Appendix 9 — Comments on Indicators (Version 3) with Responses

A9.1 Comments with Responses from SOLEC Indicators Group

The following is a compilation of comments received on both the report *Selection of Indicators for Great Lakes Basin Ecosystem Health, Version 3* and on specific indicators within the report. These comments have been grouped into one of the following categories: General Comments; Open and Nearshore Waters; Coastal Wetlands; Nearshore Terrestrial; Land Use; Human Health; Societal; and Unbounded. Responses have been prepared by the SOLEC Indicator Group, they follow each comment and are in italics.

General

1. Although the document title claims that the indicators were derived for the Great Lakes basin ecosystem, a disproportionate number of the indicators describe the state of the lake waters and their shorelines. Perhaps a more representative title would mention Great Lakes Aquatic Ecosystem Health rather than the basin. A total of 46 indicators have been developed to monitor and describe the state of open waters, nearshore waters, coastal wetlands and nearshore terrestrial areas.

   We recognize that there is much more work needed on the terrestrial portion of the basin (and will happen in the future), but as it now stands, we are using indicators that we hope are a catchment of what is happening farther up in the land basin (i.e. Monitoring at the shoreline). The report title will remain as is.

2. The importance of establishing and consistently following protocols for monitoring and for inclusion of data in indicators can never be over-stated.

   We agree about this - it will be future work as the process evolves.

3. Further development work could also consider an indicator or two that goes beyond single species and looks into the biodiversity characteristics of various parts of the basin or aquatic ecosystem.

   We agree on this as well - but this is very complex. We currently have indicators that use "indices of biotic integrity", but they need further development work before we can monitor for them fully.

4. Some thought could be given to the development of specialized "early warning" indicators that are able to signal changes in the ecosystem before they become permanent. For example, it would be useful to have indicators that could detect the emergence of exotic species or species range extensions or could detect the environmental changes that precede these shifts.

   The state indicators will tell us about changes in the state of the system, but perhaps the best "early warning" will be with zooplankton which are quick to respond to changes in the system. Early warnings may emerge when trends come out of enough data.

5. The language in Version 3, has been edited to the point of making the document of little use to anyone. It appears that the indicator description language has compromised the scientific credibility of nearly every indicator. For example:

   Contaminants in Snapping Turtle Eggs (Indicator #4506)

This indicator will measure the accumulation of organochlorine chemicals and mercury in Snapping Turtle eggs and indirectly measure the concentrations, as well as identify the source, of organochlorine chemicals and mercury in food webs of Great Lakes coastal wetlands.

This is one of the best examples of the problems with the new Version 3 language. Of course, any measurement of organochlorine chemicals and mercury will be direct measurements, certainly not **indirect measurements of concentrations.** And certainly, measurement of turtle egg concentrations in and of themselves cannot **identify the source**. Much additional investigation is needed to pinpoint sources.

We agree that the short blurbs (taken from the Purpose statement in the descriptor information) for each indicator needed work. They have been revised for the Version 4 indicator descriptions.

6. Section 2.5: Stress that list of indicators are not static - they will evolve with our understanding of the system, and as warranted by "surprises".

   We strongly agree with this, and have also stressed this point in the 1999 State of the Great Lakes report.

7. In general, the indicators are quite detailed and numerous. It may be difficult for the lay-person or general policy-maker to interpret all this information. Depending on who the intended audience is, the indicators will need to be packaged and interpreted in a way that is easy to understand and educates the reader. Consideration could be given to combining the indicators into an index within each of the seven indicator groups which could help to summarize the situation and provide a bit of context for the general reader. This comment is particularly relevant with respect to many of the biological measures listed under Nearshore and Open Waters, Coastal Wetlands and Nearshore Terrestrial indicator groups. Two alternatives to developing an index would be to:
   i. Choose a "key" or "reference" indicator that summarizes the "state" or "pressure" under each of the seven indicator groups and organize the other indicators as supporting or "second tier" indicators which provide more detailed information. For example, the aquatic habitat indicator would be a good summary indicator of the Nearshore and Open Waters indicator group since both the health of fish and other wildlife populations are dependent on a good supply of quality habitat. It could be considered to be a "key" or "reference", state indicator.
   ii. A second option is organize the presentation of the indicators so that they give a visual impression of all the trends at once (e.g., multiple mini-graphs) and include an informative, easy-to-understand summary of the situation.

   We agree that summarizing the information into some type of indices will be useful and we will work towards this, however we would like to stress that the whole suite of indicators will always be very important to give detailed information to middle managers and allow them to make sound management decisions.

8. Overall, there are quite a few scientific and technical terms used in some of the indicators. In the absence of a glossary (Appendix 6: Definitions and Acronyms does not clarify such terms), some of these should be explained within the text for the particular indicators. For example, for Indicator #72, Fish Entrainment, the precise sense of "fish entrainment" is not at all clear, and dictionary definitions did not help to clarify it. In the same indicator, what are "sentinel" species? For Indicator #101, Deformities, Erosions, Lesions and Tumours in Nearshore Fish, what is the sense of "erosion" with respect to fish? The sense of it

actually becomes more apparent in Indicator #4503, which uses the term “eroded fins”. Brownfield Redevelopment (#7006) The term “brownfield” could use some clarification.

We agree that there are many technical terms throughout the indicator descriptions, but this is, after all, a technical document. Although we have tried to use clear, yet concise language, the use of a technical term can save many words of alternate explanation. Terms like “sentinel” and “brownfield” have become an established part of our lingo to talk about Great Lakes issues.

9. There are no direct indicators presented on the condition of groundwater, streams or rivers in the Great Lakes basin, although this is covered indirectly under other indicators. It may be worth considering having representative indicators (under the Land Use indicator group) that provide a picture of the state of the other water bodies that flow into the lakes.

   We agree that this isn’t yet included in the suite of indicators, we still have some work to do...

10. Considering the current high profile of endocrine disruption and endocrine disrupting substances, it is rather surprising that there are no indicators specifically focusing on this issue. In Appendix 1, endocrine is only mentioned once, and that being a comment with respect to Indicator #4179, Pattern and Trends in Disease Incidence: “this indicator could be expanded in the future to include biomarkers of pre-disease conditions, ***endocrine disruption***, and low birth weight.”

    Endocrine disruption is an issue that is driving policy. However, endocrine disruption is a mechanism of action potentially affecting a large number of subtle health endpoints, rather than an endpoint in itself. The research is still in the developmental stage and at this time, it is not clear what could be included in such an indicator. Indicators 4177, 4083, and 4088 all include measurements of persistent and bioaccumulative toxic substances, some of which are suspected endocrine disruptors. This is a wildlife issue as well. In the SOLEC suite we do look at the effects of ED (i.e. contaminants in turtle eggs, patterns and trends in disease incidence...).

11. I am still perplexed as to how they plan to implement these. For example, preyfish populations (#17): the "measure" includes abundance, diversity, age and size of preyfish species. The "endpoint" only uses abundances, but these are yet undefined. The "features" and "illustrations" infer trends in multiple prey species will be evaluated to produce an index of potential predator biomass that can be produced from a prey complex. Wow, that task alone seems to define a career, and even if it were evaluated it would only represent a static condition that is likely lake specific and must be viewed independent of the other ecosystem linkages. i.e. if they found that 1 kg/ha of smelt can support chinook salmon in Lake Ontario (ignoring all other prey fishes) given a specific physical state (temperature and light), what happens if the temperature increases (will increase predator demand, or alter it's distribution and therefore potential overlap with prey), or smelt prey declines, or lake herring recruitment improves (alternate prey), or another predator (with it's own characteristic energetic demand, behavior and distribution) arrives in the system. In other words, 1 kg/ha of smelt may support X kg of chinook, or it may not - and I think the may nots will dominate given the ecosystem complexity.

    At this time many endpoints for the indicators are undefined and it will be a difficult process. However measurements are collected and the trends that these measurements show are a good place to start. We do have to use caution when interpreting the data.

12. I had conceptual difficulties with developing indicators and then linking them to a variety of objectives rather than vice versa. I understand the concept of multi-functional indicators, but in some cases, they aren't necessarily viewed the same way depending upon the

readers perspective.

We are servicing a number of objectives (see the table in Appendix 3). We recognize that it is not a perfect system but had to start someplace. We are aiming for parallel, collaborative processes (i.e. with the LaMP groups).

13. In some instances, the numeric value identified for a fisheries related objective was no longer relevant. In an era of rapid ecosystem change, the quantitative element of some of our biological elements may be only fleetingly relevant.

    The endpoints will need to be adjusted as the situation warrants - but we still need to collect the data regardless of the endpoint. We agree that the most current numeric targets will provide the best context in which to evaluate indicator data.

14. My other concern was attempting to develop a "state of the environment objectives" that covered off environment, quality and quantity of natural resources, and the state of human and ecological health, as a suite. What is a "success" for these elements based on the values of particular sectors may be in direct opposition to each other, hence the dilemma. For example, under some circumstances, what some may view as a sign of ecological health of the Great Lakes ecosystem may be in direct conflict with the social/economic health of the natural resource component. Without the context of goals and objectives for ecosystem health up front, it is difficult to evaluate the appropriateness of some of the indicators.

