SAB Advisory Panel on EPA's Report on the Environment (ROE) 2014

July 30-31, 2014 Meeting

Pre-Meeting Comments (as of 7/25/2014)

Joseph Arvai

1. Sustainability as the ROE 2014 conceptual framework

I think sustainability is the appropriate overarching conceptual framework for the ROE. I am also satisfied with how sustainability is defined in the report, with an emphasis on the views first articulated by the Bruntland commission.

However, if sustainability is going to be the overarching conceptual framework, it might be beneficial to place it front and center when someone first logs into the ROE webpage. As it stands, sustainability is the final top-bar tab on the page.

As far as the six examples are concerned, somebody has to drill quite deeply into the website to find them. As a result, these examples aren't as powerful as they otherwise may be.

2. Sustainability Indicators

In my view, sustainability is adequately incorporated in the ROE. With time, I would expect to see improvements—particularly as it relates to an expanded set of examples.

In terms of the four new indicators, I think they represent a nice illustration of changing patterns of resource use. The presentation is evaluable, meaning that it provides readers with a good framework for comparison.

3. Statistical Information

In my view the approach used to incorporate statistical information into the ROE is satisfactory. This is one of those hard questions to answer because it depends upon the reports readership. For lay audiences, I believe the statistical treatment to be at an appropriate level. For more sophisticated readers, more resolution around statistical validity may be desired. However, in my view, the report should appeal to as broad a range of readers as possible; more sophisticated readers should, however, be able to obtain information that is characterized more fully by descriptive statistics.

4. The ROE as a Web–based Product

There's a lot of fantastic information now present in the ROE. I was especially impressed by the links to a reader's home state and region. I also thought the 'what you can do' section was nice, and important addition.

Whilst I was reading the ROE, I found the individual pages and sections to be highly readable. However, baron mind, that I have quite a bit of expertise when it comes to environmental issues, my sense is, lay readers may have difficulty digesting the level of detail presented in the report.

I will note, however, that I had some difficulty with the web–based ROE platform. I found it difficult at times to navigate the site; I found myself having to go back and forth between pages in order to find

the information I was looking for. As far as the menu bar items were concerned, it didn't strike me that there was a rationale for how information was ordered. I think if someone spend significant time on the site, they'll be able to figure it out. However, some way of summarizing information at the front end of the site would probably be helpful to most readers – especially those who do not want to take a deep dive into the minutia of the ROE.

As far as the accuracy of the presentations is concerned, I was satisfied. However I anticipate challenges with respect to communicating the information present in the report to lay audiences.

5. Additional Indicator Recommendations

In my view, indicators in a report like this should speak directly to decisions that different stakeholders will face. This is one area where I think there are some shortcomings in the current report format. Even though the report has 'what you can do' section, it is framed rather generally. I think if some decision contexts could be framed out in the report, then the relationship of the indicators to informing decisions in these areas could be made much clearer.

6. Communication

As I am not a web designer, I'm not sure how to answer this question. However, as I noted above, I believe that the report could be made more navigable and user-friendly.

One immediate suggestion I have, is to include some sort of summary or report card that people can access if they want to simply get the gist of the report. Items in this summary, or report card, could be hot linked to individual pages of the report.

Terry Daniel

The prelude to the charge to the SAB includes the request for the SAB to comment on

> … the clarity of the ROE's objectives for EPA and other governmental scientists and policy-makers, educators, and members of the public…

As currently organized and presented, uninitiated publics are not likely to find the POE very inviting or helpful. If the declared intention to address "members of the public" is to be taken seriously, some broader introduction to the mission of the EPA, why the Agency was formed and how efforts to date have improved the health and well-being of the people and their environment would be essential background. This background should prepare the reader generally to understand the role of "indicators" in the Agency's work and then to understand the meaning and significance of each of the indicators discussed in the POE. As it is now the POE is more like "inside baseball" for professionals and others intimately aware of what the Agency is about and how it does business. The web-based ROE could provide an important opportunity for the Agency to introduce itself to a broader public audience, to point out what value the Agency has historically provided to the country and why the current transition in approach to a more integrated systems approach driven by sustainability goals is needed at this time. In that latter context, it might be useful to explain why the ROE retains the strong "medium" organization (air, water, land) and the (apparent) separation between human health and environmental/ecological quality issues.

It is surprising (and often frustrating) that an agency that has delivered so much protection and improvement in human health and environmental quality to the nation over the decades since it was established still is so little appreciated in many quarters of the public. The web-based ROE seems an ideal vehicle for achieving greater understanding and appreciation among the clients/publics whose lives have been and will continue to be affected by the actions of the Agency. But the current technically oriented document that starts in the middle of (or even late in) the "story" of EPA contributes very little to meeting this need. The Agency's accomplishments are well established "facts" and their presentation should be completely consistent with the rigorous standards set for the ROE.

Several places in the ROE (draft) offer opportunities and even cry out for concrete examples of the kind of problem the particular indicators are intended to address. There are many examples of EPA successes in identifying important threats to human health and the environment and developing programs (including regulations) that significantly reduced negative impacts. The 2014 ROE is an opportunity that should not be missed by the Agency.

Lucinda Johnson

1. Please comment on the concept of sustainability as an overarching conceptual framework for representing the relationships between indicators.

Please also comment on the clarity by which the framework is depicted and discussed in the draft ROE and provide any recommendations to improve its description and intended purpose of representing the relationship between indicators?

Sustainability has many different meanings and has, to a certain extent, become an overused concept. However, it does provide a useful underpinning for a discussion about indicators, as long as the indicators themselves have an explicit and well defined link to the stated definition of sustainability, and have a measurable component that can be linked to EPA's mission and scope.

To be truly useful the sustainability framework should not be regarded as an "add on" feature. It should be integrated into the discussion for each resource area, and instead of sitting at the end of the list of topics (far to the right) in the ROE web page, it should be listed first. If executed properly, it could be used as an umbrella under which a more complete set of indicators that are linked to each resource area can be listed.

To maximize the linkages to the three components of the sustainability framework (economy, society, environment) one or more indicators pertaining to the resource /sectors (air, water, land, human exposure, environmental condition) should be identified to measure and track trends in an important attribute that reflects whether progress is being made on the sustainability of that resource. Some of this information is already contained in the section on sustainable practices, and can be linked to or text can be migrated from that section (without having to work backwards to the sustainability page).

The introductory text for each resource / sector should identify not only those conditions that affect condition, but also those that affect sustainability. The concepts of resistance and resilience are components of a system's ability to be sustainable or not, and can therefore metrics that encompass those characteristics could be identified as potential indicators.

Charge Question 2. Sustainability Indicators

2(a). Please comment the on the adequacy by which sustainability has been incorporated into the ROE. More specifically, please comment on the descriptions and explanations for the sustainability theme, question, and the four associated indicators.

The sustainability indicators all focus on intensity of resource use, therefore the concept of "full lifecycle" must be integrated into the discussion, and where possible, the indicators must encompass measurements that reflect the life cycle. (Note: Might it be possible to identify a small set of key resources for which the life cycle is assessed and provide example case studies (in a box next to the text?)). See additional components that

As noted above, it seems that sustainability has been treated as an after-thought. The sustainability tab is furthest to the right on the home page, and the there appears to be uneven integration of the

concept of sustainability into the land, air, water, human health, and environmental condition components.

"How do ROE indicators relate to issues of concern to EPA?":
Energy consumption, solid waste generation, and hazardous waste generate are directly related to EPA's mission through the downstream impacts of those activities (e.g., coal mining; air emissions; landfill effluents; etc.) and can be linked directly to EPA's issues of concern. The link to water consumption is somewhat less direct, therefore the introductory text for this indicator must establish how EPA 's interests overlap with this issue.

Specific editorial suggestions are listed below.

2(b). Please address the utility of the four new sustainability indicators for informing the reader on the intensity of resource consumption and the relevance of these intensity metrics.

("This question (ie., sustainability) focuses on trends of the intensity of natural resource consumption in the United States in order to track progress in reducing environmental pressures due to depletion of these resources.")

The indicators addressing sustainability are focused on only resource consumption, yet an important aspect of sustainability is the concept of resilience (which links nicely to environmental condition). Are there any environmental or human activity measures that can be used to describe conditions that enhance resiliency? (perhaps some combined measures of atmospheric deposition and nutrient loading???)

2(c). EPA is anticipating expanding the sustainability theme with additional questions and indicators in future ROEs. Please provide any specific recommendations on additional sustainability topics, indicators, and extant data sources that are important to pursue. Please provide your rationale for prioritizing additional topics and indicators.

When speaking to lay audiences about complex issues (e.g., climate change, sustainability), we can't just talk about doom and gloom--- we need to provide concrete examples of ways that the issue at hand intersect with people's personal frame of reference, and also provide solutions.

In the context of the sustainability framework and indicators, the introductory text for each indicator presents information about impacts on the environment, but minimally addresses what we / society can do to enhance sustainability, e.g.,..

> "One important goal of sustainable development is to reduce overall energy use—or at least the most environmentally unfavorable methods of producing and using energy—without reducing economic well-being."
>
> "Reducing water use without reducing economic well-being is an important goal of sustainable development."

