GREAT LAKES ENVIRONMENTAL ASSESSMENT AND MAPPING PROJECT

PART I: BACKGROUND, EXPERIENCE, AND TRAINING

ASSESSING THE RELATIVE IMPORTANCE OF GREAT LAKES STRESSORS

PROJECT OVERVIEW:

The Great Lakes Environmental Assessment and Mapping (GLEAM) project focuses on mapping and analyzing how human activities are affecting the Great Lakes. The result of this effort will be a state-of-the-art synthesis of human impacts that is quantitative, spatially-explicit, and integrative. This cumulative impact map will be offered as a new resource for planning and prioritization, thereby enhancing the potential for restoration and sustainable management of the Great Lakes. As a core part of the project, we are surveying experts like you to assess the relative magnitude of threats from human activities in Great Lakes ecosystems. We refer to these influences or activities as **stressors**. Our project team is developing spatially explicit maps of each stressor throughout the Great Lakes. Your input is essential for determining how to weight each stressor in the cumulative impact maps that GLEAM will produce. In addition, published survey findings provide valuable information to the Great Lakes community.

Our analysis is restricted to **present-day effects** of human influences upon the Great Lakes ecosystem. Please focus your responses on the way that stressors have been manifested in the **last five years**, rather than on historical patterns or projections into the future. For example, we do not consider effects of past DDT use, except as they represent currently observable legacy effects; similarly, we do not consider the impacts of Asian carp, as they have not yet become established in the Great Lakes. Your responses should focus on physical, chemical, and biological conditions that together comprise **ecosystem health**, rather than addressing impacts on human users.

The survey includes the following four sections:

- Part I: Information about your background and work experience;
- Part II: Ranking of specific stressors and broad categories of stressors based on how much they presently impact the ecosystem(s) you are familiar with (hereafter, your **focal ecosystem**(s));
- Part III: Scenario comparisons to assess the relative importance of components of ecosystem impact;
- Part IV: Rating stressor effects for each component of impact in your focal ecosystem(s).

Terms will be explained throughout the survey, but feel free to e-mail or call us (Sigrid Smith, sdpsmith@umich.edu; David Allan, 734-764-6553) if any clarifications are needed.

INSTRUCTIONS:

Please complete the survey using this website. If you prefer to use a hard copy, you may download this pdf version: GLEAM print version (pdf)

We are grateful for your participation in the survey, which should require 45-60 minutes. Responses from Great Lakes experts like you are essential for determining how to weight each stressor in the cumulative impact maps that GLEAM will produce.

Your responses to this survey will be strictly confidential. Responses will be stored securely and assigned a random identifier code to allow us to conduct analyses without any personally identifying information. The list of respondents will not be shared beyond the five-member analytical team based at the University of Michigan. Your participation is, of course, voluntary. You may skip any question(s) as desired. Please understand that by returning the survey to us you are agreeing to take part in this study. The University of Michigan Health Sciences and Behavioral Sciences Institutional Review Boards have determined that this study is exempt from IRB oversight.

When navigating through the survey, please use the **back** and the **save/continue** buttons located in the bottom left corner of the survey screen.

- Please do not use your internet browser's back button, as it will cause you to exit the survey.
- If you are unable to complete the entire survey at one time or need to return to a previous page, please click save/continue first to record your current responses. You can return to the survey where you left off anytime using the original link in the invitation e-mail.

Also note that you can view additional information when you hold your mouse over underlined words.

Please do not hesitate to contact us (Sigrid Smith, sdpsmith@umich.edu; David Allan, 734-764-6553) if you have any questions or concerns.

PART I. BACKGROUND, EXPERIENCE, AND TRAINING

Type of position (please select one of the following):

- ○ Academic
- ○ Agency
- ○ Non-governmental organization
- ○ Other (please specify)

If your position is at an agency, which type? Please select one of the following.

- ○ Federal
- ○ State/province
- ○ Local
- ○ Tribal/first nation
- ○ Other (please specify)

Which of the following best describes your primary work responsibilities? Please select your primary role.

- ○ Scientific research
- ○ Natural resource management
- ○ On-the-ground restoration and implementation
- ○ Environmental advocacy
- ○ Environmental policy
- ○ Other (please specify)

Year of birth:

Gender:

- ○ Male
- ○ Female
- ○ Other/decline to answer

To which of the following broad categories of stressors do your experience and/or expertise apply? Please

base this answer on all of your activities related to the Great Lakes (e.g., scientific studies, advocacy, management). Please check all that apply.