    We recognize that there will be conflicting results and it is inevitable that we will have to deal with this. Conflicts, however, point out the strengths of having a "suite" of indicators. Also, at this time we don't have a lot of social well-being indicators. See response for comment 12.

15. I think there were was an applaudable effort to find indicators that could serve a variety of purposes and offer a basin snapshot. It is a positive step to strive for measures of basin-wide health. However, in the end, an indicator can't be all things to all people, and it may have been better to focus in an ecosystem health perspective rather than attempting to find the ultimate indicator. The other alternative would be to split the "state of the environment" indicators description and interpretations into the sub-categories, so that some reflect the environmental state when viewed a particular way, some reflect resource quantity and quality, and other reflect basin health. I think that once the results are in place, interpreting the results by these categories would offer an interesting picture of the various social values at work, particularly if a social/economic component was added.

    We are not trying to develop the "ultimate" indicator. See response for comment 14.

16. Section 2.1 provides a definition of terms associated with indicators. The term "target" is defined as "specific, attainable, quantitative end point or reference values for an indicator.....". The term end point implies that we want or need to move in a specific direction - and I'm not sure this is the case for all of the indicators. For example, in the case of phosphorus loading, end point may be an appropriate term for Lake Erie where we are trying to move from high to lower P loading. However, in the case of Lake Superior, although we may have a certain level (i.e. criteria) of P loading we don't want to exceed I don't think we are currently trying to go in a higher or lower direction. I would suggest that Criteria would be a more appropriate term to use than Target and that the term end point be removed from the definition.

    We agree and recognize that the endpoint could possibly be the current conditions, but we don't want to remove the sense of an endpoint (or where we want to be). We want to show progress towards and endpoint in time and space (even if that means changing nothing).

17. In Appendix 1 the endpoint is used in the detailed descriptions for each indicator. To be consistent with the terminology which is presented in Section 2.1 replace endpoint with target, (or more preferably with criteria).

    No - see comment 16 response.

18. I wonder whether some of the indicators are doable and there are two aspects to this. First, are we currently collecting the information and if not, then do we have the resources to. Secondly, even if we have the necessary resources, do we really know how to measure some of these parameters and what the criteria (target) should be? (Or is significant investment in research required to develop the measurement tools and the criteria?) For example, are we currently measuring the quality and area of aquatic habitat in the Great Lakes Ecosystem? To measure aquatic habitat by area and by type in a quantitative way (i.e. relates to fish production or ecosystem health) is a huge job and I'm not aware that we are currently doing it. Furthermore, I would question whether we even have the tools/knowledge to measure and interpret this type of information in a way that is quantitative and defensible.

    We acknowledge and understand that there is still much more to be done (we are only just scratching the surface). The "next steps" will take a lot of resources.

19. For many of the proposed indicators there is not yet a defined "endpoint" or criteria. When will this be done? Are there gaps in our science which must be addressed first? This should probably get sorted out before data collection begins.

    We agree that endpoints have not yet been established for some indicators, but data collection can still proceed to identify trends or baseline information. Some indicators also need research to determine methodology and interpretation. Each indicator will be taken on a case by case basis.

20. An indicator measuring suspended solid/turbidity, pathogen, pesticide, and other drinking water contaminants of concern, at the mouths of tributaries should be added for tributaries that have the potential to affect water quality at drinking water intakes. Measure of stream flow and suspended sediments at the mouth of major tributaries and connecting channels has already been included in the Stream Flow, (#8142).

    We held a joint SOLEC-IJC workshop in August, 1999, to discuss this and other issues on "Drinkability". Results of that workshop are being used to better define measurements for indicator #4175 Drinking Water Quality.

21. With regard to #111(phosphorus), #4860 (nitrates), #104 (benthic diversity and abundance) and indicators related to deformities/contaminant effects on fish populations, additional information for assessing the state of the Great Lakes environment can be obtained from the data submitted to Environment Canada for the regulated Cycle 2 Environmental Effects Monitoring studies conducted under the Federal Pulp and Paper Effluent Regulations by the pulp and paper mills. In Ontario, there are seven mills that discharge effluent to Lake Superior so data would be available from seven EEM studies on April 1, 2000.

    Thank you for the data source.

22. Most of the indicators in the various categories have some scientific foundation in that a direct or indirect relationship can be ascribed over time between the indicator and changes in the overall quality of the Great Lakes environment. However, this is not the case with the proposed Societal Indicators. Most of the listed parameters will be subject to differing interpretations as to what impact a change in any one will have on the Great Lakes

environment. This also applies to some of the Land Use Indicators, such as transportation efficiency, green planning process, and energy consumption. Two separate documents, one dealing with environmental and one dealing with societal factors, or at least a much clearer differentiation between the two in a single document, would be more useful.

One of the overarching philosophies of SOLEC is the integration of all parts of the ecosystem (including societal and natural resource aspects). We think it would be a mistake to separate these components.

23. The issue of comparability will have to be addressed, i.e., how will data collected by various agencies using different methods be compared?

    This comment points out the necessity for SOLEC to get at issues such as this. QA/QC will be a challenge.

24. Data for many of the indicators are not currently collected on a systematic, widespread basis. How will entities involved in monitoring be encouraged to collect data in support of the indicators?

    By getting buy-in and participation to the SOLEC indicator process, we hope that agencies/organizations will recognize the necessity of the work and voluntarily "sign-on". In addition, a strong case for new monitoring and collection needs to be made to government officials and binational organizations such as the BEC (Binational Executive Committee).

25. First we believe that the indicator list as given in Appendix 1 defeats the entire purpose and intent of the exercise. It is a list of 80 indicators which are not consolidated in any way. What is needed are a few, e.g., 5 or 6 indicators which can be readily understood by the lay public and the IJC Commissioners. Note the up-front requirement "to establish a consistent easily understood suite of indicators". Many of the indicators will show improvement, many deterioration, and many little change. What do we conclude?

    We are addressing this concern through the potential development of 6-10 indices. However, we need the complete suite of indicators to provide good information to middle management. The Table in Appendix 3 provides several alternative groupings of the SOLEC indicators.

26. Let us express some frustration. Our Centre has worked hard in this area in recent years deriving and advocating the concept of Equilibrium Lipid Partitioning as an ecosystem-wide indicator of levels of contamination. We attempted to present these ideas at SOLEC but the format was not conducive to receiving new ideas. We have presented the concept at IAGLR and a paper on the topic will be published soon in JGLR. In our view this consolidates all the contaminant concerns in one indicator.

    This looks like it could be included in the SOLEC suite of indicators at a future date (and if successful, possibly remove other indicator(s)). In your opinion, how do we make SOLEC more "conducive to receiving new ideas"? We are always open for suggestions.

27. For the less informed reader of the SOLEC Indicators List, is it worthwhile to list "invasive" more such as done in "4513 ... invasive plants"? -- -- such as adding "invasive" to 18 Sea Lamprey, and can it be added to 8134 ... problem species? Adding "invasive" more in the List, where it can be added, may help amplify and focus the Great Lakes ecosystem invasive-and-biological integrity issues to "incrementally" more effectively inform and influence certain readers about needed actions on existing invasives in the Great Lakes ecosystem and/or about needed actions to better prevent new ones from coming in.

    We think there is some confusion between non-native and invasive. Many species are non-native but not invasive, and there are native species that are invasive.

28. I believe SOLEC needs to directly address the issue of data collection and SOLEC's expectations of state agencies. Without funding to specifically collect data for SOLEC indicators, those SOLEC indicators that provide little direct utility to a state agency will not receive priority consideration for monitoring.

    We understand the concern that SOLEC will lead to an unfunded mandate to the states and provinces to collect the data for the indicators, but it is not our intent to dictate programs, nor should any single agency provide all the funding. Rather, the SOLEC indicators are seen to be an means to more efficient monitoring programs with more collaboration and cooperation from all the Great Lakes partners.

29. One limitation is the lack of linkages between the state and pressure indicators. In rare instances are the pressure indicators clearly connected to an identified state indicator. For example, the list includes a contaminant deposition indicator, a contaminant in fish tissue, and a contaminant in sediment indicator (Indicators # 0117-0120). These are very useful indicators, but without concomitant collection of contaminant releases and uses within the basin, the primary sources of the contaminants cannot be addressed. Mercury, for example, is still used and present in process and products within the Great Lakes Basin. Reducing mercury use and releases within the Great Lakes Basin (and beyond) is necessary to begin reducing the atmospheric input of mercury to the Great Lakes. Unfortunately, the SOLEC list lacks any indicators of contaminant use or release within the Great Lakes Basin. This data gap means that states and citizens within the Great Lakes Basin will have limited information to determine the source of contaminants affecting our Great Lakes. [Our Agency] therefore recommends SOLEC include contaminant use and release indicators in the SOLEC indicators list. To affect the condition of the state indicators already identified, users of the indicators must understand the source of the pressure.