"Beyond the potential environmental impacts of hazardous waste disposal, patterns in hazardous waste generation reflect a component of the total materials a society creates and uses, which is an important aspect of sustainability."

"An important goal of sustainable development is a reduction in material use without a reduction in economic well-being."

The statements in each of the Introductions are an incomplete explanation of what is meant by sustainability in the context of each indicator topic, and how to achieve more sustainable solutions for energy consumption, water use, material use and solid waste generation. At minimum there should be links to resources that address potential solutions.
Examples of existing indicators that can be included or linked to sustainability are embedded under each of the sectors include:

- one or two key air emission metrics (e.g., SOx / NOx; ozone)
- water quality metrics (e.g., nitrogen / phosphorus loading; flows; pesticides)
- land metrics (agricultural chemical use; land area used for ag / land area used for urban; …)

Important additional concepts to include:

- life cycle assessment (material extraction, use, re-use, processing, recycling, disposal)
- land area used should be considered in the context of energy, water, material use
- Ecological footprint is a useful concept that has meaning for individuals because they can be measured at various scales, from personal to community and beyond.
- Material footprint- similar to ecological footprint, but is not as well-known or used.

Additional Comments:
The overall site would benefit from a professional editor. Specifically, the "issues of concern" sections use slightly different terms addressing similar issues. "emissions from vehicles" is "Transportation" in another issue.

Conceptual Framework.
Figure out a way to incorporate the concept of full lifecycle into the framework so that it is possible to show multiple points in the cycle where humans can positively influence the outcomes.

For each set of indicators, find indicators that reflect progress towards achieving sustainability.

Native Americans strongly object to the fact that we tend to define ecosystems only in the context of benefits to humans. They feel that the environment has intrinsic value that is important outside of the economy and human well-being. We need to respect this view of "services" where possible.

Editorial issues:

- Box under SOCIETY in the conceptual diagram- need to define Quality of Life (can include human health; jobs; culture)
- Blue boxes show the adverse effects of acid precipitation on soil and water chemistry and on built structures, and how these effects impact the **environment** and ecosystem services

important for **economy** and **society**. BUT THERE ARE NO BOXES REFLECTING BUILT STRUCTURES IN THIS FIGURE.

Issues of Concern:

There is an opportunity to identify cross-linkages among the issues of concern, showing that systems are interconnected. Actions that affect one issue may either benefit or detract, but

- Acidic Deposition: define Quality of Life somewhere in the front page of the sustainability section.
- Infrastructure could be a blue box under society
- Key attributes: in addition to affecting soil chemistry plants / forests are negatively affected--- therefore a blue box is needed in the environment sector, and this should be mentioned in the text in addition to the aqauatic impacts.

- Coastal hypoxia: I suggest editing the introductory text for this issue to expand the relevance of this issue to the Great Lakes hypoxic zones. ("Hypoxia (low oxygen) occurs in coastal waters when excess nutrients stimulate algal blooms. When these algae die and decay, the oxygen in the water is depleted. Hypoxia causes aquatic organisms that use oxygen to become sick, or die.")
- In coastal freshwaters, phosphorus is limiting and therefore problematic. This is a huge issue in the Great Lakes (where the issue is not specifically coastal, but is nonetheless relevant), where quagga and zebra mussels have changed the food web and phosphorus cycling- and dead zones are becoming problematic in Lake Erie and elsewhere.
- Freshwater waters are both a red box and a blue box in the environment, if the Great Lakes are ecosystems of interest.
- Does "Production" mean industrial output?
- Key Attributes: Emissions from power plants are probably a greater factor in delivering nitrogen and contributing to coastal hypoxia than vehicle emissions.
- Not clear how human health is affected by coastal hypoxia. This is mainly an ecosystem and potentially a food supply, and possibly a quality of life issue
- Button "Select another figure for this issue" does not work. It reloads the same diagram.

- Acid deposition: Need a red box for energy under Society, since power plants generate much of the SOx and NOx resulting in acid deposition.
- Identify linkages
- Fish Mercury contamination: does "production" mean industrial output? (red box under economy)
- Nutrient Input: "production" should be defined.
- Nitrate is a human health problem in high concentrations in drinking water, and in some parts of the country is a significant issue.
- Link this issue to the coastal hypoxia issue page so that you show connections among these distinct examples.
- You could add a red box to the environment box "harmful algae blooms"
- Tropospheric Ozone: is "transport" transportation?
- Another opportunity to link issues would be with nutrient impacts.
- Wetland Loss: water storage in general is a service (benefits during drought and flood)
- There is no site map, so it is easy to get lost among the different pages and links.

Robert Johnston

General Comment: The ROE includes a wealth of useful data to help illustrate status and trends in the environment, ecosystems and human health. The new web platform enables significant enhancements in functionality beyond that possible in a printed document, and enables the ROE to better illustrate relevant linkages. The web-based version is a significant improvement over the prior versions. However, despite the adoption of sustainability as an overarching conceptual framework and a number of additional enhancements, the Report has not yet realized its full potential. While the sustainability framework is an improvement, this framework seems to be largely peripheral to the data which comprise the body of the ROE. Moreover, the four ROE indicators chosen to illustrate "sustainability" are poorly suited to this task. Specific comments to the charge questions are as follows:

1. **Please comment on the concept of sustainability as an overarching conceptual framework for representing the relationships between indicators. Please also comment on the clarity by which the framework is depicted and discussed in the draft ROE and provide any recommendations to improve its description and intended purpose of representing the relationship between indicators?**

Sustainability represents an important lens through which it is possible to interpret much of the data included in the ROE. Among the goals of the adoption of sustainability as an overarching conceptual framework should be to address some of the primary concerns noted by the SAB in their 2007 and 2009 reports on ROE. Among these were the lack of a clear unifying conceptual framework through which to interpret the wealth of data in the ROE, along with a lack of data interpretation and conclusions. The extent to which sustainability ultimately provides a useful framework will depend on the extent to which it enhances the usability and interpretability of the information provided in the ROE.

In the 2014 version of the ROE, sustainability has been adopted as an overarching framework, but this framework appears to be more cosmetic than substantive. The primary evidence of the sustainability framework within ROE appears within the Conceptual Framework pages that are dedicated to describing the sustainability framework itself. The primary content of these pages is a sequence of sustainability framework diagrams for six illustrative topic areas (acid deposition, coastal hypoxia, fish mercury contamination, nutrient impacts, tropospheric ozone and wetland loss), with three successively more complex diagrams for each topic (overview, key attributes, relevant ROE indicators). The primary message of these diagrams appears to be that ROE includes a number of different indicators that are broadly relevant to different aspects of the related human/natural system (or three pillars of sustainability). Beyond this general relevance, ROE does not illustrate the relationship of each indicator to any specific and systematic treatment of sustainability, or to how sustainability (or sustainability tradeoffs) would be quantified. There appears to be no consideration of many of the nuances of sustainability (e.g., sustainability of what and for whom?). It is also unclear whether and how the sustainability framework influenced the selection or presentation of individual ROE indicators, or how the framework applies to these indicators. Perhaps the most useful (if very general) treatment of sustainability is contained in the "What the Data Show" section of each indicator. These sections often include good if simple summaries of the trends and patterns in the data, which can provide some insight into whether the patterns illustrated are sustainable in a general sense. However, even in this section there is no explicit treatment of sustainability.

That is, while sustainability is described as an overarching framework, it appears to have had little impact on the selection, presentation and interpretation of data across the ROE website. From an external perspective, it appears as if the 2014 ROE has simply placed a sustainability framework over the top of existing ROE indicators. Although it is clear that significant work has gone into the development of the

framework, it does not yet serve the important purpose of enhancing the general usability and interpretability of the information provided in the ROE. The specific manifestation of the sustainability concept and relevance for the selection and interpretation of ROE indicators remains unclear.

The 2011 National Academy of Sciences report, *Sustainability and the US EPA*, recommends that (p. 5) the Agency develop "specific processes for incorporating sustainability into decisions and actions. As part of the framework, EPA should incorporate upfront consideration of sustainability options and analyses that cover the three sustainability pillars (social, environmental, and economic), as well as trade-off considerations into its decision making." Considering this recommendation, the ROE would be improved by a more substantive discussion of the relationship of each indicator to specific sustainability tradeoffs. This would require a more transparent consideration of what each indicator implies (or does not imply) about different facets of sustainability, and why each indicator is (or is not) a superior indicator for conveying sustainability in different areas. Such a treatment would require a more specific treatment of sustainability tradeoffs than is provided by the present conceptual diagrams.

2(a). Please comment the on the adequacy by which sustainability has been incorporated into the ROE. More specifically, please comment on the descriptions and explanations for the sustainability theme, question, and the four associated indicators.

Many of the responses to question #1 above are relevant here as well. A review of the 2014 ROE suggests that sustainability has been *laid over the top* of an existing set of ROE indicators, rather than having been *incorporated into* the ROE. For example, it is unclear why many of the existing indicators would be chosen if the primary goal is to convey sustainability related to human-environment interactions. Moreover, there are other indicators that would seemingly do a better job of conveying sustainability tradeoffs. While the sustainability diagrams provide a useful if broad overview of the issues involved, the only way that these diagrams seem to carry over to the specific ROE data is though the identification of indicators that are relevant to certain broad areas within the three identified pillars of sustainabilituy. The intended use of these indicators to understand and quantify various aspects of sustainability remains unstated.