- ☐ **Climate change** (Changes to seasonal, average and extreme temperature, precipitation, and ice cover)
- ☐ **Toxic chemical pollution** (Chemical pollutants from industrial and agricultural sources)
- ☐ **Nonpoint source pollution** (Nutrients, sediments, and waterborne contaminants transported from watersheds to the Great Lakes by streams and rivers and atmospheric deposition)
- ☐ **Aquatic habitat alterations** (Changes to aquatic habitat from diverse causes, such as shoreline hardening and erosion control structures, port and marina development, and tributary dams)
- ☐ **Coastal development** (Land-based human development near lake margins, such as residential and commercial development and industrial activities)
- ☐ **Invasive and nuisance species** (Changes to Great Lakes ecosystems from invasive and nuisance species in the Great Lakes in abundances not previously seen)
- ☐ **Fisheries management** (Changes to Great Lakes ecosystems resulting from fishing pressure, stocking activities, and aquaculture)
- ☐ **Water withdrawals and diversions** (Changes to Great Lakes ecosystems resulting from water withdrawals and diversions, both from surface waters of the Great Lakes and from surface and groundwater within watersheds)

Please indicate the years of experience and/or expertise you have within each lake and/or its associated waters (wetlands, bays, tributaries, etc.). Please include any experience, expertise, or other involvement in Great Lakes issues (e.g., scientific studies, advocacy, management). Please select the appropriate number of years.

	No experience	1-2 years	3-5 years	6-10 years	> 10 years
Lake Superior	○	○	○	○	○
Lake Michigan	○	○	○	○	○
Lake Huron	○	○	○	○	○
Lake Erie	○	○	○	○	○
Lake Ontario	○	○	○	○	○
No geographic specialization	○	○	○	○	○

Please indicate the years of experience and/or expertise you have within the following ecosystem zones within the lakes. We understand that you may work in multiple zones listed here, since these zones are derived from how we are mapping the impacts of different stressors. Please select the appropriate number of years.

	No experience	1-2 years	3-5 years	6-10 years	> 10 years
Coastal wetlands and river mouths	○	○	○	○	○
Open littoral with hard substrates (nearshore coastal waters down to 5 m deep)	○	○	○	○	○
Open littoral with soft substrates (nearshore coastal waters down to 5 m deep)	○	○	○	○	○
Sublittoral with hard substrates (nearshore habitats 5-30 m deep)	○	○	○	○	○
Sublittoral with soft substrates (nearshore habitats 5-30 m deep)	○	○	○	○	○
Offshore pelagic (more than 30 m deep)	○	○	○	○	○
Tributaries and/or whole watershed/catchment	○	○	○	○	○
No ecosystem specialization	○	○	○	○	○

PART II: RANKING STRESSORS BY RELATIVE IMPACT ON THE GREAT LAKES

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We assume your responses to most questions in the rest of the survey apply to all of the lakes and ecosystem zones you specify at the beginnings of Parts II and IV. If you feel it is important to provide distinct responses for different lakes or ecosystem zones, please follow the instructions in this document: Parts 2A and 4 (pdf). We will repeat this link at the end of the survey if you do not wish to follow it now.

PART II (CONTINUED): RANKING STRESSORS BY RELATIVE IMPACT ON THE GREAT LAKES

Section A

Of the many human activities influencing the Great Lakes, the GLEAM working group has identified 50 stressors that are quantifiable, are currently or will soon become mappable, and represent the major classes of threats identified by the Great Lakes community. Although this stressor list is not comprehensive due to practical constraints, we believe it is sufficient to enable an overall assessment of the state of the lakes.

Please select the five most significant stressors affecting your focal ecosystem(s) in the Great Lakes at the present time. Spend no more than **5 minutes** on this task.

First, please select the lakes and ecosystem zones to which your answers apply.

Lake(s) to which these answers apply:

- [ ] Superior
- [ ] Michigan
- [ ] Huron
- [ ] Erie
- [ ] Ontario
- [ ] All Great Lakes

Ecosystem zone(s) to which these answers apply:

- [ ] Coastal wetlands and river mouths
- [ ] Open littoral with hard substrates (<5 m deep)
- [ ] Open littoral with soft substrates (<5 m deep)
- [ ] Sublittoral with hard substrates (5-30 m deep)
- [ ] Sublittoral with soft substrates (5-30 m deep)
- [ ] Offshore pelagic (>30 m deep)
- [ ] All ecosystem zones

Now, please select the five most significant stressors. The stressors are grouped by category to help you navigate the list. Hold your mouse over the stressor category (e.g., "Invasives") to view its full name.