    First, we agree that linkages are very important, but explicit cause-effect relationships aren't always known. This is perhaps a future consideration but at this time we are not ready to collect this level of information. It works for mercury because the use of mercury in the basin has a direct effect. Second, it is not the place (or intention) of SOLEC to collect source information at the scale of LaMPs/RAPs/local levels. We work at a different (larger) scale.

30. Other indicators identified lack the ability to support the indirect use envisioned in the indicator description. As written, Indicator #111 (Phosphorus concentrations or loadings in nearshore or open waters) may provide technically useful information, but the concentrations or loadings alone would not support the indirect uses identified. Actual concentrations of phosphorus may not provide direct utility, as the concentration inducing loss of beneficial use is different among the aquatic ecosystems which compose the Great Lakes. The most useful representation would be the phosphorus loadings (relative to local tolerable levels) combined with a measure of the number of days and lake acres impaired due to nuisance algae conditions. Ideally, Indicator #0111 would be linked with the prevalence of nuisance algal blooms or a shift in the predominant phytoplankton species to provide the greatest utility. Though Indicator #109 focuses on phytoplankton populations, the description does not clearly indicate an explicit linkage to the phosphorus loading indicator. Nor does the description for Indicator #109 mention how the phytoplankton population information would be presented in a useful manner to non-technical users.

    See the response to comment 5. We have revised the Purpose statements for all the indicators, but some of the linkages between the indicators remain implied rather than explicit. The table in Appendix 3 presents several groupings of the indicators for which linkages can be identified.

Open and Nearshore Waters

31. The set of indicators identified seems sufficient to provide basin-wide trend information. However, there are no indicators included regarding the direct abundance of introduced or exotic aquatic species, merely some indirect measures such as native unionids.
    We agree. We have received several comments about this, and we are attempting to identify an "exotic species indicator" for the SOLEC list.

32. Which invasive species number category covers the zebra mussel, spiny water flea, river ruffe, and the other bad water invasives?
    Same as for #31.

33. I still think we need an exotics indicator (endpoint zero introductions). Annex 6 of GLWQA would seem to require one associated with ballast. It's certainly in GLFC Vision. Maybe "exotics in lake" plus "target for ballast discharge" (which needs research). Remember that there is such as thing as authorized introductions, e.g., beetle to eat loosestrife, salmon to eat alewife.
    Same as for #31.

34. Isn't a general aquatic animal "health" indicator needed beyond tumors, e.g. it is highly unusual for fish to die of BKD in wild, whirling disease range is spreading, whitefish condition is so low in northern Lake Huron that filleting machines barely work on the skinny things, Glugea hertwigi was a worrisome parasite of smelt there for a while. And EMS. Sometimes, but not always, these are signs of a problem in the lake that needs attention.
    We agree that some sort of "condition factor" may be a good idea, and we would appreciate some suggestions.

35. There seem to be few indicators focusing on predator and prey fish populations. Is there an opportunity to combine these? Would trends in water temperature be an important pressure indicator within this category? It could be linked to climate change but more directly associated with the health of Open and Nearshore Waters.
    We have combined some predator-prey indicators. See indicators #9 (Walleye and Hexagenia) and #93 (Lake Trout and Diporeia).

36. In many instances the quoted end-points have been revised and are no longer appropriate. I think as long as it is recognized the most current management plan or FCGO's indicates the most appropriate end-point then that's all you can do.
    We agree. End points can change, but we still the measurements to support the indicator.

37. Aquatic Habitat (#6). Should indicate in limitations section that in many cases we do not know how to recognize critical aquatic habitat, nor do we understand the relationship between the quantity of habitat and aquatic production. The problem is further compounded by issues of scale such as (cumulative loss, connectivity of habitat between life stages or interacting species).
    We agree. This will be an evolving indicator as we conduct research and learn more about what to measure.
38. Aquatic Habitat (#6). FYI, the GLFC has approved in principle and will edit and revise for December approval the April 99 draft GLFC Declaration for the Conservation and Rehabilitation of Aquatic Habitat.
    Thanks for the reference.

39. Aquatic Habitat (#6). This indicator is useful in that it measures a component of the ecosystem which directly affects the physical, chemical and biological integrity of the lakes, but it may not be easy to measure and interpret. It will be difficult to establish reference points or a desired condition for most of the proposed measurements, e.g., Are good, quantitative historical data on the surface area for the different habitat types available? How much area and how many of each habitat are needed to support healthy populations? How do you objectively measure the quality of each habitat?

    We agree. This may be a research question for a while, but SOLEC recognizes the need for such an indicator.

40. Aquatic Habitat (#6). The description talks only about fish habitat, not about habitat for other organisms such as mussels, benthic inverts, and mollusks. Either the description should be broadened or the indicator changed to Fish Habitat. Also, will the focus be on a variety of habitats for all species or on specific habitat types for a few sport fish?

    We have renamed this indicator Fish Habitat. We have other indicators for benthos (#104) and mussels (#68), for which habitat is inferred.

41. Salmon and Trout (#8). Ecosystem Objective: FYI, in addition to lake trout, the LSC (Lake Superior Committee) has just approved a coaster brook trout rehabilitation plan. Comments: Coded wire tags (??nasal insert tags??) are used mostly on fingerlings and not just "larger fish'. Also, snouts are usual but not only place they're inserted. >>Ouch<< There are several other marking techniques that are used less frequently. Endpoint, Limitations, Comments: endpoints should be those of the duly mandated authorities, i.e., fish community objectives. Those of us who disagree with stocking should either influence states etc. or ask Congress to give feds authority, but a state-of-the-lakes exercise should NOT substitute its own endpoints (e.g., 100 % self-sustaining) for those of duly mandated authorities. To do so oversteps our mandate and invites backlash or non-cooperation in future documentation of indicators. For example, the Lake Huron fish community objectives state, "For most United States waters, stocking will play a large role in maintaining anadromous salmonine fisheries because of a lack of suitable tributaries for spawning." [GLWQA tiptoes up to states rights challenge but does not cross line - check very careful language of Lake Superior lake trout objective. Even if GLWQA did cross line, it would change nothing since GLWQA is not a Congressionally ratified treaty. Canada-Ontario division of responsibilities is much less clear with Canada perhaps having more say than do their U.S. counterparts but having delegated to Ontario -- if I correctly understand the highly nuanced Canadian system.] Endpoint: I'll see if I can get salmonine harvest targets for Superior and Erie. LSC fish community objectives are in progress, and LEC's are being edited. LOC's latest FCOs are also being edited - did you use 1990s harvest targets?

    We agree that endpoints that are already established are best. Sometimes proposed SOLEC indicators force the issue with suggested endpoints. You are correct that SOLEC should not arbitrarily substitute endpoints if others are already accepted.

42. Salmon and Trout (#8). The assertion that the data to support this indicator is routinely collected is not true and is dangerously misleading. Harvest and economic statistics associated with commercial fisheries are collected routinely. However, with the exception of Lake Erie, recreational fishery harvest now dominate the yield in the Great Lakes. Tracking of the yields of recreational fisheries is expensive, and is rarely done on a whole lake annual basis. Reported statistics are often only partial and are associated with high degree of measurement error. Identifying the origin of salmon and trout as wild or hatchery is an added difficulty associated with this indicator as many fish stocked in the Great Lakes are not uniquely marked. Reliable and cost-effective methods for classifying unmarked trout and salmon need to be developed.

Thank you for this information. This indicator needs some clarification by fisheries personnel.

43. Salmon and Trout (#8). These make sense as indicators, but it should be kept in mind that increases and declines in numbers/biomass/productivity may reflect changes in stocking rather than changes in the environment. Comments: In the first paragraph, it is stated that Atlantic salmon have been introduced to the upper four Great Lakes, but the next sentence states that "If Atlantic salmon are introduced to the upper four Great Lakes, they should be treated as exotics." These two statements are not consistent.

    Thank you for this information. This indicator needs some clarification by fisheries personnel. We have clarified the reference to Atlantic salmon introductions in the Comments section.

44. Walleye and Hexagenia (#9). Limitations: Delete “easily” re overfishing. While walleye were being overfished before 1970, I seem to recall some data that showed walleye overshot their preybase in the 1980s in spite of harvest.

    O.K.

45. Walleye and Hexagenia (#9). The description mentions that the goal for walleye is to move toward historical levels in mesotrophic waters throughout the basin; however, this goal may not be realistic considering the introduction and continued stocking of salmon.

    Thank you for this information. This indicator needs some clarification by fisheries personnel.