Some of the limitations in full integration of sustainability in ROE are evident in the Sustainability section of the website, http://cfpub.epa.gov/roe/chapter/sustain/index.cfm. This section does a good job of describing sustainability in an abstract sense. However, none of the four indicators included under this section (energy use, freshwater withdrawals, hazardous waste, municipal solid waste) provide direct insight into sustainability. This limitation is highlighted explicitly in the technical documentation for each indicator.

For example, the technical documentation for the energy use indicator explicitly notes that "There are no thresholds or values that are considered "sustainable" on a national scale for energy consumption, energy consumption per capita, or energy consumption per unit of real GDP. Rather, this indicator provides general insights on energy consumption trends. The degree of "sustainability" in energy use depends on factors such as the source (e.g., coal versus hydropower), the manner in which the source was produced (e.g., specific fossil fuel extraction methods), and the manner in which the energy has been used (e.g., where emissions are released and whether emissions control technology is used)." That is, the indicator of energy use included in the Sustainability section of ROE does not provide direct insight into energy sustainability. Moreover, the ROE does not provide guidance to help the reader interpret the provided data in light of sustainability. For example, the energy consumption data in ROE suggest a continued reliance on fossil fuels for a significant proportion of our energy consumption, but that the energy consumption per dollar of GDP

continues to decline. What does this imply for sustainability? There are complex sustainability tradeoffs implied by this juxtaposition, but the ROE does not help the user understand these tradeoffs.

Similar statements are found in the technical documentation the other three "sustainability" indicators. For example, the technical documentation of the freshwater withdrawals indicator states that "This indicator does not describe the extent to which freshwater withdrawals are truly "sustainable" (i.e., at levels that will not adversely impact water availability and the environment for future generations). The extent to which water withdrawals can be considered sustainable depends on local and regional factors such as water availability, groundwater recharge rates, and ecological needs." The technical documentation of the hazardous waste indicator states, "Exhibit 3 does not necessarily indicate the extent to which RCRA hazardous waste is being generated and managed at environmentally "sustainable" levels (i.e., levels that will not adversely impact the environment for future generations)." The technical documentation of the municipal solid waste indicator states similarly that "Exhibit 2 does not necessarily indicate the extent to which waste is being generated and managed at environmentally "sustainable" levels (i.e., levels that will not adversely impact the environment for future generations)."

In all of these cases, it would be possible—at least in principle—to develop a more revealing set of indicators that provided direct insight into sustainability associated with each topic area. For example, when considering freshwater withdrawals, one could pair the current national data on freshwater withdrawals with region-specific data on river and aquifer levels, along with other data that could help convey whether the illustrated withdrawals are indeed sustainable. As currently presented, however, the user has no way of determining whether the data show a sustainable or unsustainable trend, or the sustainability tradeoffs that might be involved. Similar examples could be provided for each of the four areas covered in the Sustainability section.

In summary, the four illustrative sustainability indicators do not, as currently presented, provide direct insight into sustainability. It seems puzzling that these four indicators were chosen for the sustainability section, as there are other indicators within ROE that do a better job of conveying sustainability trends. For example, indicators such as greenhouse gas concentrations provide a more clear indication of whether we are on a sustainable path (in this example, at a global level).

2(b). Please address the utility of the four new sustainability indicators for informing the reader on the intensity of resource consumption and the relevance of these intensity metrics.

The four sustainability indicators provide useful, if limited information on the intensity of resource consumption. As discussed above, the relevance of these indicators for *sustainability* is limited; without additional interpretation and supporting data these indicators provide little insight into the sustainability of the illustrated consumption trends. This issue is discussed in response to question 2(a) above. However, these indicators do provide insight into consumption.

The relevance of these indicators appears to be uneven and all are incomplete – each indicator implies additional important questions which remain unanswered. For example, the illustrated energy consumption trends (Exhibit 1. Total US Energy Consumption by Source, 1949-2010) show a relevant pattern in which US energy needs are still met by substantial fossil fuel consumption. However, it is unclear the extent to which this continued reliance on fossil fuels has been offset (in terms of effects on pollution) by increased pollution control technology. Also, the energy use per capita and per dollar of GDP is now declining, and the impact of these changes (along with population growth and development of renewable energy sources)

for the overall sustainability of US energy consumption is unclear. Data beyond 2010 would also be relevant here, given the significant increase in US fossil fuel production since that time.

Interpretability of the freshwater withdrawals indicator is hampered by the absence of relevant data on water supply and other relevant factors. Based on the ROE indicators provided, it appears that freshwater withdrawals have been constant or declining since 1980, and that the efficiency of water use has increased (per person and per dollar of GDP). However, absent data on water supplies and recharge (in different regions) and other relevant factors (including the return rate from various types of water withdrawals), it is impossible to evaluate the implications of these data for sustainable freshwater resources.

Information on RCRA Hazardous Waste Generated and Managed also leaves relevant questions unanswered. First, as noted above, the implications for sustainability are unclear. Second, it is unclear how the illustrated trend data should be interpreted. The primary pattern that is evident from the data appears to be a drop in hazardous waste generated in 2003. Is this an important observation or merely spurious? Beyond this "blip" in 2003, the primary message seems to be that hazardous waste generation and disposal is largely unchanged. Also, it is unclear why the format of these graphs differs from those of the other sustainability indicators.

Finally, beyond the limited implications for sustainability discussed above, the Municipal Solid Waste indicators do not appear to be indicators of actual waste disposal, but rather a set of indirect projections: "The data in this indicator are derived from economic statistics on materials generation and estimates of the life cycle of goods, rather than from direct measurements of wastes disposed." Hence, this indicator does not provide direct information on solid waste. Moreover, it is unclear to what extent these indicators account for relevant factors such as the actual versus projected recycling rate of different types of materials. Given these projections, this is an indicator in which information on uncertainty and statistical variability are particularly relevant – yet this information is not presented.

2(c). EPA is anticipating expanding the sustainability theme with additional questions and indicators in future ROEs. Please provide any specific recommendations on additional sustainability topics, indicators, and extant data sources that are important to pursue. Please provide your rationale for prioritizing additional topics and indicators.

The sustainability focus of the ROE would be enhanced by the combined use of indicators that represent status, trends and relevant sustainability considerations. I would recommend the increased use of data that convey more direct insight into whether past resource uses have been sustainable and relevance for human well-being. A few examples might include:

- Changes in mean or seasonal aquifer or reservoir levels across different regions of the US
- Changes in downstream flows and water availability in regions and rivers
- Population indicators for threatened, sensitive and sentinel species.
- Fisheries stocks and harvests. This could also include readily available indicators of fisheries that are overfished or subject to overfishing, fisheries under rebuilding plans, etc. These data are readily available from NMFS for many commercial and recreational species in federal waters.
- Improved and more detail land cover and land use indicators (currently, the land use and land cover indicators are of limited usefulness).
- Areas open/closed to shellfishing as an indicator of coastal and estuarine water quality and associated human uses.

Other indicators could be developed to address pressing issues with critical regional and national importance, also with sustainability and human welfare implications. Examples might include:

- Damage due to invasive species and extent of invasions (e.g., mountain pine beetle).
- Areas affected by extreme weather / climate events such as floods and droughts, along with related use and resource indicators (e.g., crop loss due to droughts/floods).
- Areas, extent and duration of harmful algal blooms (HABs).
- Areas affected by wildfires (particularly given potential relationships to invasive species, climate change, drought, etc.)
- Indicators related to community- or state-level water restrictions or bans.
- Spatial changes in northeast lobster harvests over time (particularly given potential relationships to water temperature changes and coastal water quality).

Given the sustainability framework for the ROE, priority should be given to indicators that – either alone or in combination – provide direct insight into sustainability across different areas. Priority should also be given to indicators with relatively clear implications for human well-being, and for which relevant trend and status data are available.

3. Please comment on the approach used to incorporate statistical information into the 2014 ROE. Please provide any recommendations to enhance the presentation, including the clarity in describing uncertainty.

Among the primary concerns noted by the SAB in their 2007 and 2009 reports on ROE was that "the Report contains little data interpretation and no conclusions supported by statistical analysis." From the wording of the current charge to SAB, it seems that the provision of new statistical information and interpretation was not a priority in developing the current version of ROE: "EPA determined not to conduct de novo statistical analysis at this time, but instead to include extant statistical information, typically analysis performed by the primary researchers or scientists that collected and provided the data. Reflective of the current scope of the ROE, EPA did not provide an interpretation of indicator trends for the draft ROE 2014."

This rather modest degree of attention has resulted in in a rather modest degree of success in addressing the SAB's original concerns. The lack of interpretation and statistical information has been ameliorated at least somewhat through a limited number of statistical test results communicated in table footnotes and in the technical documentation of each indicator. These additions were made for some but not all indicators. This added information provides insight into the statistical significance of some trends and differences, for some indicators. However, this additional information is modest and found primarily in footnotes and fine print. It has not been fully integrated into the ROE presentations in a way that substantively enhances the communication and relevance of ROE data. The original SAB recommendations appeared to be aimed at enhancing the conclusions that could be drawn from ROE data, "to make [the ROE] a "science report," as indicated by its title, rather than simply a data report" (SAB Advisory on EPA's Draft Report on the Environment 2007: Science Report, page xi). The added statistical data has not yet accomplished this goal.