- [ ] Ballast water invasion risk - Invasives
- [ ] Emerging fish diseases (VHS, etc.) - Invasives
- [ ] Harmful algae blooms (Microcystis, etc.) - Invasives
- [ ] Invasive underwater plants (Eurasian milfoil, etc.) - Invasives
- [ ] Invasive planktonic species (spiny water flea, Hemimysis, etc.) - Invasives
- [ ] Invasive fish (round gobies, etc.) - Invasives
- [ ] Decreasing ice cover- Climate
- [ ] Warming water temperatures - Climate
- [ ] Coastal development (residential and commercial) - Coastal
- [ ] Coastal mining - Coastal
- [ ] Coastal power plants - Coastal
- [ ] Coastal recreational use (camping, swimming, beach maintenance) - Coastal

- [ ] Invasive sea lamprey - Invasives
- [ ] Invasive wetland plants (Phragmites, Typha, etc.) - Invasives
- [ ] Invasive zebra and quagga mussels - Invasives
- [ ] Nuisance benthic algae blooms (Cladophora) - Invasives
- [ ] Areas of concern (AOCs) - Toxics
- [ ] Emerging toxic chemicals (PBDEs, etc.) - Toxics
- [ ] Toxic metals - biomagnifying (mercury, etc.) - Toxics
- [ ] Toxic metals - non-biomagnifying (copper, etc.) - Toxics
- [ ] Toxic organic chemicals - biomagnifying (PCBs, etc.) - Toxics
- [ ] Toxic organic chemicals - non-biomagnifying (PAHs, etc.) - Toxics
- [ ] Toxic pesticides (atrazine, etc.) - Toxics
- [ ] Aquaculture - Fish
- [ ] Commercial fishing - Fish
- [ ] Diporeia decline - Fish
- [ ] Native fish stocking - Fish
- [ ] Non-native fish stocking - Fish
- [ ] Recreational fishing - charter - Fish
- [ ] Recreational fishing - non-charter - Fish
- [ ] Changing water levels due to climate change - Climate
- [ ] Coastal road density - Coastal
- [ ] Water withdrawals and diversions (Great Lakes) - Withdrawals
- [ ] Water withdrawals and diversions (inland and groundwater) - Withdrawals
- [ ] Combined sewer overflows (CSOs) - Nonpoint
- [ ] Nitrogen loading - Nonpoint
- [ ] Pharmaceutical loading - Nonpoint
- [ ] Phosphorus loading - Nonpoint
- [ ] Sediment loading - Nonpoint
- [ ] Channel dredging - Aquatic
- [ ] Hypoxia (low oxygen) - Aquatic
- [ ] Industrial ports and harbors - Aquatic
- [ ] Light pollution - Aquatic
- [ ] Marinas & recreational boating - Aquatic
- [ ] Shipping lanes - Aquatic
- [ ] Shoreline extensions (piers, docks, jetties, etc.) - Aquatic
- [ ] Shoreline hardening - Aquatic
- [ ] Submerged cables & pipelines - Aquatic
- [ ] Tributary dams (altered flow,sediment retention) - Aquatic
- [ ] Tributary dams (barriers to fish passage) - Aquatic

Section B

Please list any stressors affecting your focal ecosystem(s) that are not listed above, and state whether you would rank them among the top five stressors overall.

Section C

To summarize the relative importance of major categories of stressors, GLEAM is comparing the eight overarching stressor categories listed below. Based on your knowledge of the cumulative impact of ALL stressors on ALL Great Lakes, which categories **currently** influence the ecosystems most strongly? Please consider all lakes and all ecosystem zones for this question. Please partition total human impact among these categories. For example, if you think that stressors in each of the eight categories affect the Great Lakes equally, you would rate each category as having 12.5% of the total impacts on the Great Lakes (100/8 = 12.5%). On the other hand, if you feel that only one category impacts the Great Lakes measurably and that none of the other categories are of any importance, you would fill in 100% for that category and 0% for the others. **Please fill in percentages below, making sure they sum to 100%.**

Climate change 0

Toxic chemical pollution	0
Nonpoint source pollution	0
Aquatic habitat alterations	0
Coastal development	0
Invasive and nuisance species	0
Fisheries management	0
Water withdrawals and diversions	0
Please enter 100 here if you prefer not to answer	0
Total	0

PART III: RANKING COMPONENTS OF ECOSYSTEM IMPACT

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In Part III, we use scenario comparisons to assess which components of ecosystem impact for environmental stressors you consider most important. In Part IV, we will ask you to rate each stressor according to the five components of ecosystem impact. First, we introduce and define the following five **components of ecosystem impact**, adapted from the Millennium Ecosystem Assessment and recent cumulative impact analyses for marine ecosystems. We will estimate the impacts of stressors using the following five components.