46. Preyfish populations (#17) Features: In addition to top-down management (predation), preyfish are also heavily influenced by phosphorus management and exotics such as zebra mussel. Climate is also important to exotics’ ability to overwinter, e.g. alewife. Comments: LOC-99-1 -- The LOC (Lake Ontario Committee) recognizes a potential window of opportunity for reintroduction of bloater chub. OMNR supports a NYDEC attempt. NYDEC will seek resources. An operation and assessment plan will be written, resources reviewed and sought, and a timeline adopted. LEC-99-8 -- The LEC (Lake Erie Committee) recognizes that reintroduction and restoration of indigenous fish species / stocks is a responsibility of the committee, which is comprised of representatives from the fishery management agencies of Ontario, Michigan, New York, Ohio, and Pennsylvania. The LEC accepts this responsibility and will actively, and in a timely manner, address the potential, feasibility, biological implications, commercial and recreational fishing impacts and costs associated with restoration and rehabilitation of species such as lake sturgeon, lake herring, sauger, etc. The LEC may actively seek partners in pursuing restoration efforts, but the LEC will implement and coordinate all reintroduction and restoration programs approved by the five jurisdictional management agencies.

    Thank you for this information. SOLEC wishes to work closely with the Lake Committees.

47. Preyfish Populations (#17). As is the case with the Salmon and Trout indicator, changes in many preyfish populations may reflect changes in predator stocking rather than an environmental change.

    O.K. We need to be careful interpreting the data.

48. Sea Lamprey (#18). Ecosystem Objective, Endpoint: Please mention that 1955 Convention on Great Lakes Fisheries created the GL Fishery Commission “to formulate and implement a comprehensive program for the purpose of eradicating or minimizing the sea lamprey populations in the Convention Area.” Features: I think the most thorough assessment we do is of “transformers” in order to determine need for treatment before animals descend tributaries to begin predaceous phase. Limitations: While wound classification is subjective (as is for example scale aging) GLFC and cooperating biologists

hold workshops etc. to standardize evaluation as much as possible.

We have revised the indicator description to reflect these concerns, and we continue to request input from fisheries experts.

49. Sea Lamprey (#18). The endpoint measures percent reductions in each lake. What year is used as the benchmark against which reductions will be measured? Some of the targets recommend a 50-75 percent reduction by 2000 (next year). Depending on the benchmark year, this may not be realistic.

    The reductions are based on year-of-issue of the Fish Community Goals and Objectives for each lake. The endpoint field for this description has been revised to clarify this point.

50. Native Unionid Mussels (#68). Would it be better to call them bivalves to include for example fingernail clams? Features: Again, I'm no expert, but does burrowing starve rather than suffocate zebes attached to native bivalves?

    The intent of this indicator really is focused on unionids. By extension, the indicator may infer conditions favorable to fingernail clams, but we cannot measure all ecosystem features everywhere.

51. Native Unionid Mussels (#68). The lack of historical data may make the use of this indicator problematic. We recommend that the endpoint be species distribution rather than abundance (due to the lack of historical abundance data). Also using 12 species as the threshold for healthy sites seems high - healthy sites may have fewer species due to historical patterns of distribution.

    Distribution and abundance are both important features of population statistics.

52. Fish Entrainment (#72). The focus of this indicator seems to be *water withdrawal*, yet it is named "fish entrainment". Overall, the indicator is very confusing.

    We have re-assessed this indicator and combined it with Fish Habitat (#6).

53. Lake Trout and Scud (#93). Ecosystem objective: See diatribe under Salmon & Trout. With "Oligotrophic waters in the other Great Lakes should be similarly maintained", SOLEC again seems to be seeking to create endpoints - which we should avoid. Endpoint: "The objective for lake trout restoration in Lake Superior is to restore self-sustaining stocks that can annually yield approximately 2 million kg (4 million lb), the average annual yield in 1929-1943." (M. Hansen, ed. April 1996. A Lake Trout Restoration Plan for Lake Superior. GLFC) "Lake trout yields may approximate 1.4-1.8 million kg two decades into the next century." (R.L. Desjardine et al. 1995. Fish-Community Objectives for Lake Huron. Spec. Pub. 95-1) Re Lake Erie, the FCOs being edited call for "historical levels". Some unpublished work under Henry Regier suggests that Lake Erie lake trout produced 110,000 lbs. or 50kg annually.

    See our response to #41. We have revised the indicator description to reflect current Fish Community Goals and Objectives.

54. Lake trout and Scud (#93). Features: the statement that there is lakewide assessments annually in each lake is not true. Limitations: the implication that harvest controls are needed to promote sustained use if the species is to be used as an indicator puts the cart before the horse. A management objective is to promote sustained use whether or not the species is an indicator species. The statement that status of D. hoyi populations is generally known and the understanding of changes related to Dreissena mussel invasion is emerging is misleading. In the last two-years it is clear that we have seen catastrophic declines in D. hoyi associated with presence of mussels but the mechanisms are unknown and vary widely in their implications. Not all stocked lake trout are marked so strain comparisons are not always possible. Interpretation: Seems to overstate the simplicity of this indicator. The fact that we are having trouble rehabilitating lake trout in

Lake Ontario does not in itself mean the ecosystem is unhealthy, as it could be related to the availability of appropriate lake trout stocks. If we are successful in establishing a stock of lake trout superbly adapted to the current state of the ecosystem (essentially a state that never existed before with most of the biomass comprised of exotic species at several trophic levels) can we argue that the system is healthy, or just healthier or perhaps sustainably ill? I think a cautionary statement that interpretation of this indicator is complicated by the degree and extent of recent species introductions and ecosystem perturbations would be appropriate.

These are good points that reflect the need to be cautious when interpreting indicator data. This does not negate the value of collecting and reporting the supporting data.

55. Lake Trout and Scud (#93). Lake trout continue to be stocked in the four lower Great Lakes, so using lake trout abundance/biomass as an indicator may reflect stocking practices rather than environmental changes.

    Stocking information will be useful to interpret lake trout abundance data.

56. Deformities, Erosions, Lesions and Tumors in Nearshore Fish (#101) You may (or may not) wish to refer to Tumor Manual at http://www.glfc.org. (Easiest to just use search mechanism for "Tumor Manual" at our website.)

    Thanks for the tip.

57. Benthos Diversity and Abundance (#104). Why is this indicator only limited to species of oligochaeta? Have they responded better to anthropogenic related changes than other taxa? A change in some species of oligochaeta does not necessarily reflect a predictable change in whole benthic assemblages. Why not look at a wider range of benthic taxa (chironomids, plecoptera, etc.) which might provide a more sensitive response to stress and a clearer picture of the relative health of benthic communities.

    We are continually faced with the challenge of not being able to measure everything everywhere. Oligochaets are a diverse group that could provide information from which we can infer more general conditions about the benthos.

58. Phosphorus Concentrations and Loadings (#111) Features Reliable load estimates are needed to interpret lake concentrations and fine-tune and manage as P loadings approach target levels (Article IV, Objective 3.b. of GLWQA). The IJC reports that analysis of loading is not ongoing and reliable. Ongoing monitoring has been eliminated or severely reduced and loading estimates are no longer reliable. There are also problems with reporting and commitment to continue phosphorus load estimates for all lakes. The interruption of lakewide P loading trend data is a particular concern of the Great Lakes Fishery Commission, as reported to Governments.

    Agreed

59. Phosphorus Concentrations and Loadings (#111). It seems that the presence of algal blooms could be used in conjunction with this proposed indicator. The document indicates that a great deal of remote sensing and satellite imagery information is available on algal blooms.

    Agreed. The presence of algal blooms could be reflective of excessive nutrients, but the indicator itself is intended to address the specific pressure of nutrient loadings.

60. Phosphorus Concentrations and Loadings (#111). Lacks adequate focus on phosphorus sources. Though the concentrations and loadings are useful, especially to support the total maximum daily loading efforts, greater utility would be achieved by discriminating the loadings among the primary phosphorus sources (i.e. permitted point sources, agricultural sources, urban runoff sources, natural loadings, etc.). The loadings so discriminated would allow users of the indicators to identify where to focus attention to reduce phosphorus

loadings.

To the extent that general categories of sources are known, we can report them, i.e., tributary loads, point sources, etc. The scope of SOLEC indicators, however, would be to combine many local measurements into a more general assessment of Great Lakes conditions. The localized data could be used by states or other more local authorities to influence environmental management actions.

61. Contaminants in Recreational Fish (#113). Finding an endpoint or target concentration for this indicator is likely to be contentious because states use different levels to trigger consumption advisories. One approach may be to choose as an endpoint the fish tissue concentration that relates to the attainment of Great Lakes Initiative standards, rather than using advisories as a target.

    As we have responded to other comments, SOLEC does not presume to set endpoints, but rather endpoints provide the frame of reference to interpret the indicator data. If an endpoint is contentious, it may be reflective of a larger debate being played out across the basin.

62. Atmospheric Deposition Of Toxic Chemicals (#117). This indicator may fit better under the Unbound Indicators group since the sources of contaminants can originate well outside the Great Lakes basin.

    Perhaps. Indicators #117, 118, 119 and 120 really go together as a package, however.

63. Contaminant Exchanges Between Media (#120). These measurements make for interesting science but seem redundant given that contaminant levels in all other media are proposed as indicators. We recommend dropping this indicator.