The presentation of uncertainty in the ROE is largely peripheral, and again is found primarily in in table footnotes and in the technical documentation of each indicator. Most of the discussions of uncertainty are purely qualitative in nature – identifying sources of uncertainty in the data.
There is little evidence of quantitative analysis to quantify or communicate the degree of uncertainty associated with each ROE indicator, or that would enable users to evaluate the extent to which different indicators or subject to greater or lesser uncertainty.

To be most helpful, information on statistical variability, testing and uncertainty should be directly incorporated into the presentation of each indicator, to help users understand the implications of the data for conclusions that can and cannot be drawn. While some indicators now include enhanced content such as error bars, most do not. These would focus on primary science questions rather than simple patterns in the data. Despite the addition of the new sustainability framework and limited details on statistical testing, the ROE still comes across primarily as a data report.

4(a). Please comment on the scientific rigor and clarity of the ROE content with the transition from a printed document to an online presence.

The transition to an online presence provides opportunities to enhance the scientific rigor and clarity of the ROE. For example, it provides the ability to provide additional scientific detail and relevant links that were not possible in the printed version of the report. Useful enhancements include an ability to zoom in to maps in order to view relevant data at different scales and locations. This is an enhancement over the printed version. Additional data can also be presented on the technical basis of the presented indicators. The website also includes links to the original data used for each indicator – this is a significant enhancement. Overall, the web-based version of the ROE represents a significant improvement over the prior printed versions.

However, the functionality of a web-based presence has not been fully realized in the 2014 ROE and there are still many enhancements which could be made. There were many instances in which I attempted to click on data presented in a chart (e.g., to discover underlying details), only to find that the charts were not clickable – there was no underlying linked content. The ROE maps, while more informative than prior printed versions, are still relatively rudimentary compared to those present in other types of online decision-support tools. For most if not all maps, the sole functionality is an ability to zoom in (or out) to different scales, or turn off selected data layers. This stands in contrast to more sophisticated interfaces on other web-based tools that allow the user to select among many different types of data layers, to develop maps for different types of purposes. That is, the usability of the current user interface is limited. The ability to turn some data layers on and off (for example in certain charts or maps) is clever but does not enable the graphics to illustrate additional data.

Similarly, the clarity of much of the data remains similar to that in a printed document. A very positive feature of the website is an ability to download the data underlying the illustrated charts and graphs. This enables users to create additional graphs and implement statistical tests beyond those already included in the ROE. I was hoping that this feature would also allow users to access additional data above and beyond those in the simple charts and graphs, including data to address more sophisticated questions. However, the downloaded data includes only the exact points shown on the graph. Future versions of the ROE would be enhanced by providing access to a broader range of data, beyond those shown in the highlighted graphs.

The “Where You Live” and “What Can You Do” sections of the website are currently of limited utility for the primary science purposes of the ROE. For example, when clicking through to the “Where You Live” ROE data for each state (I tested Massachusetts, my home state), one is simply directed to the main page for each ROE indicator – no state-specific indicator data are presented. For mapped indicator data, one is directed to the main US map, which then must be manually zoomed to locate the desired state. That is, the “Where You Live” functionality is extremely limited. The “What Can You Do” page simply provides links to external websites.

Another potential advantage of a web-based platform is the capacity to incorporate new data with greater speed than might be possible with a printed document. However, the 2014 ROE does not appear to have taken full advantage of this capacity. Much of the land cover data, for example, are based on data that are over ten years old (e.g., Ecological hubs and corridors in the contiguous U.S. are based on 2001 data). While newer data are available for some indicators, the majority of indicator data are dated to some degree.

4(b). Please provide suggestions on other factors that could be considered concerning the overall content, format, credibility, user friendliness and navigability of the site.

The information in the ROE can be expanded significantly now that the report is on a web-based platform. For example, the ability of a user to "drill down" into additional data to explore hypotheses and answer science questions is limited or nonexistent in most cases, although links are provided that enable users to access the original source data in some cases (via external websites). The presence of data sources links is an excellent addition to the ROE. These links could also be added to the indicator graphs themselves. For example, each table in the ROE includes a text citation to the source of the data. Why not make this citation a live link that (where possible) allows the user to immediately connect to the original source of the data? This would supplement the links available in the Data Sources tab. The ROE could also be an excellent platform for some of these datasets – rather than simply providing users with external links.

In some cases, the website provides misleading descriptions of the ROE data. This diminishes credibility. For example, the Greenhouse Gases section of the ROE is characterized via the following question: "What are the trends in greenhouse gas emissions and concentrations and their impacts on human health and the environment?" However, the ROE indicators in this section provide no direct insight in the impacts of greenhouse gasses on human health. Moreover, the ROE does not show the impacts of greenhouse gas concentrations on the environment. Rather, it shows parallel trends in environmental variables that are likely related to greenhouse gas concentrations in complex ways. Hence, while this description may seem fine from a causal and colloquial perspective, it is not an accurate characterization of the ROE data. Similar statements are found in many ROE categories. For example, the Fresh Surface Waters category is characterized by the question: "What are the trends in the extent and condition of fresh surface waters and their effects on human health and the environment?" However, the ROE indicators in this category include no indicators that characterize effects on human health. A more accurate description of what the ROE data illustrate (and what they do not illustrate) would improve the scientific rigor and clarity of the website.

As noted above, the "Where You Live" functionality of the website is limited, and provides little additional data beyond that available from the basic nationwide ROE indicators. This functionality could be enhanced to provide place-specific data, above and beyond the basic nationwide indicator data currently in the ROE.

Additional suggestions are provided in response to question 4(a) above.

5(a). Please provide feedback on the approaches used in the ROE to provide information such that audiences with varying interests can efficiently and reasonably find information concerning the status and trends of environmental conditions. Please provide any recommendations to enhance the access to information.

Development of the ROE is somewhat constrained by the lack of a well-defined primary audience. This issue has been raised by prior SAB reviews. That is, the intended use of the ROE by different audiences is not entirely clear. Because the ROE attempts to serve heterogeneous (and often unstated) needs of such a

diverse audience, its utility for more targeted groups (e.g., scientists, policymakers, general public) and research needs is limited. Currently, the design of the ROE seems best suited to audiences that require less sophisticated or targeted analysis, and are simply looking for broad and illustrative information on status and trends. The data housed on ROE itself, and the accompanying indicators, are fairly simple. Moreover, the dates and format of the data do not enable straightforward merging of data across ROE indicators or categories. As a result, beyond the provision of links to external websites housing source data, the ROE is not currently configured in a way that enables expert researchers to address complex questions, test hypotheses, or drill-down into more detailed data. A small set of hypotheses could be tested using the data currently in ROE, but the utility of the Report for expert researchers is currently limited.

Among the first steps in enhancing the value of ROE to different user groups would be to interact with representatives of these groups to evaluate how they might use the ROE and enhancements that would increase the utility of the website. For example, one could conduct focus groups or interviews with different types of users to obtain feedback on the usefulness of the ROE. It is unclear to what extent such evaluations have been used to guide the present design.

A second recommendation would be to enhance the flexibility of the ROE for different users. Although the new web design of the ROE enables much greater flexibility and an ability to view and analyze data in myriad ways, the basic structure of the ROE is still grounded in a small number of pre-set graphs and maps, with simple underlying data. A more flexible and useful system could involve much larger and more sophisticated datasets that could be viewed and analyzed in multiple ways. That is, the ROE could be envisioned as a broad data platform rather than as a simple set of illustrative graphs.

Another observation is that the ROE is currently structured so that each indicator must be viewed independently. There is no way to link or cross-reference data from different indicators. A more ambitious set of enhancements might enable data from multiple ROE indicators to be merged into one dataset for analysis and/or illustrated on the same set of graphs. Developing such flexibility would be a labor-intensive and difficult process, as it would require an ability to reconcile indicators collected for different purposes and at different time scales. However, improvements in this direction would greatly enhance the ROE as a science and research tool, rather than as a simple data illustration tool. Such enhancements, however, would likely require a substantial increase in the resources available to develop the ROE.

Finally, the website is structured in a relatively opaque manner, such that it is easy to miss important content. For example, to reach the discussion of greenhouse gasses (http://cfpub.epa.gov/roe/chapter/air/ghgs.cfm), it appears that the user must follow the path from the ROE Home, to Air, and then to the hyperlink to the Greenhouse Gasses page. If one instead jumps directly to one of the individual greenhouse gas indicators through the "Air" banner on the ROE homepage, the only way to return to the Greenhouse Gasses page is to notice the small note at the bottom (i.e., This indicator relates to: Greenhouse Gases). Other hyperlinks are designed in a somewhat confusing manner. For example, if one clicks on the left hand side of the "View Indicators: Greenhouse Gases" link, one is shown the drop-down list of indicators. If one clicks the right hand side of the same link, one is taken to the Greenhouse Gasses main page. This functionality is not immediately obvious, and as a result I repeatedly found myself directed to unintended areas of the website. Overall, I found the website somewhat awkward to navigate. Even after spending hours exploring the ROE website I am still finding new areas that I had not located earlier. To a certain extent this is unavoidable given the substantial quantity of information in the ROE. However, my suspicion is that the website could be redesigned to be more transparent and to enable users to access information more effectively and easily.