1) Spatial Extent - how far the impact of a stressor extends beyond the location where it occurs

2) Temporal Frequency - how often a stressor occurs at a given location

3) Ecological Scope - how many species or trophic levels of the food web are affected by a stressor

4) Magnitude of Change - how strong the ecological impacts of a stressor are, expressed as a change from previous conditions

5) Recovery Time - how long the ecosystem takes to return to previous conditions after a stressor is alleviated

Detailed Definitions of Components of Ecosystem Impact

1) Spatial Extent – the spatial scale at which a single stressor occurrence impacts the ecosystem, measured in square kilometers (km^2).

This component reflects the effects of a **single** event, not the aggregate effect of the stressor being repeated in time or space. For example, a single shoreline structure may influence local currents (<1 km^2), while all structures of a given type together may impact thousands of km^2 of Great Lakes coastline. The first scale is what we are interested in, while the second scale will be captured by our maps of the actual distribution of such structures.

Please consider spatial extent on the following scale:

0: N/A (no impact or positive effect)
1: Very low (0.1-9 km^2; within a couple of km or mi)
2: Low (10-999 km^2; up to area of Grand Traverse Bay)
3: Medium (1000-9999 km^2; the size of Saginaw Bay and Green Bay)
4: High (10000-19999 km^2; up to the area of Lake Ontario)

5: Very high (>20000 km^2; a whole lake or more, up to all Great Lakes)

2) Temporal Frequency – the average frequency of stressor occurrence at a particular location, measured as occurrences per year or as days/year for prolonged events.

Consider a case where combined sewer overflows (CSOs) occur frequently in many cities, but you think that major CSOs only occur four times per year from an individual treatment plant. The frequency in this case would be four times per year. Importantly, frequency is not a measure of duration of the effects of the event, but rather only the occurrence of the stressor event itself. The consequences of some stressors may persist for years, but duration of a stressor's impacts will be captured in the recovery time category below. In cases where a stressor permanently destroys or changes an ecosystem or part of an ecosystem, the frequency of that activity should be counted as daily, since it has a continuous impact on the system. If a stressor can have different frequencies, please consider the average value.

Please consider temporal frequency on the following scale:

0: N/A (no impact or positive effect)
1: Rare (less often than once in several years)
2: Infrequent (less often than once per year, or <1 day/year for a prolonged event)
3: Moderate (1-5 events/year, or 1-30 days/year for a prolonged event)
4: Frequent (5 to many events/year, or 30-180 days/year for a prolonged event)
5: Near-continuous to continuous (180-365 days/year)

3) Ecological scope – the extent of impact of a stressor on the species, community, or food web of an ecosystem.

For this component, we assess the broader impact of a stressor within the focal ecosystem and region, looking at the range of aquatic life affected negatively: does the stressor impact just one or a few species, or the entire community and its associated habitats?

Please consider ecological scope on the following scale:

0: N/A (no impact or positive effect)
1: Very low (single species)
2: Low (a few to multiple species)
3: Moderate (single trophic level of the food web; e.g., all prey fish in the area affected)
4: High (multiple trophic levels, or a large portion of the food web)
5: Very high (entire community, potentially including habitat structure)

For example, in evaluating the impact of a zebra mussel invasion, you might rank this impact as a '4' if you felt that the invaders have cascading effects on phytoplankton (algae) populations and the physical characteristics of the

ecosystem. If you think that recreational boating and associated moorings and anchor damage affects many species of sessile invertebrates within the same trophic level without any cascading effects to the rest of the ecosystem, you might rate this as a '3' (single trophic level). In contrast, if hook-and-line fishing removes large numbers of species from several trophic levels but leaves the habitat structure intact you would rate this as a '4' (multiple trophic levels).

4) Magnitude of change – the degree to which an ecosystem's 'natural' state is altered by a stressor, measured as the percent of change from previous conditions.

This component summarizes whether a stressor's impacts are subtle or cause drastic ecosystem change. For example, a 10% change indicates that a stressor has little effect on the ecosystem and its constituent organisms, a 50% change indicates that changes are clear but not absolute, and a 100% change indicates that the ecosystem is dramatically and fundamentally changed by the stressor.

Please consider magnitude of change on the following scale:

0: N/A (no impact or positive effect)
1: Very low (1–10% change from previous conditions)
2: Low (10-25% change from previous conditions)
3: Moderate (25-50% change from previous conditions)
4: High (50-75% change from previous conditions)
5: Very High (75-100% change from previous conditions)

For instance, some chemical stressors may never be toxic (low score), while others may be known to be acutely toxic to organisms where the chemicals are present (high score).

5) Recovery time – the average time required for the focal ecosystem to return to its 'normal' state or previous conditions following the end of a disturbance, measured in months or years.

For recovery time, please consider the average time required for an ecosystem to return to its previous state following alleviation of a single stressor, in the absence of other stressors.