    We think the approach taken by this indicator has merit, but it may require additional research and testing to be fully appreciated and useful to managers.

Coastal Wetlands

64. All the wetland indicators are good, but some will be tedious and others will be costly. The bigger problem is that many cannot be set in concrete because inverts, fish, amphibians, and birds among others are dependent on plant communities for habitat. Those plant communities can change radically from year to year depending on water-level fluctuations and without any change in human impact at all. Since these changes are natural, any indicator metrics would have to be scaled according to water-level history leading up to the date of data collection. This could be VERY difficult and confusing. It could also mean that nobody would use the indicators.

    We recognize that many changes in wetlands are natural, and that many relate to water-level fluctuations. We hope to distinguish the natural changes from the human-induced changes. You are correct that this task will be difficult and confusing. As a recognized expert on the subject, would you be willing to offer advice and figure out how to best do this?

65. For coastal wetlands it is suggested that one of the criteria for selection of an indicator is that monitoring can be done by volunteers. I would suggest that this criteria would eliminate many (e.g. coastal invertebrate community, coastal wetland fish community health, deformities/eroded fins/lesions/tumours in coastal wetland fish, etc) of the proposed indicators.

    We are suggesting that where possible, monitoring be conducted by volunteers, but acknowledge that this will not be possible for all of the indicators. Using volunteers was not a criteria for the selection of the indicator, but rather a way of operationalizing the monitoring

required to report on the indicators where possible. The added bonus of using volunteers is to build community support for SOLEC, Great Lakes cleanup and habitat conservation.

66. The presence of non-native species might be considered as a pressure on the health of coastal wetlands.

    We did address the presence of non-native plant species in the context of invasive plants (#4513), and elected not to limit our monitoring to non-native species, but to also include invasive native plants as well. We do not have an indicator specifically for non-native non-plant species, such as carp, zebra mussels or ruffe, but this information will come out as part of looking at invertebrate, fish, amphibian and bird populations.

67. The endpoints for most of the indicators listed in this category have yet to be defined and will require a great deal of effort and research to finalize.

    We acknowledge that most of the endpoints have yet to be established and that there will be much work required to do this. In part, there is simply not the history of science and research for coastal wetlands that exists for many other ecosystem indicator groups such as human health.

68. The biological indicators such as CW Invertebrate Community Health (#4501), CW Fish Community Health (#4502), Amphibian Diversity and Abundance (#4504), Wetland Dependent Bird Diversity and Abundance (#4507), and Presence, Abundance and Expansion of Invasive Plants (#4513) are certainly all useful, but they are subject to a lot of natural variability due to natural water-level fluctuation patterns.

    We acknowledge this and hope to be able to distinguish the effects of natural and human-induced stress on these communities. Again, we would welcome your advice on how to best accomplish this.

69. DELT (#4503) and Contaminants in Snapping Turtle Eggs (#4506) could be important in some of the bad sites but may not mean much in uncontaminated areas.

    This may be true, but for the wetlands which are in urban and agricultural landscapes, we wanted to capture contaminants as a stress on wetlands as well as their effects. For example, using snapping turtles as a top-predator that does not migrate very far will integrate the effects of a suite of contaminants.

70. CW Area by Type (#4510) and Gain in Restored CW by Type (#4511) are good generic indicators, but they again are subject to water-levels, as noted in the write-up. I am glad to see recognition that wetland types differ because the biological indicators above will differ somewhat between wetland types.

    Again we hope to be able to distinguish the effects of the natural from the human-induced stresses for these indicators, and would welcome your advice.

71. Coastal Wetland Area by Type (#4510). The endpoint for this proposed indicator is no net loss; however, the year that will be used as the baseline is not mentioned.

    You are correct, the selection of the baseline year still needs to be discussed.

72. Gain in Restored Coastal Wetland Area by Type (#4511). This indicator could be misleading. While a gain in restored wetlands might normally be thought of as positive, it also could indicate an increased loss or degradation of natural, high-quality wetlands, followed by their restoration to a quality lower than the original.

    The intent was that this indicator would capture the efforts to restore wetlands that were lost some time ago, rather than current permitted compensation projects. We acknowledge the need to clearly distinguish wetland area and wetland quality. We hope that the other

indicators in the suite will be able to pick-up on the question of quality of the restored areas.

73. Presence, Abundance and Expansion of Invasive Plants (#4513). In the interpretation, if a ranking is developed the "combined score" could also consider factoring in whether the invasive plants are alien/non-native/exotic or native. The invasion of alien species is well recognized as a key threat to Canada's native biodiversity, and the lower Great Lakes basin is one of the principal areas where this threat is being felt. The distinction between native and alien has been made in Indicators #0109, #8129 and #8134.

    We certainly intend to look at non-native invasive plants in this indicator, but also want to acknowledge that the expansion of invasive native plants also indicates stress on wetlands. We have modified the interpretation of the indicator to specifically include native and non-native as a factor.

74. Sediment Flowing into C W (#4516) and Nitrates and Total P into C W (#4560) could be rather difficult to measure accurately for a wetland as a whole. Where do you measure?

    The intent was to use existing (USGS and Environment Canada) networks of tributary monitoring stations, upstream of coastal wetlands for these indicators. These would indicate land use changes in the watersheds of coastal wetlands as well as the stressor of sediments and nutrients themselves.

75. Nitrates and Total Phosphorus Into Coastal Wetlands (#4860). The purpose of this indicator needs clarification. It states "to determine instances of non-excessive nutrient levels in the wetlands", whereas the subsequent text indicates that "excess nutrients can be detrimental to the health of coastal wetlands".

    Although nutrient levels will be monitored to determine excessive or non-excessive levels, in the interpretation, instances of non-excessive nutrient levels (or absences of excessive levels) will be reported rather than the concentrations themselves.

76. Sediment, nitrate, and phosphorus loads into wetlands should be flow-normalized, since observed differences between years could be due to changes in flow from one year to the next.

    We acknowledge the potential for changes being due to flow rather than load. If by 'flow-normalization' you mean using stream-specific and regularly updated relationships of flow and sediments, we believe that the current tributary monitoring system in place by USGS and Environment Canada addresses this and separates the changes in loadings from the changes in flow.

77. I like Water Level Fluctuations (#4861) because it obviously points out that Lake Ontario flunks.

    Thank you.

78. Habitat Adjacent to Wetlands (#7055) is a bit subjective but has considerable value.

    We acknowledge the subjectivity, but also think that using it as an indicator will provide useful information.

79. There are applications for Extent of Hardened Shoreline (#8131) and Artificial Coastal Structures (#8146) to wetlands because they partially determine the supply of littoral sediments to maintain barrier beaches that protect many wetlands.

    We acknowledge this, but have let the Nearshore Terrestrial group be the lead for these two indicators.

Nearshore Terrestrial

80. Area, Quality and Protection of Special Lakeshore Communities (#8129). The term "special" is applied very subjectively in this indicator. All naturally occurring lakeshore communities are important ecologically, but 12 specific types have been selected for the indicator because of particular properties, which may include rarity, uniqueness or sensitivity. The "special" aspect can be noted once in the text but does not need to be in the title and repeated throughout the indicator description (15 times altogether). Suggest omitting the word "special' from the indicator title, i.e., …Protection of Lakeshore Communities.

    We agree

81. Nearshore Plant and Wildlife Problem Species (#8134). It would be preferable to use "Plant and Animal" as wild plants are also a component of Canada's wildlife. In the report, *A Wildlife Policy for Canada*, the Wildlife Ministers' Council of Canada defines **wildlife** as the following: Pertains to all nondomesticated living organisms. It includes not only vertebrate animals (mammals, birds, fish, amphibians and reptiles) but also invertebrate animals, vascular plants, algae, fungi, bacteria and all other wild living organisms (Wildlife Ministers' Council of Canada. 1990. *A Wildlife Policy for Canada*). Thus, the word "wildlife" in the indicator title should be replaced by "animal", i.e., … "animal problem species".

    We agree

82. Contaminants Affecting Productivity of Bald Eagles (#8135). "Measure: 1) Concentrations of DDT Complex (including DDE, a breakdown product of DDT), PCBs, PCDD, PCDF and other organic contaminants …". At first mention, it should be clarified that the initials PTS stands for persistent toxic substance.

    We agree. PTS is also used in other indicator descriptions, and it is included in the list of acronyms in Appendix 6.

Land Use

83. The indicators: water consumption, energy consumption, wastewater pollution and solid waste generation, currently listed under the human activities or response category should be included under the pressure category since they are not measuring programs or efforts to improve the situation.

    O.K.

84. Many of the indicators proposed for this category will be very difficult to measure and many factors other than environmental ones may contribute to changes. Some indicators that seem susceptible to this problem include brownfield redevelopment, mass transportation, green planning process, and energy use.

    We agree. Many of these indicators require refinement and testing.