5(b). Please comment on the accuracy of the ROE's presentations and their effectiveness in communicating complex scientific information to a broad range of technical and non-technical audiences. Please provide recommendations for specific components of the ROE as appropriate.

In a general sense, many of the ROE presentations are effective at communicating scientific information, although the complexity of the underlying data is often obscured. The suitability of different indicators for technical versus non-technical audiences is mixed. Most of the indicators seem targeted at a non-technical audience, although some require considerable technical expertise to interpret. However, the best way to evaluate the effectiveness of the ROE in communicating data to diverse user groups is through direct interactions with user groups (e.g., focus groups, interviews) to guide platform development. Requesting SAB input is not a substitute for direct input from the intended user groups – particularly to the extent that these intended user groups include non-scientists.

In a scientific sense, the accuracy of the ROE's presentations is difficult to evaluate, as little information is presented on the uncertainty/variability of the underlying data. In most cases, indicators do not include information on statistical accuracy, sampling variation, uncertainty, etc. This issue is discussed above in greater detail.

The indicators in the Sustainability section of the ROE should be reevaluated, as the selected indicators are not effective in addressing the sustainability theme. Suggestions to improve these indicators are provided above.

6. Please provide suggestions concerning existing or potential future indicators so as to more fully address the questions of interest to the agency outlined in the ROE. Please provide specific recommendations concerning approaches to an integrated understanding of the status and trends for environmental and human health conditions related to the mission of the agency.

Currently, the ROE is almost entirely focused on natural science and human health indicators. There are few indicators that directly related to human uses of the environment or implications for human well-being beyond human health. Economics or social science indicators are almost entirely absent. This is particularly notable given the ROE is a component of ORD's SHC program area, within which human well-being is a central theme. ROE would be improved by a more comprehensive set of indicators addressing human dimensions of the environment. Non-health examples might include indicators addressing recreational/commercial fisheries, outdoor recreation, restrictions/bans on water use, droughts/flood events, etc. There are also no indicators related to resource *uses* such as agriculture, forestry or fisheries. Other examples are provided in response to question 2(c) above. A broader focus on human uses, dimensions and impacts would enhance the utility and relevance of the ROE as a means to understand the implications (sustainability and other) of environmental changes.

James Mihelcic

Charge Question 1. Sustainability as the ROE 2014 Conceptual Framework

1. Please comment on the concept of sustainability as an overarching conceptual framework for representing the relationships between indicators. Please also comment on the clarity by which the framework is depicted and discussed in the draft ROE and provide any recommendations to improve its description and intended purpose of representing the relationship between indicators?

Response.

I am supportive of the ROE adopting sustainability as an overarching conceptual framework for the representing the relationship between indicators. Use of a systems perspective should also allow the ROE to include linkages between the environment, economy and society to better understood when the linkages and interactions between components are considered in addition to the understanding the individual components.

However, the conceptual framework is overly focused on "environmental sustainability' and unless EPA wants to start providing equal weight to economic and social indicators, I would suggest they refer to this as "environmental sustainability." It was also not clear to a reader why the ROE developed the six examples of condition or outcome-specific diagrams for just: tropospheric ozone, acid deposition, nutrient impacts, coastal hypoxia, wetland loss, and fish mercury contamination. So something needs to explain to a user why these six examples were selected. Most importantly, 1) it was confusing to this reviewer how the six outcome-specific diagrams for sustainability framework were related to the four sustainability indicators of natural resource consumption (I assume this is also confusing to other users from the general public) and 2) it was not clear to this reviewer why the ROE believed that a new sustainability theme should only be focused on consumption of natural resources.

As I suggest in my response to Charge Question 2, I am also not a supporter of normalizing environmental indicators to conventional economic indicators such as gross domestic product and suggesting to a user of the ROE that this adequately presents an appropriate linkage between the environment and economy. One reason for this is that gross domestic product could grow for reasons one would not link to a sustainable healthy economy or society. For example, economic expenditures related to hazardous waste remediation (versus pollution prevention and advances in green engineering), expansion of regional cancer treatment facilities (versus prevention efforts), response to road congestion by expansion of conventional road systems that lead to unhealthy communities, all these items increase GDP but are not part of what would be considered a sustainable community of the future. There are many other examples of unsustainable products and services that GDP captures. As I state below in response to charge question 2, the ROE seems overly focused on using what are very traditional economic indicators (e.g., "size of the economy as measured by GNP and GDP) while a more sustainable economic indicator would be something like "percent of local economy based on renewable local resources."

I agree conceptually with the sustainability framework adapted from Fiskel (2012). It correctly shows that the economy and society are dependent on the environment. However, it does not use the word "health" anywhere. I was surprised by this, especially because the mission of EPA is to protect human health and the environment. The ROE should consider adjusting the link between environmental and society that indicates the service of improved public health and community well-being that comes from this route along with provision of ecological goods and services. There is a route of human exposure to waste produced by the economy and society, however, it again, does not use words like public health. I also think the link of "recycling' back to the economy from "waste" is not correctly labeled for a focus on sustainability. The

pollution prevention hierarchy clearly mandates that "source reduction" is preferred over recycling (which perhaps should be written as "recycling/reuse" as "reuse" is used commonly in industry and the public. Accordingly, "source reduction" should be worked into this process so it is clear to ROE readers that the pollution prevention hierarchy is followed correctly.

Finally, while the frameworks of systems thinking and life cycle thinking are related, there are clear differences. While these two frameworks are related, there are clear differences where life cycle thinking is focused on material and energy flows and the subsequent impacts while systems thinking can also capture the relationship of political, cultural, social and economic considerations and potential feedbacks between these considerations and material and energy flows. I think the sustainability framework as written is capturing material, energy, and pollution flows, but not capturing the relationship between these material flows and political, cultural, social and economic considerations and potential feedbacks.

Regarding the six specific framework examples, I have several specific comments. I think they can be used as examples of how the six examples could be made both internally consistent and also developed to use language that the general public would understand more clearly (versus a scientific or regularly stakeholder). 1) I noticed that on the examples, the only impact society has on economy is through regulations? That seems very limited to me. 2) Population growth is considered a contributor (in the society box) for wetland loss but none of the other five examples? Seems like it is important to all six examples. 3) Septic tanks are included as a contributor in coastal hypoxia example but are left out of the nutrient impact example. 4) In the example of nutrient impacts, the arrows of the relationship between society to economy, nothing is provided on households impact in terms of driving cars and residential lawn management? This is language I think the general public would use. Also using wording like "urban runoff" seems to vague. I am not sure how the general public would understand what urban runoff is, and perhaps stormwater runoff is a better choice of words? 5) In this same example, economy and society contribute to "nutrient load to surface waters" but I think you mean "nutrient load to surface waters and groundwater" as below it is included groundwater as an impact (and some load is directly to groundwater (i.e., agricultural and septic tanks). 6) for the nutrients example, should include "water reuse" because this is a contribution of valuable nutrients but also is a way to recycle/reuse nutrients. 7) In the tropospheric ozone example "overview" seems very low in demonstrating to the general public and others the health impact tropospheric ozone has on society. 8) In addition, on this same overview slide, it is written that ozone damages "plants" but shouldn't plants be "crops and forest" which seems more clearly for people to understand economic implications of tropospheric ozone?

Charge Question 2. Sustainability Indicators

2(a). Please comment the on the adequacy by which sustainability has been incorporated into the ROE. More specifically, please comment on the descriptions and explanations for the sustainability theme, question, and the four associated indicators.

2(b). Please address the utility of the four new sustainability indicators for informing the reader on the intensity of resource consumption and the relevance of these intensity metrics.

2(c). EPA is anticipating expanding the sustainability theme with additional questions and indicators in future ROEs. Please provide any specific recommendations on additional sustainability topics, indicators, and extant data sources that are important to pursue. Please provide your rationale for prioritizing additional topics and indicators.

Response.

In my opinion, the ROE does a poor job of incorporating sustainability into the current draft. A sustainability indicator measures the progress toward achieving a goal of sustainability and sustainability indicators should be a collection of indictors that represent the multidimensional nature of sustainability, considering environmental, social, and economic facets. The focus on the whole ROE and the sustainability section is primarily on "environmental sustainability." Indicators of economy and society are basically ignored, or integrated in a very traditional way. For example, a traditional economic indicator is "size of the economy as measured by GNP and GDP." A more sustainable economic indicator would be something like "percent of the local economy based on renewable local resources." [1]

Sustainability indicators provide new information about progress towards sustainability that is not captured by more traditional indicators; for example, a sustainable economic indicator should define basic needs in terms of sustainable consumption. Traditional environmental indicators include reporting ambient levels of pollution in air and water (like is reported throughout the ROE) and tons of solid waste generated (like is referred to as a sustainability indicator in the ROE). In contrast, sustainable environmental indicators might include: 1) use and generation of toxic materials (both in production and by end user), 2) vehicle miles travelled, 3) percent of products produced that are durable, repairable, or readily recyclable or compostable, and 4) ratio of renewable energy used at renewable rate to nonrenewable energy (see footnote 1 for more information).

