of a clean Great Lakes environment.

Project Budget:

	Federal Share Requested (\$)	Applicant's Share (\$)
Personnel:	15,000	180,000
Fringe:	0	39,000
Travel:	10,000	0
Equipment:	5,000	0
Supplies:	5,000	0
Contracts:	0	0
Construction:	0	0
Other:	50,000	0
Total Direct Costs:	85,000	219,000
Indirect Costs:	22,100	0
Total:	107,100	219,000
Projected Income:	0	0

Funding by Other Organizations (Names, Amounts, Description of Commitments):

An unspecified amount of in-kind support for field operations will be provided by MDNR and USFWS (see below).

Description of Collaboration/Community Based Support:

Robert Haas, Michigan DNR, Lake St. Clair Fisheries Station, has agreed to provide vessel support and participate in the sampling in Michigan waters of western Lake Erie and Saginaw Bay in 2001.

Robert Elliott, U.S. Fish and Wildlife Service, Fisheries Resources Office, Green Bay, Wisconsin, has agreed to provide vessel support and participate in the sampling in Green Bay in 2001.

We will contact local newspapers and sport fishing groups in each study area, inform them of our study, and ask them to report any Hexagenia mating swarms that occur in 2000 and 2001.