85. Urban Density (#7000). Endpoint: "There is no conceivable upper end to urban densities from an ecosystem perspective since higher densities are associated with improved urban efficiency and reduced stress on the rest of the ecosystem. Thus, higher densities are better." These are highly arguable statements. "From an ecosystem perspective", it seems inconceivable for there to be an infinitely high urban density. Higher densities can be associated with certain urban efficiencies, but they are not certainties. Further, increasing densities can lead to concentrated environmental stresses that can affect

surrounding ecosystems (e.g., ground-level ozone that spreads into rural areas and higher amounts of municipal wastewater and solid waste that get disposed of in “the rest of the ecosystem”). Higher densities *may be* better in some regards, but it is not a “given” that they “are better”.

We recognize that this indicator needs further development, data collection and testing, and we welcome specific suggestions to consider.

86. Land Conversion (#7002). The suggestion is zero change and the implication is that all conversion is some sort of sprawl. I would think that in some cases land conversion would be desirable and that not all conversion will be sprawl.

    There is no intention to imply that all land conversion is sprawl.

87. Brownfields (#7006). What constitutes a brownfield?

    We have included a more explicit definition under “Features.”

88. Mass Transportation (#7012). This indicator would not be sensitive to any change in the numbers of people walking or bicycling to work or tele-commuting. Eventually this indicator should be supplemented with estimates of actual automobile use for commuting. It is probably a reasonable indirect measure for the time being. New vehicle surveys, conducted by Natural Resources Canada and Statistics Canada may be helpful in the future.
89. Mass Transportation (#7012). This is a useful indicator, but as expressed, the indicator will provide marginal utility. A measure of mass transportation use supplies only one piece of the complex issue around private motor vehicle use and urban commuting. Complimenting the mass transportation indicator with measures of average commute time and distances within urban areas near the Great Lakes will provide a much more useful picture of the system. Also, providing measures of the increase in urban population relative to the increase in urban/developed land will show the degree of pressure being placed on the system by conversion of land to urban uses. Such information would provide insight on the factors behind the use of private motor vehicles in urban areas within the Great Lakes Basin.

    Mass transit numbers are relatively easy to get. As for other Land Use indicators, this one is evolving. Suggestions like these are welcomed.

90. Only one indicator (#7028) deals with agriculture. You should be aware that AAFC has been working to develop environmental indicators for agriculture. A publication presenting the results of this work is being prepared for release this fall. Should your initiative wish to further develop its treatment of agriculture, you may wish to consider/draw on our approach.

    Thanks.
91. There is only one indicator related to agriculture, "Sustainable Agricultural Practices", #7028, which is a response indicator. It seems to be unrelated to any state or pressure indicator, so the questions arise: What is it a response to? Which pressures is this response supposed to alleviate? Which deteriorating state to improve? Which indicator measures whether the response is effective? Agriculture plays an important socio-economic role in the basins of the lower Great Lakes and is probably the most significant source of transformation of land in these basins and a source of phosphorus, nitrogen, pesticides and other substances. It is estimated that it contributes over 50% of phosphorus loadings and most pesticide loadings to the lower Great Lakes. It can also be a major source of contamination of rural drinking water. A single "response" indicator seems insufficient and at least pressure indicators are required to describe the impact of

agriculture on the Great Lakes ecosystem. Which pressures should be represented depends on the goal of the SOLEC indicator initiative. If the goal is to provide tools for management, then indicators for pressure, related state, and response should be available. If the goal is to have indicators relevant to the GLWQA, then indicators related to the objectives of the GLWQA (in this case phosphorus and toxic pesticide loadings) should be available. If the goal is to assure that the SOLEC agricultural indicators will actually be monitored, then the indicators should be coordinated with those being developed by Agriculture/Agrifood Canada and with past and current monitoring efforts of Agriculture Canada, the Natural Resources Conservation Service/USDA, and the USGS. As a last point, it may be useful to point out that most pressures caused by agriculture on aquatic and terrestrial ecosystems originate either from soil loss due to cropping practices or to manure production due to animal husbandry. Thus a single indicator of "farmland intensity" would be too general to be useful. Livestock density and cropping intensity or quantities partially derived from the former (e.g. estimated soil loss and manure production per unit area) may be useable pressure indicators.

92. The 3 goals listed in the 9th Biennial Rpt. on GLWQA should be reflected in the SOLEC indicators, i.e. Conservation Tillage ac., Buffer-strips mi., & Herbicide applications. These 3 are all tracked by USDA-NRCS, CTIC & USGS. In addition, the new EPA emphasis on animal waste will be targeted (& tracked) through an increase in issuance of NPDES permits. NRCS & others will be developing Comprehensive Nutrient Mgt. Plans (CNMPs) for all livestock operations over the next few years as called for in the U.S.-Clean Water Action Plan. These are the bare minimum that will be needed for SOLEC. The NRCS does a 5 yr. Natural Resource Inventory (NR)) & an annual Work Load Analysis (WLA) that can also be a valuable source of historic data base & trends in AG.

    These are good points, and we anticipate much further development and refinement of this indicator. If ready-made indicators are available, we will take a look at them immediately. We added some text under "Unfinished Business" showing the need to develop indicators for conservation tillage, buffer strips and herbicide application. The AAFC indicators may be very useful, especially if data are already being collected.

93. In addition to urbanization, climate has a large role in land use change through its influence on agricultural intensification. An indicator that describes the influence of climate on land use change would be useful, especially as an early warning or predictive indicator. (We can provide further details)

    The influence of climate change should show up over time in the Land Conversion indicator (#7002).

94. Water Consumption (#7056). On what basis is 50% reduction chosen? Re waste water it may not only be a matter of reducing the amount of waste water but also dealing with effective treatment.

    The 50% reduction endpoint was chosen to elicit some discussion. We would like suggestions for alternate, supportable endpoints.

95. Water Consumption (#7056). Instead of estimating wastewater volumes indirectly based on a direct measure of water usage, wastewater discharge volumes should also be quantified directly, since most wastewater flow rates would be documented on provincial certificate of approvals for effluent discharges. Hopefully, heated water is covered as wastewater, since large volumes of cooling water are discharged into the Great Lakes by nuclear power plants and other industrial plants.

    We looked at wastewater volume as an indicator, but we think that water consumption is the better measure. The indicator description refers to water use, not just permanent extraction.

96. Water Consumption (#7056). I would just like to ensure that you are aware that this

indicator on water use is very important and we expect that it will become even more important in the future. The IJC is currently considering Water Uses and Diversions under a reference. As well as the need to know about the quantity of water used, the discussion about diversions is putting considerable emphasis on water conservation. This will need to be tracked.

Thanks. We'll keep this indicator. It is now called Water Withdrawal.

97. Energy Consumption (#7057) - seeking additional input from Ontario Hydro on this indicator. As good as KWH are as an indicator I think it should be coupled with KW demand as well. Seeking additional information and will pass on.

Thanks for your help.

98. Wastewater Pollution (#7059). The description in the front section (section 4.2.1) of the document lacks specificity of those pollutants that would be measured by this indicator. The specific pollutants are listed in the appendix 1 description, but the initial description leaves the reader with a question as to the specific pollutants targeted by the indicator. In addition, the measure has limited utility as presented. As described, the loadings would be presented without context to the size of the wastewater treatment facility, the size and characteristics of the facility's service area, and the relative contribution or the facility the pollutants released in the local or regional area. Also, ignoring the facility's disposition of biosolids may under-represent the problems posed by pollutants, such as mercury and other heavy metals, which are typically associated with biosolids. The releases of pollutants from the biosolid disposal practices, especially incineration, may be larger than the amounts of pollutants released in a facility's effluent.

We agree that this indicator needs refinement. Initially, the details for this indicator may depend, in part, on what data are available. From an ecosystem viewpoint, the absolute quantity of loadings is the item of interest. From the perspective of a regulator or treatment facility operator, the context for the magnitude of loadings may have a bearing on management decisions.

99. Solid waste (#7060). How is solid waste defined as many jurisdictions differ in what they allow into their waste stream? For example are yard wastes and organics included? What about construction materials? Are these items solid waste or resources?

We agree that this indicator needs refinement. Initially, the details for this indicator may depend, in part, on what data are available

100. Streamflow (#8142). We believe that this is a good indicator, but the endpoint listed in the document, "Functioning longshore transport processes necessary for healthy coastal ecosystems," is not a quantifiable endpoint. Desired flows must be determined for each stream/river that is assessed.

We agree that the endpoint is not quantifiable at this time. We have renamed this indicator as Sediment Available for Coastal Nourishment to more accurately reflect its intention.

101. Streamflow (#8142). We are not convinced that Indicator #4175 (Drinking Water Quality) adequately addresses Annex 16 of the GLWQA, "Pollution from Contaminated Groundwater." Groundwater can be important in sustaining surface water quality/quantity. The IJC Indicators for Evaluation Task Force recommended that "Quality and Quantity of Stream Base Flow" be used as an indicator related to Annex 16. SOLEC indicator #8142 should, therefore be expanded to include base flow reporting and trend analysis.