As I suggested in my response to Charge Question 1, I am also not a supporter of normalizing environmental indicators to conventional economic indicators such as gross domestic product and suggesting that this adequately presents an appropriate linkage between the environment and economy. One reason for this is that gross domestic product could grow for reasons one would not link to a sustainable healthy community. For example, economic expenditures related to hazardous waste remediation (versus pollution prevention), expansion of cancer treatment facilities (versus prevention efforts), response to road congestion by expansion of conventional road systems that lead to unhealthy communities, all these items increase GDP but are not part of what is a considered a sustainable future. There are many other examples of unsustainable products and services that GDP captures. The ROE is using traditional economic indicators (e.g., "size of the economy as measured by GNP and GDP) while a more sustainable economic indicator would be something like "percent of local economy based on renewable local resources."

Within the sustainability theme, the ROE provides trends in consumption of natural resources as a way to capture measurement on progress towards sustainability. Regarding the utility of the four new sustainability indicators for informing the reader on the intensity of resource consumption and the relevance of these intensity metrics, I commented above on the inappropriateness of normalizing this data to gross domestic product. The ROE should also be more forward thinking in this section; that is, the ROE could demonstrate some leadership in this area and move away from use of traditional indicators (such as the four proposed) to indicators that truly capture sustainability. As I mentioned above, it would be better to consider items such as: 1) use and generation of toxic materials (both in production and by end user) versus simply quantity of RCRA hazardous waste generated and managed, 2) vehicle miles travelled versus just simply energy use normalized to GDP. It also might be interesting (and more useful to users) to select some energy use indicators that are important to individual households? (energy use per household, vehicle miles traveled per year) and I was surprised there was not an indicator here related to carbon emissions or ratio of renewable energy used at renewable rate to nonrenewable energy. I was also surprised there is not indicator related to environmental justice as a measure of sustainability. This would also help to capture some of the societal aspect of sustainability.

[1] Mihelcic, J.R., J.B. Zimmerman, "Chapter 1. Sustainable Design, Engineering, and Innovation," *Environmental Engineering: Fundamentals, Sustainability, Design*, 2nd Edition, John Wiley & Sons, New York, 2014.

Charge Question 3. Statistical Information

3. Please comment on the approach used to incorporate statistical information into the 2014 ROE. Please provide any recommendations to enhance the presentation, including the clarity in describing uncertainty.

Response.

The 2007 SAB review pointed out the limited usefulness because it contained data interpretation and no conclusions supported by statistical analysis. The ROE now displays confidence intervals and trend lines for some indicators; however, there is not data interpretation and conclusions from the ROE that are supported from this statistical analysis. I would suggest the statistical analysis is being provided for a more scientific and technical community, but is not interpreted for the general public.

Charge Question 4. ROE 2014 Web-based Product

4(a). Please comment on the scientific rigor and clarity of the ROE content with the transition from a printed document to an online presence.

4(b). Please provide suggestions on other factors that could be considered concerning the overall content, format, credibility, user friendliness and navigability of the site.

As I reviewed the information provided, I noticed that much of data is 10 years old. Before reading the ROE I thought I was going to be reading a 2014 Report. I was quite disappointed at the age of data when expecting some information more current. Stating a report is 2014 suggested to me that I would learn something about where our Nation is at this year, not 5 or 10 years ago.

Regarding the new section "where you live" I found this very disappointing and felt like the developers had not fully clicked on all the different permutations. Just to provide a quick example, when I clicked on FL for ozone I got US ambient concentrations (not FL ambient concentrations or especially the part of Florida I live in). When I clicked on FL for regional haze, for regional haze I was provided data on the visibility in selected national parks in the western U.S.? I gave up at this point, seems like this new section was not even checked and is not related to where you really live. This seemed like a great idea, especially for the general public, however, it really turned me off.

Regarding the new section on "what you can do" I believe that some local and state web sites are much, much more valuable to a public citizen and/or homeowner than material provided on the links to the EPA web sites that were provided. There are also valuable sources for homeowners on other government web sites (e.g. NOAA on coastal nutrients, DOE or Transportation, USGS) that would be very valuable. I did not find any of these and was wondering if I just missed them, or if there are fewer than was suggested. I felt that this new section was really just a collection of web sites, some are better and more valuable than others, but many don't provide real ways to affect change at the local area.

Regarding the "related links" sites, this web page, http://cfpub.epa.gov/roe/chapter/water/surface.cfmyou should connect to the EPA nutrient pollution web site, http://www2.epa.gov/nutrientpollution

Charge Question 5. Communication

5(a). Please provide feedback on the approaches used in the ROE to provide information such that audiences with varying interests can efficiently and reasonably find information concerning the status and trends of environmental conditions. Please provide any recommendations to enhance the access to information.

5(b). Please comment on the accuracy of the ROE's presentations and their effectiveness in communicating complex scientific information to a broad range of technical and non-technical audiences. Please provide recommendations for specific components of the ROE as appropriate.

Overall I believe the ROE communicates complex scientific information to a broad range of technical and non-technical audiences. However, please see my comments to the first four charge questions which I believe can improve the presentation.

Charge Question 6. Additional Indicator Recommendations

6. Please provide suggestions concerning existing or potential future indicators so as to more fully address the questions of interest to the agency outlined in the ROE. Please provide specific recommendations concerning approaches to an integrated understanding of the status and trends for environmental and human health conditions related to the mission of the agency.

Response.

I made this comment in an earlier charge and will repeat here. In my opinion, the ROE does a poor job of incorporating sustainability into the current draft and should really rethink it development of sustainability indicators that are forward thinking and represent the multidimensional nature of sustainability, considering environmental, social, and economic facets. The focus on the whole ROE and the sustainability section is primarily on "environmental sustainability." Indicators of economy and society are basically ignored, or integrated in a very traditional way. For example, a traditional economic indicator is "size of the economy as measured by GNP and GDP." A more sustainable economic indicator would be something like "percent of the local economy based on renewable local resources."

Sustainability indicators provide new information about progress towards sustainability that is not captured by more traditional indicators; for example, a sustainable economic indicator should define basic needs in terms of sustainable consumption. Traditional environmental indicators include reporting ambient levels of pollution in air and water (like is reported throughout the ROE) and tons of solid waste generated (like is referred to as a sustainability indicator in the ROE). In contrast, sustainable environmental indicators might include: 1) use and generation of toxic materials (both in production and by end user), 2) vehicle miles travelled, 3) percent of products produced that are durable, repairable, or readily recyclable or compostable, and 4) ratio of renewable energy used at renewable rate to nonrenewable energy (see footnote 1 on an earlier page for more information).

As I suggested in my response to Charge Question 1, I am also not a supporter of normalizing environmental indicators to conventional economic indicators such as gross domestic product and suggesting that this adequately presents an appropriate linkage between the environment and economy. One reason for this is that gross domestic product could grow for reasons one would not link to a sustainable healthy community. For example, economic expenditures related to hazardous waste remediation (versus pollution prevention), expansion of cancer treatment facilities (versus prevention efforts), response to road congestion by expansion of conventional road systems that lead to unhealthy communities, all these items increase GDP but are not part of what is a considered a sustainable future. There are many other examples of unsustainable products and services that GDP captures. The ROE is using traditional economic indicators (e.g., "size of the economy as measured by GNP and GDP) while a more sustainable economic indicator would be something like "percent of local economy based on renewable local resources."

Regarding the utility of the four new sustainability indicators for informing the reader on the intensity of resource consumption and the relevance of these intensity metrics, I commented previously on the inappropriateness of normalizing this data to gross domestic product. The ROE should also be more

forward thinking in this section; that is, the ROE could demonstrate some leadership in this area and move away from use of traditional indicators (such as the four proposed) to indicators that truly capture sustainability. As I mentioned above, it would be better to consider items such as: 1) use and generation of toxic materials (both in production and by end user) versus simply quantity of RCRA hazardous waste generated and managed, 2) vehicle miles travelled versus just simply energy use normalized to GDP.

It also might be interesting (and more useful to users) to select some energy use indicators that are important to individual households? (energy use per household, vehicle miles traveled per year) and I was surprised there was not an indicator here related to carbon emissions or ratio of renewable energy used at renewable rate to nonrenewable energy. I was surprised there was not an indicator related to environmental justice as a measure of sustainability. This would also capture some of the societal aspect of sustainability.

Eileen Murphy

General Comments: I love the interactivity of the new web-based report. Although I somewhat miss having a hard copy document with an executive summary, once I delved into the online program, I found myself exploring topics that I normally might not have read through in hard copy form. Plus, links to additional information on a particular topic is included right on the indicator page, making it quite easy to navigate to these other sources of information. This is just not possible in a hard copy report. The organization of the page is quite user-friendly, and I could navigate back and forth as I explored one indicator after another.

Of particular note are the interactive maps and the "where you live" feature.
For future improvements, it would be good to have the data on broad topics such as exposure to environmental contaminants, available on the local level. This data does not currently exist, but EPA headquarters and regions should work together to gather and include this data in future editions.