Please consider recovery time on the following scale:

0: N/A (no impact or positive effect)
1: Very rapid (<1 month)
2: Rapid (1-12 months)
3: Moderate (1-5 years)
4: Long (5-50 years)
5: Very long (>50years)

Part III (CONTINUED): RANKING COMPONENTS OF ECOSYSTEM IMPACT

The following table presents 20 distinct scenarios with different combinations of ecosystem impact components. We will use your rankings of these scenarios to infer which components of ecosystem impact you consider most important.

Please rank the top five scenarios having the most significant overall impacts (1-5) on the health of a Great Lakes ecosystem, where 1 indicates the biggest impact, using the dropdown boxes below. Please be as general as possible as you rank scenarios, as the numbers in each scenario represent the impacts of a hypothetical stressor in a hypothetical Great Lakes ecosystem.

We recommend you approach this by first considering which component(s) of ecosystem impact you consider most important, and then scanning for scenarios that have high values of that/those component(s). For example, if you think the spatial extent of a stressor is far more important than the other four impact components, you might choose only scenarios with spatial extents exceeding 20000 km^2; however, if you think spatial extent, magnitude of change, and recovery time are equally important, you might choose scenarios in which all three are high. Please spend no more than **15 minutes** on this task.

This reference sheet (pdf) describes the five components of ecosystem impact that you read about on the previous

page.

SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME
1 Very Low (0.1-9 km2)	**1** Rare (<one time in several years)	**1** Very Low (1 spp.)	**1** Very Low (<10%)	**1** Very Rapid (<1 month)
2 Low (10-999 km2)	**2** Infrequent (<once/yr; <1 day/yr)	**2** Low (a few - multiple spp.)	**2** Low (10-25%)	**2** Rapid (1-12 months)
3 Medium (1000-9999 km2)	**3** Moderate (1-5 X/yr; 1-30 days/yr)	**3** Moderate (1 trophic level)	**3** Moderate (25-50%)	**3** Moderate (1-5 years)
4 High (10000-19999 km2)	**4** Frequent (5+/yr; 30-180 days/yr)	**4** High (> 1 trophic level)	**4** High (50-75%)	**4** Long (5-50 years)
5 Very High (>20000 km2)	**5** Near-continuous	**5** Whole Community	**5** Very High (75-100%)	**5** Very Long (>50 years)

						Your Rank
Scenario 1	2	5	1	4	3	Not in top 5
Scenario 2	1	5	4	3	2	Not in top 5
Scenario 3	5	1	2	3	4	Not in top 5
Scenario 4	3	5	1	2	4	Not in top 5
Scenario 5	3	1	5	2	4	Not in top 5
Scenario 6	5	4	1	2	3	Not in top 5
Scenario 7	1	4	5	3	2	Not in top 5
Scenario 8	3	1	2	5	4	Not in top 5
Scenario 9	4	2	3	1	5	Not in top 5
Scenario 10	2	3	4	5	1	Not in top 5
Scenario 11	5	1	3	4	2	Not in top 5
Scenario 12	4	3	5	1	2	Not in top 5
Scenario 13	1	4	2	3	5	Not in top 5
Scenario 14	4	5	3	2	1	Not in top 5
Scenario 15	2	3	1	4	5	Not in top 5
Scenario 16	1	2	5	4	3	Not in top 5
Scenario 17	3	2	4	1	5	Not in top 5
Scenario 18	4	3	2	5	1	Not in top 5
Scenario 19	2	4	3	5	1	Not in top 5
Scenario 20	5	2	4	1	3	Not in top 5

PART IV: RATING ECOSYSTEM IMPACT FOR INDIVIDUAL STRESSORS

PART IV: RATING ECOSYSTEM IMPACT FOR INDIVIDUAL STRESSORS

In this last section of this survey, we ask you to rate each stressor based on the five components of ecosystem impact. Our analysis must account for potential differences in the effects of the same stressor on different ecosystem zones, since the effect of a particular stressor may be strong in some environments and weak in others. For this purpose, we again ask you to select which lakes and ecosystem zones in the Great Lakes your responses apply to.

In the following table, you are asked to fill in your estimates of each component of ecosystem impact **for one event of each stressor at the present time**. Consider a couple of examples based on a similar survey conducted in marine ecosystems.

- Respondents on average rated ocean acidification as having long recovery time (25 years), high frequency (continuous), high ecological scope (affecting multiple trophic levels), and moderate magnitude of change (30% change).
- When rating tourism in the form of surfing, respondents suggested it is of little consequence (indicated "No impact").

Please make your scores reflect the relative impact of a given stressor compared to other stressors, assuming that all stressors are present at high levels. Since our maps will account for whether or not a stressor is present at a location, your ratings should instead focus on the relative impact of a stressor if it is present.