Indicator #8142 was clarified to reflect Sediment Available for Coastal Nourishment. There is

currently no SOLEC indicator for tributary flow. We are aware that SOLEC may need to look more closely at tributary monitoring and related issues.

Human Health

102. All the human health indicators are good ones and both parties are commended for developing this list. The indicators assess exposure but provide little in the area of human health effects.
We agree that health effects indicators need to be developed.

103. Indicators of health effects related to human exposure should be another indicator - markers of biological effects. Even though considerable research is required to establish this relationship, there already exist two established research programs which are ongoing in the U.S. and Canada, both investigating the potential for adverse human health effects from exposure to PTSs.
We agree that health effects indicators need to be developed. At this time, the health effects work is largely research-based and there is a need to translate that research into indicators. Some indicators have potential, for example, those relating ambient air pollution to hospital admissions.

104. For the human health indicators there should be a clear statement about at-risk or susceptible populations. The research findings of the ATSDR Great Lakes Human Health Effects Research Program have shown that body burden levels of persistent toxic substances (PTSs) in populations in the Great Lakes basin are similar to the general population. However, the body burden levels of at-risk populations, i.e., sport anglers, Native Americans, the elderly, etc., are much higher than the general population. There should be a focus on these populations as the indicators are pursued in the Great Lakes and St. Lawrence Basins. There should be another category or indicator for at-risk populations.
Some indicators will attempt to look at at-risk populations separately from the general population. For example, indicator #4177 (Chemical Contamination in Human Tissue) will incorporate at-risk populations, and reference to that effect is in the Comments section of the indicator description.

105. Indicators of well being or societal health should be reconsidered as an indicator for human health. This indicator can gauge population attitudes, knowledge, behaviors and perception of risks to elements in the Great Lakes and St. Lawrence River basins.
We agree that indicators of well being or social health need to be present. Under SOLEC, well being and social health indicators have been incorporated into the Societal indicators. Societal indicators need both thought and development.

106. The SOLEC indicators selected should reflect spatial and temporal scale and should also include historical data as well as currently collected material so that longer term trends can be reported, e.g., *8135, #8150, #4167(?), #4506 and many others.
We agree. That is the intent of the SOLEC indicators.

107. Fecal Pollution (#4081). While this would be a valuable indicator, getting agreement on an endpoint may be difficult given that some states have standards for E. coli while others use fecal coliform.
We agree that this will be a continuing challenge. There is some activity nationwide in the

U.S. for the adoption of uniform E. coli standards and methodology. We have renamed this indicator E.coli and Fecal Coliform Levels in Nearshore Recreational Waters.

108. Fecal Pollution (#4081). Under the Limitations section, a comment on variability related to changes in weather patterns from year to year would be appropriate. In many locations this variability is the primary reason for year to year change in bacterial counts.
The suggested statement was added to the indicator description.

109. Chemical Contaminants in Fish Tissue (#4083). This is redundant, as this indicator already is proposed as an indicator under Nearshore and Open Waters.
The two indicators are different. #4083 is simpler and more direct, i.e., reporting concentrations of contaminants in dorsal muscle from selected fish species, and some data are currently available. #113 calls for developing an index of contamination based on relative proportion each species contributes to the total annual catch. #113 requires further development, including some modeling, but it may be the foundation for a useful, general index.

110. Chemical Contaminants in Fish Tissue (#4083). There is no indication of which PBTs should be measured. Although the standard routine is to measure concentrations of contaminants in skinless, boneless fillets, most of he contaminants of concern concentrate in the fat. It is incorrect to assume that most fish-eaters eat only skinless, boneless fillets. Measuring concentrations in the fillets may be the most accurate way to determine trends, but the concentrations in fillets will underestimate the dose of many contaminants in terms of dietary intake.
The PBTs suggested for measurement are those targeted by the Great Lakes water Quality Agreement (see Measure statement), along with those identified by the LaMPs and Binational Strategy for Toxics Reduction.. Principally, those would be PCBs, DDT/DDE, dioxins, dieldrin, chlordane, hexachlorobenzene, toxaphene and mercury.

111. Chemical Contaminant Intake from Air, Water, Soil, and Food (#4088). We recommend dropping this indicator. Other proposed indicators include contaminants in fish, drinking water, and air. Therefore, this indicator is redundant.
The Air Quality Indicator (4176) deals with "smog" constituents rather than the PBT chemicals referred to in 4088, thus they are addressing altogether different parameters. In addition, there is no soil or food (other than Great Lakes fish) indicator in the current suite. Other indicators include concentration of contaminants in various environmental compartments. However indicator 4088 combines the data into a multimedia exposure assessment. The indicator requires further development, but it could be one that is closely followed.

112. Chemical Contaminant Intake from Air, Water, Soil, and Food (#4088). Some of the exposure indicators are too broad in scope and will take considerable time to accomplish to provide answers in a timely 3-5 year period. For example, The purpose of Indicator #4088 is to estimate the daily intake of PBT chemicals from all sources and determine if the values for the PBT chemicals are below established guidelines. Are there established guidelines for all PBT chemicals in all the media mentioned? IF not, it will take time for all parties to agree on these values. The text indicates that some of these contaminants have been estimated in Canadian diets for various age groups. Would these values be true for the American diet? This indicator for human health is good and should remain, but a more stringent strategy should be developed which would be more cost effective and obtain measurable results in a timely manner for the citizens of the Great Lakes.
We agree that 3-5 year is a short period to provide answers in a timely manner. However, we recognize that the development and use of indicators is long term effort. With regards to

guidelines, Canadian Tolerable Daily Intake (TDI) guidelines are available for most PBT chemicals.

113. Drinking Water Quality (#4175). SDWB [U.S. EPA, Region 5, Safe Drinking Water Branch] main concern is that any drinking water indicator adopted by SOLEC, Lakewide Management Plans, and Remedial Action Plans be based on ambient water meeting human health water quality criteria rather than treated water meeting maximum contaminant levels (MCLs) and treatment techniques of the National Primary Drinking Water Regulations. Measure: The reference to treated and distributed drinking water data should be removed. The reference to drinking water disinfection by-products (e.g., trihalomethanes) in treated drinking water should be removed, or replaced with measures of disinfection by-product precursors in ambient water, e.g., total organic carbon. Turbidity should be added to the list of contaminants. Excessive turbidity can overwhelm filtration with break through of protozoan pathogens to finished drinking water, and interfere with the disinfection process. The reference to alkylphenols should be removed, because these are still basically investigatory in nature and are not currently regulated. Ecosystem Objective: This should be modified to make it clear that the objective is related to ambient water meeting human health water quality criteria, not to treatment in drinking water treatment plants. Features: The references to treated and distributed drinking water data should be removed.
There is some debate about drinking water being assessed as ambient (raw), finished, or distributed. Perhaps some items are best measured at different locations. For example, turbidity in raw water, pathogens in finished water, and lead in distributed waters. A workshop was held in August, 1999, to more clearly define the elements of drinking water indicator(s), and for SOLEC and the IJC to reach consensus on priorities for monitoring and reporting on drinking water quality. Results of that workshop are being used to better define the measurement for this indicator.

114. Drinking Water Quality (#4175). The Endpoint of this indicator states, "Densities of disease-causing organisms or concentrations of hazardous to toxic chemicals or radioactive substances should not exceed human health objectives . . . or guidelines. We have not read what the human health objectives are in this document. These objectives need to be identified in section 4.5 Human Health.
We did not explicitly state the drinking water guidelines or objectives. In Canada, Canadian Drinking Water Guidelines and Ontario Drinking Water Guidelines exist for over 100 parameters and may differ with individual State standards. This indicator could handle reported contaminant data from treatment plants obtaining their raw water from ground sources. Obtaining contaminant data for Individual wells serving individual homes is problematic.

115. Air Quality (#4176). The trends could also be illustrated spatially using GIS which would show changes before and after the implementation of government, industry or community initiatives. Since the relationship between adverse respiratory effects (e.g., hospital admissions) and air pollutants such as ozone has been established for the Great Lakes region (or at least provincially), it may be useful to show the annual number of pollutant increments as illustrated in the British Columbia air quality reports. For example, for each 10 ppb increase in ozone levels (above a specific level), there is an equivalent percentage increase in respiratory-related hospital admissions. Thus, each increase of 10 ppb is considered an increment. By showing the annual number of pollutant increments for a specific area over a given time period, the pollutant levels are portrayed in a human health context. It also avoids the problems associated with different standards or objectives for various jurisdictions.

Thanks for the suggestion. We will consider it.

116. Chemical Contaminants in Human Tissue (#4177). This indicator would measure PBT in human tissues such as blood, breast milk, hair, and adipose tissue. We would also add urine to this list. Under Comments please add the following: The Agency for Toxic Substances and Disease Registry Great Lakes Human Health Effects Research Program has determined body burden levels of various PTSs in at-risk populations. These body burden levels for some PTSs are 2 to 4 times greater than the general U.S. population. Reference: Johnson et al., 1998. Public Health Implications of Persistent Toxic Substances in the Great Lakes and St. Lawrence Basins. J. Great Lakes Res. 24(2):698-722.
"Urine" was added as a component, and the reference was added to the Comments section.