Charge Question 1. Sustainability as the ROE 2014 Conceptual Framework

Please comment on the concept of sustainability as an overarching conceptual framework for representing the relationships between indicators. Please also comment on the clarity by which the framework is depicted and discussed in the draft ROE and provide any recommendations to improve its description and intended purpose of representing the relationship between indicators?

The Agency used a three-pronged approach in incorporating sustainability as an overarching conceptual framework rather than overwhelming the report. The three components are: (1) adopting a systems-based sustainability framework as the overarching conceptual model for the ROE, (2) adding a new sustainability theme that focused on the question of consumption of natural resources, and (3) developed indicators to help address that question. I like this approach, as it introduces the concept of sustainability as an indicator itself but presents information within the sustainability framework.

Most of the indicators are presented as stressors or conditions with only the four sustainability indicators quantifying the influence of social and economic factors. In future drafts, it would be good to expand the sustainability concept into the other indicators. But, for this year, I think EPA's approach was satisfactory.

Regarding the clarity with which the framework is depicted and discussed, I think this needs some organization. It is not clear that sustainability is the overarching theme unless you click specifically on "sustainability" or "Explore a conceptual framework and associated diagrams…." I think that EPA is being cautious and is separating the framework from the actual indicators for this round, and that is an acceptable approach in that comments generated on the conceptual framework will be useful for future editions of the ROE. However, a true overarching framework is where sustainability themes are incorporated directly into each indicator and not separated out like this. Similarly, I think there should be links to this framework under "basic information." Currently, the framework is at the bottom of the list of items under "what you can do on this site." It is not intuitive to the user that this framework is significant.

The actual description of sustainability is excellent, and I really like the diagrams. I like that EPA used the overall sustainability diagram template for each of the indicators presented. I found the diagrams easy to follow and well presented. When I got to the "Relevant ROE indicators," I was overwhelmed at first. But,

as I looked more closely and clicked on several of the blue indicators, I was impressed with the linkages provided. Excellent job here.

Charge Question 2. Sustainability Indicators

2(a). Please comment the on the adequacy by which sustainability has been incorporated into the ROE. More specifically, please comment on the descriptions and explanations for the sustainability theme, question, and the four associated indicators.

Well, I don't think that sustainability has been "incorporated" per se. It is its own subject with its own indicators. At some point, sustainability should be a part of the other themes rather than its own. I do understand that this is difficult to do right now and that over time the incorporation will become more seamless.
The descriptions and explanations for the four associated indicators are well presented.

2(b). Please address the utility of the four new sustainability indicators for informing the reader on the intensity of resource consumption and the relevance of these intensity metrics.

The freshwater withdrawal description needs to include information on droughts. From the indicator information, one would not guess that there are severe water quality issues in the western part of the US. The graphs show a somewhat stagnant impact on water resources. But combined with widespread drought, water scarcity becomes significant. This indicator is misleading without the contest of population growth and drought impacts.

2(c). EPA is anticipating expanding the sustainability theme with additional questions and indicators in future ROEs. Please provide any specific recommendations on additional sustainability topics, indicators, and extant data sources that are important to pursue. Please provide your rationale for prioritizing additional topics and indicators.

Given the dilapidated quality of drinking water (and other) infrastructure, I think EPA should include indicators on this issue. For instance, how many lead service lines and pipes have been replaced? How many water systems have upgraded their distribution systems? What types of treatment technologies have been constructed based on contamination? We tend to focus on contaminants and water quality when discussing drinking water issues, but drinking water infrastructure is a significant issue that needs some public attention. By including infrastructure as an indicator, EPA can measure the improvements, and the public can become educated on the importance of adequate infrastructure.

Charge Question 3. Statistical Information

Please comment on the approach used to incorporate statistical information into the 2014 ROE. Please provide any recommendations to enhance the presentation, including the clarity in describing uncertainty.

The section under each indicator, "What the Date Show" is excellent. Basic statistical analysis is presented and interpreted here in a way that I think is understandable to the lay reader.
Likewise, I think uncertainly is covered adequately under "limitations."

Charge Question 4. ROE 2014 Web-Based product

4(a). Please comment on the scientific rigor and clarity of the ROE content with the transition from a printed document to an online presence.

As I mentioned in my general comments, it was a learning curve for me to move from a written document to the web-based report. At first, it felt like something was missing – particularly an executive summary. But as I

delved deeper into the webpage, I understood that there is a power and depth of information in the web-based product that is just not possible to get in a written document. I am overwhelmingly supportive of the web-based approach for this report.

4(b). Please provide suggestions on other factors that could be considered concerning the overall content, format, credibility, user friendliness and navigability of the site.

The indicators themselves are very general. For instance, the two indicators for ground water and "Nitrate and Pesticides" and "Freshwater Withdrawals." However, EPA does provide a link to other programs and information on ground water, which I found helpful and informative. By providing additional links for users who want more in-depth scientific information on more current issues like fracking, providing these links gives the agency more credibility.

Charge Question 5. Communication

5(a). Please provide feedback on the approaches used in the ROE to provide information such that audiences with varying interests can efficiently and reasonably find information concerning the status and trends of environmental conditions. Please provide any recommendations to enhance the access to information.

I think this was handled very well. No suggestions.

5(b). Please comment on the accuracy of the ROE's presentations and their effectiveness in communicating complex scientific information to a broad range of technical and non-technical audiences. Please provide recommendations for specific components of the ROE as appropriate.

There are some complex data sets that EPA had to incorporate here and overall did a good job. However, under "Serum Persistent Organic Pollutants Level," some definitions needs to be included for the lay reader. It is not apparent to a lay audience what the significant of lipid-adjusted numbers or serum concentrations are. These terms need to be defined and explained. Similarly, in the "Childhood Cancer Incidence," please define and explain "incidence" as opposed to "mortality" which is used in other indicators. Lay audiences don't always distinguish between these two terms.

Charge Question 6. Additional Indicator Recommendations.

Please provide suggestions concerning existing or potential future indicators so as to more fully address the questions of interest to the agency outlined in the ROE. Please provide specific recommendations concerning approaches to an integrated understanding of the status and trends for environmental and human health conditions related to the mission of the agency.

Yes, infrastructure quality, particularly drinking water infrastructure.

James Opaluch

Charge Question 1. Sustainability as the ROE 2014 Conceptual Framework

Please comment on the concept of sustainability as an overarching conceptual framework for representing the relationships between indicators. Please also comment on the clarity by which the framework is depicted and discussed in the draft ROE and provide any recommendations to improve its description and intended purpose of representing the relationship between indicators?

Sustainability is a good organizing concept to serve as the basis of the framework for the ROE. But the concept of sustainability is both vague and comprehensive, and the challenge is how to properly operationalize the concept. I like the concept of "questions" as a way to organize the information, but different audiences are likely to have very different questions.

For example, under "Acidity in Lakes and Streams" the ROE states:

> "2. ROE Question(s) This Indicator Helps to Answer
>
> "What are the trends in the extent and condition of fresh surface waters and their effects on human health and the environment?
>
> "What are the trends in outdoor air quality and their effects on human health and the environment?
>
> "What are the trends in the critical physical and chemical attributes of the nation's ecological systems?"

These are fine questions for policy makers and scientists, but not for the general public. These questions need to be tested. I would think question like "Is water quality getting better or worse", "How well does our nation's water support wildlife" would be the kind of questions for the general public. Indeed, it might be useful to have more general water quality indicators on the public track, since the general public may misunderstand that is meant by "acidity" of lakes and streams. The ROE should be carefully tested on representative members of the various potential user groups. As it stands, I fear the ROE might be of least usefulness for members of the general public.

In terms of the 2nd question. I could not see information on the effects of outdoor air quality on human health and the environment. More generally, effects on health and the environment are uncertain enough that I would recommend you say "what is known about the effects on human health and the environment".

Charge Question 2. Sustainability Indicators

2(a). Please comment the on the adequacy by which sustainability has been incorporated into the ROE. More specifically, please comment on the descriptions and explanations for the sustainability theme, question, and the four associated indicators.

2(b). Please address the utility of the four new sustainability indicators for informing the reader on the intensity of resource consumption and the relevance of these intensity metrics.

2(c). EPA is anticipating expanding the sustainability theme with additional questions and indicators in future ROEs. Please provide any specific recommendations on additional sustainability topics, indicators, and extant data sources that are important to pursue. Please provide your rationale for prioritizing additional topics and indicators.

Sustainability seems to be used for the overall organizing framework for the ROE, and as one of six themes. I'm not sure it make sense to have a separate sustainability theme. Instead, I'd recommend having each theme focus on a dimension of sustainability so the themes become "sustainability of air", "sustainability of water" etc. In this case we might change the sustainability theme to "sustainability of resource use"

Charge Question 3. Statistical Information

SAB previously recommended that the indicators:

- Include formal statistical analyses and/or additional information, such as error bars around mean values.
- Report statistical limitations when insufficient data are available for robust quantitative analyses.

3. Please comment on the approach used to incorporate statistical information into the 2014 ROE. Please provide any recommendations to enhance the presentation, including the clarity in describing uncertainty.