If you feel that a stressor does not affect your focal ecosystem(s), please mark "No impact," even if you think the stressor is important in other lakes or ecosystem zones. If you are unable to assess a particular stressor due to data gaps or uncertainty, please fill in "Don't know" for its individual components.

First, please specify the lakes and ecosystem zones to which your answers apply.

Lake(s) to which these answers apply:

☐ Superior ☐ Michigan ☐ Huron ☐ Erie ☐ Ontario ☐ All Great Lakes

Ecosystem zone(s) to which these answers apply:

- ☐ Coastal wetlands and river mouths
- ☐ Open littoral with hard substrates (<5 m deep)
- ☐ Open littoral with soft substrates (<5 m deep)
- ☐ Sublittoral with hard substrates (5-30 m deep)
- ☐ Sublittoral with soft substrates (5-30 m deep)
- ☐ Offshore pelagic (>30 m deep)
- ☐ All ecosystem zones

Now, please fill in your estimates of each component of ecosystem impact for one event of each stressor.

This reference sheet (pdf) describes the five components of ecosystem impact that you read about previously.

Invasive and Nuisance Species

	SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
	1 Very Low (0.1-9 km2) 2 Low (10-999 km2) 3 Medium (1000-9999 km2) 4 High (10000-19999 km2) 5 Very High (>20000 km2) ? Don't Know	1 Rare (<one time in several years) 2 Infrequent (<once/yr; <1 day/yr) 3 Moderate (1-5 X/yr; 1-30 days/yr) 4 Frequent (5+/yr; 30-180 days/yr) 5 Near-continuous ? Don't Know	1 Very Low (1 spp.) 2 Low (a few - multiple spp.) 3 Moderate (1 trophic level) 4 High (> 1 trophic level) 5 Whole Community ? Don't Know	1 Very Low (<10%) 2 Low (10-25%) 3 Moderate (25-50%) 4 High (50-75%) 5 Very High (75-100%) ? Don't Know	1 Very Rapid (<1 month) 2 Rapid (1-12 months) 3 Moderate (1-5 years) 4 Long (5-50 years) 5 Very Long (>50 years) ? Don't Know	
Ballast water invasion risk	☐	☐	☐	☐	☐	☐
Emerging fish diseases (VHS, etc.)	☐	☐	☐	☐	☐	☐
Harmful algae blooms (Microcystis, etc.)	☐	☐	☐	☐	☐	☐

	SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
Invasive underwater plants (Eurasian milfoil, etc.)						
Invasive planktonic species (spiny water flea, Hemimysis, etc.)						
Invasive fish (round gobies, etc.)						
Invasive sea lamprey						
Invasive wetland plants (Phragmites, Typha, etc.)						
Invasive zebra and quagga mussels						
Nuisance benthic algae blooms(Cladophora)						

SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
1 Very Low (0.1-9 km2) 2 Low (10-999 km2) 3 Medium (1000-9999 km2) 4 High (10000-19999 km2) 5 Very High (>20000 km2) ? Don't Know	1 Rare (<one time in several years) 2 Infrequent (<once/yr; <1 day/yr) 3 Moderate (1-5 X/yr; 1-30 days/yr) 4 Frequent (5+/yr; 30-180 days/yr) 5 Near-continuous ? Don't Know	1 Very Low (1 spp.) 2 Low (a few - multiple spp.) 3 Moderate (1 trophic level) 4 High (> 1 trophic level) 5 Whole Community ? Don't Know	1 Very Low (<10%) 2 Low (10-25%) 3 Moderate (25-50%) 4 High (50-75%) 5 Very High (75-100%) ? Don't Know	1 Very Rapid (<1 month) 2 Rapid (1-12 months) 3 Moderate (1-5 years) 4 Long (5-50 years) 5 Very Long (>50 years) ? Don't Know	

Toxic Chemical Pollution

	SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
Areas of concern (AOCs)						
Emerging toxic chemicals (PBDEs, etc.)						
Toxic metals - biomagnifying (mercury, etc.)						
Toxic metals - non-biomagnifying (copper, etc.)						
Toxic organic chemicals - biomagnifying (PCBs, etc.)						
Toxic organic chemicals - non-biomagnifying (PAHs, etc.)						
Toxic pesticides (atrazine, etc.)						

SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
1 Very Low (0.1-9 km2) 2 Low (10-999 km2)	1 Rare (<one time in several years) 2 Infrequent (<once/yr; <1 day/yr)	1 Very Low (1 spp.) 2 Low (a few - multiple spp.)	1 Very Low (<10%) 2 Low (10-25%)	1 Very Rapid (<1 month) 2 Rapid (1-12 months)	

3 Medium (1000-9999 km2) **4** High (10000-19999 km2) **5** Very High (>20000 km2) **?** Don't Know	**3** Moderate (1-5 X/yr; 1-30 days/yr) **4** Frequent (5+/yr; 30-180 days/yr) **5** Near-continuous **?** Don't Know	**3** Moderate (1 trophic level) **4** High (> 1 trophic level) **5** Whole Community **?** Don't Know	**3** Moderate (25-50%) **4** High (50-75%) **5** Very High (75-100%) **?** Don't Know	**3** Moderate (1-5 years) **4** Long (5-50 years) **5** Very Long (>50 years) **?** Don't Know	

Fisheries Management

	SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
Aquaculture						
Commercial fishing						
Diporeia decline						
Native fish stocking						
Non-native fish stocking						
Recreational fishing - charter						
Recreational fishing - non-charter						

SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
1 Very Low (0.1-9 km2) **2** Low (10-999 km2) **3** Medium (1000-9999 km2) **4** High (10000-19999 km2) **5** Very High (>20000 km2) **?** Don't Know	**1** Rare (<one time in several years) **2** Infrequent (<once/yr; <1 day/yr) **3** Moderate (1-5 X/yr; 1-30 days/yr) **4** Frequent (5+/yr; 30-180 days/yr) **5** Near-continuous **?** Don't Know	**1** Very Low (1 spp.) **2** Low (a few - multiple spp.) **3** Moderate (1 trophic level) **4** High (> 1 trophic level) **5** Whole Community **?** Don't Know	**1** Very Low (<10%) **2** Low (10-25%) **3** Moderate (25-50%) **4** High (50-75%) **5** Very High (75-100%) **?** Don't Know	**1** Very Rapid (<1 month) **2** Rapid (1-12 months) **3** Moderate (1-5 years) **4** Long (5-50 years) **5** Very Long (>50 years) **?** Don't Know	

Climate Change

	SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
Changing water levels due to climate change						
Decreasing ice cover						
Warming water temperatures						

SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
1 Very Low (0.1-9 km2) **2** Low (10-999 km2) **3** Medium (1000-9999 km2) **4** High (10000-19999 km2) **5** Very High (>20000 km2) **?** Don't Know	**1** Rare (<one time in several years) **2** Infrequent (<once/yr; <1 day/yr) **3** Moderate (1-5 X/yr; 1-30 days/yr) **4** Frequent (5+/yr; 30-180 days/yr) **5** Near-continuous **?** Don't Know	**1** Very Low (1 spp.) **2** Low (a few - multiple spp.) **3** Moderate (1 trophic level) **4** High (> 1 trophic level) **5** Whole Community **?** Don't Know	**1** Very Low (<10%) **2** Low (10-25%) **3** Moderate (25-50%) **4** High (50-75%) **5** Very High (75-100%) **?** Don't Know	**1** Very Rapid (<1 month) **2** Rapid (1-12 months) **3** Moderate (1-5 years) **4** Long (5-50 years) **5** Very Long (>50 years) **?** Don't Know	

Coastal Development

	SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
Coastal development						

		SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
(residential and commerical)							
Coastal mining							
Coastal power plants							
Coastal recreational use (camping, swimming, beach maintenance)							
Coastal road density							

SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
1 Very Low (0.1-9 km2) **2** Low (10-999 km2) **3** Medium (1000-9999 km2) **4** High (10000-19999 km2) **5** Very High (>20000 km2) **?** Don't Know	**1** Rare (<one time in several years) **2** Infrequent (<once/yr; <1 day/yr) **3** Moderate (1-5 X/yr; 1-30 days/yr) **4** Frequent (5+/yr; 30-180 days/yr) **5** Near-continuous **?** Don't Know	**1** Very Low (1 spp.) **2** Low (a few - multiple spp.) **3** Moderate (1 trophic level) **4** High (> 1 trophic level) **5** Whole Community **?** Don't Know	**1** Very Low (<10%) **2** Low (10-25%) **3** Moderate (25-50%) **4** High (50-75%) **5** Very High (75-100%) **?** Don't Know	**1** Very Rapid (<1 month) **2** Rapid (1-12 months) **3** Moderate (1-5 years) **4** Long (5-50 years) **5** Very Long (>50 years) **?** Don't Know	

Water Withdrawals

		SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
Water withdrawals and diversions - Great Lakes							
Water withdrawals and diversions - inland and groundwater							

SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
1 Very Low (0.1-9 km2) **2** Low (10-999 km2) **3** Medium (1000-9999 km2) **4** High (10000-19999 km2) **5** Very High (>20000 km2) **?** Don't Know	**1** Rare (<one time in several years) **2** Infrequent (<once/yr; <1 day/yr) **3** Moderate (1-5 X/yr; 1-30 days/yr) **4** Frequent (5+/yr; 30-180 days/yr) **5** Near-continuous **?** Don't Know	**1** Very Low (1 spp.) **2** Low (a few - multiple spp.) **3** Moderate (1 trophic level) **4** High (> 1 trophic level) **5** Whole Community **?** Don't Know	**1** Very Low (<10%) **2** Low (10-25%) **3** Moderate (25-50%) **4** High (50-75%) **5** Very High (75-100%) **?** Don't Know	**1** Very Rapid (<1 month) **2** Rapid (1-12 months) **3** Moderate (1-5 years) **4** Long (5-50 years) **5** Very Long (>50 years) **?** Don't Know	

Nonpoint Source Pollution

		SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
Combined sewer overflows (CSOs)							
Nitrogen loading							
Pharmaceutical loading							
Phosphorus loading							
Sediment loading							

SPATIAL	FREQUENCY	ECOLOGICAL	MAGNITUDE	RECOVERY	NO

EXTENT		SCOPE		TIME	IMPACT (X)
1 Very Low (0.1-9 km2) 2 Low (10-999 km2) 3 Medium (1000-9999 km2) 4 High (10000-19999 km2) 5 Very High (>20000 km2) ? Don't Know	1 Rare (<one time in several years) 2 Infrequent (<once/yr; <1 day/yr) 3 Moderate (1-5 X/yr; 1-30 days/yr) 4 Frequent (5+/yr; 30-180 days/yr) 5 Near-continuous ? Don't Know	1 Very Low (1 spp.) 2 Low (a few - multiple spp.) 3 Moderate (1 trophic level) 4 High (> 1 trophic level) 5 Whole Community ? Don't Know	1 Very Low (<10%) 2 Low (10-25%) 3 Moderate (25-50%) 4 High (50-75%) 5 Very High (75-100%) ? Don't Know	1 Very Rapid (<1 month) 2 Rapid (1-12 months) 3 Moderate (1-5 years) 4 Long (5-50 years) 5 Very Long (>50 years) ? Don't Know	

Aquatic Habitat Alterations

		SPATIAL EXTENT	FREQUENCY	ECOLOGICAL SCOPE	MAGNITUDE	RECOVERY TIME	NO IMPACT (X)
Channel dredging							
Hypoxia (low oxygen)							
Industrial ports and harbors							
Light pollution							
Marinas & recreational boating							
Shipping lanes							
Shoreline extensions (piers, docks, jetties, etc.)							
Shoreline hardening							
Submerged cables & pipelines							
Tributary dams (altered flow, sediment retention)							
Tributary dams (barriers to fish passage)							

RATING STRESSORS FOR ADDITIONAL LAKES OR ECOSYSTEM ZONES

Would you like to rate stressors for different lakes and/or ecosystem zones?

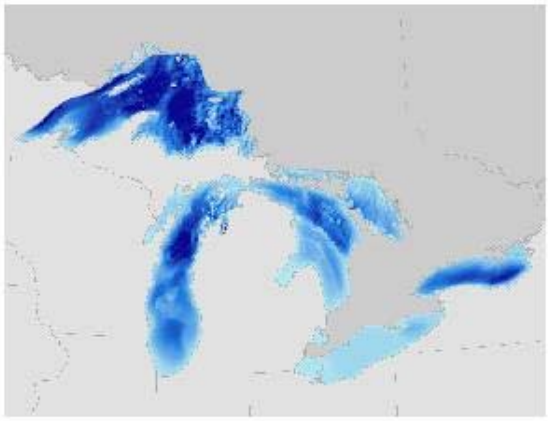
- Yes
- No

You have indicated that you would like to rate stressors for different lakes or ecosystem zones. Please download and complete a shortened version of the survey with submission instructions here: Parts 2A and 4 (pdf). Submit the completed portion by e-mail, fax, or mail (instructions in pdf). Please contact us (Sigrid Smith, sdpsmith@umich.edu, David Allan, 734-764-6553) if you have any questions.

THANK YOU

THANK YOU FOR SHARING YOUR EXPERTISE!

Please visit our website (http://www.snre.umich.edu/greatlakesthreats) to learn more about our project. We hope that the results of the project will enhance public appreciation of the many stressors affecting the Great Lakes, and that they will provide an important new perspective for management and policy efforts based on cumulative impact. We will make the findings freely available to all.



Please click **save/continue** one more time to record your responses.

Click save/continue in the lower left of the survey screen to record your responses. You can return to complete the survey at any time.