117. Radionuclides (#4178). This indicator will not enable one to measure ecosystem effects. From a human health perspective, direct measurements of tritium instead of relying of the beta counts for air, water, and precipitation would be very valuable. The absence of alpha monitoring is also noted. This picks up the uranium and thorium related isotopes, including plutonium (which because of its half life of billions of billions of years, is essentially forever once contaminating a system). Also Co-60 should be considered in the list of nuclides. This nuclide has a 5 year half life and is one which is widely used in chemotherapy and other medical situations. Some lakes with unusual cobalt levels are examples of a lack of radioactivity monitoring because cobalt is very rare geochemically, and the only explanation for the high cobalt levels found in these systems is the radioactive decay of iron and nickel isotopes (from nuclear power plant emissions) and direct inputs of radioactive cobalt from hospitals and nuclear medicine groups to a feeder stream to these waterbodies.
We agree that this is an indirect measure of environmental and human exposure and have acknowledged the limitations of this indicator in the text. We currently don't have a great deal of expertise on the Health Core group to appropriately respond to the radionuclide indicators issues and need to find an advisor. It should be noted that this is the only indicator pertaining to ionizing radiation and radionuclides that was proposed throughout the SOLEC process.

118. Geographic Patterns and Trends in Disease Incidence (#4179). The incidence of certain kinds of acute health-related events (e.g., hospital visits for asthma attacks, miscarriages, birth defects, etc.) could be considered as complementary to this indicator.
Thanks for the suggestion.

Societal

119. There may be some measures that have been suggested in the literature as a means of getting at quality of life as part of the state indicators. Some examples include: Mortality pre-age 65, Suicide rate, Greenspace per capita, Accident rates, Crime rate, Literacy rates, Percentage of labour force employed, Estimates of homeless population and Percentage of households with income below low income cut-off.
We would like to incorporate quality of life aspects from a positive health perspective in an aesthetics indicator.

120. Most of the listed parameters in this category will be subject to considerable and unresolvable interpretations as to what impact a change in any one will have on the

Great Lakes environment. Two separate documents, one dealing with environmental and one dealing with societal factors or at least a much clearer differentiation between the two in a single document would be more useful.
Please see our response to General Comment #22.

121. The inclusion of Societal Indicators to the SOLEC effort is a bold and welcome addition. The MPCA [Minnesota Pollution Control Authority] also realizes the need to connect environmental improvement and protection with economic and social conditions.
Agree. Thanks for the comment.

122. A number of the indicators under the Societal section represent useful measures of the integration of an environmental ethos within the Great Lakes Basin. What appears to be missing, though are measures which indicate the impact of healthy Great Lakes on local and regional economies. One suggested measure of this impact is the relative percent of a local or regional economy dependent upon Great Lakes based tourism. The North Shore portion of Lake Superior provides an example of the tourism value of a pristine Great Lake to the regional economy.
We agree. Good advice. We will consider this as we further develop societal indicators.

123. The economic value of the Great Lakes could also be expanded to show the non-tourism dependence of a local or regional economy and social structure upon a healthy Great Lakes ecosystem. Uses such as drinking water sources, shipping of goods, fishing could all be integrated into a percent of the regional or local economy and social structure that depend on the Great Lakes.
We agree. Good advice. We will consider this as we further develop societal indicators

124. Also lacking from the Societal Indicators list are indicators of population changes within the Great Lakes Basin. A primary threat to the Great Lakes is the increasing populations in urban areas within the Great Lakes Basin and concomitant changes in land use. Indicators used to report the issue of urban sprawl would prove useful in the Societal category. Measures of the amount of green space in Great Lake urban areas, the number of National, State or Provincial parks near the Great Lakes, recreational trails (hiking, biking, canoeing, kayaking, etc.) near the Great Lakes, as well as the population and demographics of those living on the Great Lakes would show the value society places on healthy Great Lakes.
We will deal with this issue in terms of conversion of land for commercial or residential land. This is a pressure.

125. General societal pressures upon the Great Lakes could be shown by displaying the number and location of releasers of toxic chemicals in the Great Lakes Basin (from the USEPA TRI and EC equivalent). The percent of local or regional economics dependent upon companies releasing toxic chemicals within the Great Lakes Basin would further show the systemic relationships between socio-economics and the state of the Great Lakes. Another societal pressure indicator would be the number, size (i.e. gallons per day of discharge) and location of wastewater treatment plants discharging to a Great Lake or a tributary of a Great Lake. Specific for mercury, a pressure indicator could depict the percent of energy produced, imported or consumed within the Great Lakes Basin that was produce through coal combustion.
We will consider these suggestions under Land Use indicators.

126. Positive indicators flowing from the above mentioned pressures could include the

number of companies within the basin that have environmental management systems (i.e., ISO 14000). Concerning wastewater treatment facilities, the number of facilities with toxics reduction plans would show the movement towards pollution prevention within the Great Lakes Basin.
Indicator #3513 deals with this.

127. Citizen/Community Place-Based Stewardship Activities (#3513). Good broad indicator. Maybe could track government spending (funding through grants, etc) as a measure of activity or lack of the same??
***Indicator #8140* addresses this.**

128. Aesthetics (#7042). Good broad indicator - very hard to qualify - even more difficult to quantify - Maybe able to capture some aspects of this indicator through documentation of Spills (aquatic and terrestrial) - as tracked by OMOE.
Please see our response to comment 119, dealing with Quality of Life.

Unbounded

129. Could UV radiation input to the Great Lakes basin be a worthwhile unbounded indicator?
***We are not sure if this would be useful, but we would welcome advice on the matter. Maybe some kind of UV rating or index related to human exposure would work. Perhaps this topic could be discussed at a future SOLEC* breakout session.**

130. The term "unbounded" sounds like miscellaneous, maybe these could be called global.
We have struggled to find the right descriptor for this category. It is not miscellaneous. The indicators have a geographic scope on the scale of the whole Great Lakes basin or larger, i.e., regional, continental or global, hence the "unbounded" term.

131. There is a problem with nomenclature and the use of the phrase *Global Warming,* since the indicators being suggested are in fact nothing more than measures of short term variations of weather. Global warming and/or cooling is a phenomenon that is better measured in terms of geologic time frames. A renaming of those indicators and a revision of their descriptions would be appropriate.
Good point. We will use the term Climate Change instead of global warming.

A9.2 Positive Feedback

1. It is obvious that an impressive amount of work went into the development of indicators that reflect the state of the waters and shorelines of the Great Lakes. The current suite of indicators are quite comprehensive in describing the state of the waters and take advantage of existing monitoring programs where possible. Careful thought has been given to developing indicators that incorporate change or can indicate change.

2. An impressive amount of work went into developing these indicators. The indicators are quite comprehensive and geared towards change.

3. ...recognized high level of scientific integrity. This effort is notable and very much appreciated.

4. Congratulations on making substantial progress -- -- which should be reported on in future key US-Canada high-level meetings.

5. The indicator development process is thorough and inclusive, especially in bringing together the necessary expertise. The selection of indicators document is an excellent resource. In most cases, the indicators themselves seem to capture the key ecosystem health issues related to the Great lakes.

6. We commend the State of the Lakes Ecosystem Conference (SOLEC) Steering Committee on its extensive efforts to identify environmental indicators and produce this document. [This agency] recognizes the need for relevant, scientifically credible environmental indicators for the Great Lakes.

7. Overall, the draft report is an excellent first step in identifying meaningful and measurable parameters that can be used to assess and track changes in the Great Lakes system. Most of the indicators in the various categories have some scientific foundation in that a direct or indirect relationship can be ascribed over time between the indicator and changes in the overall quality of the Great Lakes environment.

8. This version of the indicators represents a commendable evolutionary step in the process to identify indicators for the Great Lakes Basin. The range of issues and spatial size of the basin pose challenges to the compilation of a comprehensive list of indicators. The broad range of potential users also creates a substantial challenge to effectively meet a diversity of information needs.

9. I wish to commend the various committees on focusing on basin-wide issues. The spatial scale of the indicators shows that the committees were very cognizant of the need to maintain a focus on the entire Great Lakes Basin. This geographic scale allows [this agency] to contribute to and benefit from coordinated efforts throughout the Great Lakes Basin.

10. They have changed the format of the descriptions to make the definitions and criteria more useful.

11. I think there was an applaudable effort to find indicators that could serve a variety of purposes and offer a basin snapshot. It is a positive step to strive for measures of basin-wide health.

12. From an agency response perspective, I think that we can congratulate the SOLEC team on their effort, recognizing that experts and agencies still have a ways to go in fine-tuning indicators and collecting the appropriate information.

13. As an agency we should strongly support the move towards the development and use of standard indicators of ecosystem health. This applies not only to the Great Lakes but also to inland waters. This initiative is a step in the right direction and is essential to evaluating the effectiveness or our current policy and programs.