EPA's ROE summarizes a vast collection of information, some of it from formal statistical studies in quantitative form with statistical measures of uncertainty, some of it quantitative but with no indicators of variability, some of it purely qualitative. Compiling this information in a single set of indicators, and accounting for variability of each measure, is a major challenge.

EPA rightly does not attempt to carry out *de novo* statistical analysis as part of its ROE. Rather the ROE reports results of primary studies, and provides confidence intervals on studies, as reported by the authors of the individual studies. EPA reports that the draft ROE 2014 has a total of 21 indicators with confidence intervals, and four indicators that are based on time trends.

The provided confidence intervals are a good start for indicating statistical confidence in estimates, and given the broad nature of the Report. The confidence intervals are apparently extracted from the individuals studies, where the information is available. And it is probably not practical for the ROE to do more that this at the current stage. But it would be better to view this as a starting point, than as end point. Uncertainty analysis needs to play a larger role in EPA original research.

It is relatively straightforward to provide confidence intervals for indicators based on a single study that is statistically-based. It is more challenging characterize uncertainties for indicators that synthesize the research evidence where there are multiple studies with the same or related metrics. This can be a major challenge, since in general studies are not consistent in the definitions of metrics, the data reliability or the conceptual rigor of the study.

Two main approaches have been used in the scientific literature for synthesizing scientific evidence from different studies: meta-analysis and best evidence synthesis. A meta-analysis will compile statistical results from a number of studies, and employ Bayesian methods to combine the statistical results. For example, given to studies with results and confidence intervals, the results can be synthesized by calculating a weighted average of the results of the two studies, where the weights are inversely proportional to the standard errors of the two estimates.

It is also challenging to carry out uncertainty analyses for information from non-statistical studies, such as many process oriented models. There have been extensive efforts to validate and carry out uncertainty analyses of these models. See, for example, Arnold et al, "SWAT: Model Use, Calibration, and Validation" *Transactions of the ASABE*, Vol. 55 No. 4.

Charge Question 4. ROE 2014 Web-based Product

4(a). Please comment on the scientific rigor and clarity of the ROE content with the transition from a printed document to an online presence.

4(b). Please provide suggestions on other factors that could be considered concerning the overall content, format, credibility, user friendliness and navigability of the site.

EPA has done a good job with links to pertinent information, include links to a large number of technical reports. Many of the reports are available on-line, and also some are linked from the ROE web site, others are available on-line but not linked. Below I indicate one example where additional links would be useful.

Following menu items "Water" "Fresh Surface Waters" "Acidity of Lakes and Streams" brings you to the following page: http://cfpub.epa.gov/roe/indicator.cfm?i=12. The bottom of the chart has a data source. This could be a link to the report. On the same page, under "Introduction" The first paragraph has a reference to NAPAP, 1991. This could be a link, even if it brings you to the References at the bottom. If you click on "View References" none of these link to the original reports. A window opens that has a series of references when you click on "Technical Documentation" (http://cfpub.epa.gov/roe/technical-documentation.cfm?i=12&pvw=) but none of these have links to the original documents. It would be useful to go through the ROE and provide links, where appropriate.
In many of the graphs, users have a choice to see a subset of categories for the data. If only a subset of categories are selected, it would be interesting in many cases to recalculate percentages so they are percentages of those categories viewed. For example, some graphs show percentages of stream or lakes of high, medium and low quality, and the percentage of lakes that are not sampled. If one were to exclude unsampled category, it would be interesting for the calculations in the graph to show the percent of *sampled* lakes are high, medium and low quality, so the three categories sum to one, instead reporting the exact same percentages as in the case where all lakes are shown, including unsampled lakes.

Charge Question 5. Communication

5(a). Please provide feedback on the approaches used in the ROE to provide information such that audiences with varying interests can efficiently and reasonably find information concerning the status and trends of environmental conditions. Please provide any recommendations to enhance the access to information.

5(b). Please comment on the accuracy of the ROE's presentations and their effectiveness in communicating complex scientific information to a broad range of technical and non-technical audiences. Please provide recommendations for specific components of the ROE as appropriate.

The earlier SAB comments recommend that EPA "[d]evelop a clear mission statement for the ROE, originating from EPA leadership, in order to define the objectives and intended audiences of the report."

In my opinion, EPA has not fully responded to this comment, especially with respect to identifying a clear audience. On the ROE web site it says

> "The ROE indicators serve as a tool for EPA decision-makers, program planners, scientists, researchers, the public, and others interested in environmental science and policy to track changes in environmental condition. They allow EPA and the public to assess whether the Agency is succeeding in its mission, and they help alert EPA to new challenges that may need attention and action."

The intended audience seems to be everyone, and this may reduce its usefulness to all parties as it is challenging to meet the needs of such varied audiences. An academic audience would likely be looking for complex information, including raw data, while a public audience would likely be looking for simple, easy to understand set of indicators showing where things are getting better and where things are getting worse. Policy makers and planners might be looking for something in between.

Meeting the goals a varied audiences is fine, but it suggests that the ROE should have parallel tracks, and an interface where users indicate their goals early on, and are quickly sorted to different tracks. Ideally one could readily switch tracks, if desired, rather than starting over. For example, there could be "for more

information" links that go from simpler overviews to the more complex parallel track, and there could be "information overview" links that bring the user to the more abbreviated track. There is some of that in the current web site, where a user might dig deeper by clicking "Technical Documentation", for example. But I think a member of the public would likely be rather overwhelmed by the present formulation. Clearly, this is an area that would benefit greatly from a rigorous testing by representatives of different user groups, with direct feedback. I like the "questions" approach, but questions are likely to differ greatly across user groups, and the site would benefit from more customization for different audiences.

Charge Question 6. Additional Indicator Recommendations

6. Please provide suggestions concerning existing or potential future indicators so as to more fully address the questions of interest to the agency outlined in the ROE. Please provide specific recommendations concerning approaches to an integrated understanding of the status and trends for environmental and human health conditions related to the mission of the agency

Rebecca Parkin

These comments are based on a review in progress only. They may not reflect this reviewer's final comments.

Question 5: Communication

a. Information at different levels of detail
    1. Appropriateness for efficiently and reasonably finding information
        a. Efficiency: It takes a little time to learn where to find information and how to use some of the graphics. Once that hurdle is crossed, the patterns used to post information reduce the time to find what one is looking for.
        b. Finding information: The tiering approach is reasonable but not necessarily obvious for all of the intended audiences. The "Detailed Guide" is a "how to" explanation, rather than the reasoning behind the structure of the site. This reviewer wonders whether, or with whom, the site was pretested to determine what information or tools the intended audiences needed to readily access the level of information they want. Furthermore, how were the FAQs developed? Were answers pretested with samples of the target audiences?
    2. Recommendations
        a. The complex and data-rich site would likely benefit from a simple description of and rationale behind the tiering approach. If users know up front where to find overarching, general information vs. detailed technical information (and the levels in between), they will likely use the site more quickly and easily to meet their information needs.
b. Accuracy and effectiveness for different audiences (scientists, policy-makers, stakeholders, general public, educators and students)
    1. Audiences: It is difficult to answer this question without knowing what types of information these audiences would be seeking from the site and what level of data and contexts would meet their needs. If the Agency has empirical pretest results for these audiences, this question would be easier to address. This reviewer can only guess whether each of the intended audiences would find the site accurate and effective in meeting their information needs.
        a. Accuracy: The technical documents offer valuable information and data caveats that many users may never see. While much of the data reviewed so far appears accurate to this reviewer, some searches led to wrong locations or confusing information. For example,
            i. Although many searches were successful, one search using an unassigned U.S. zip code took this reviewer to a site in Germany. Why didn't the search yield an error message instead?
            ii. In the Asthma pages, there are inconsistencies; e.g., the exhibits and technical documentation do not match regarding which exhibits are age-adjusted or not.
            iii. Some external links already result in error messages.
            iv. In "My Maps," there is no indication what the color coding means, and no instructions to click on the gray buttons to reveal site locations on the maps. Although this section of the ROE may be the responsibility of a different part of EPA, this lack of instructions for topics in specific locations of interest to users may be frustrating and unsatisfying.
        b. Effectiveness: Scientists will find many levels of information that would be useful to them. Descriptions of data bases and their limitations are valuable for determining the nature and quality of the data for their purposes. Policy-makers, stakeholders and the general public may find the learning curve for this site more time-consuming than they would like; however, they may be sufficiently motivated to search out the data needed for their specific concern. To date this reviewer has found

only occasional links and information for educators. It is not clear what level/s of students would find this site effective for their studies. Helpful information about children and the elderly was not found until going in several levels. There is no explanation about the meaning of the tribal icon or where clicking on the icons will take the user.

2. Recommendations (without the benefit of input from intended audiences or pretest results)
    a. The current "Basic Information" button provides answers to questions about ROE and not the website. This button may be better labeled as "What is ROE?" or "Basic Information about ROE."
    b. The "Detailed Guide" button describes ways to use the site, not a guide to where to find specific information in the site. This button may be better labeled as "How to Use this Site." Furthermore, there is more "how to" information on many of the pages within the site. The current "Detailed Guide" button is a starting point only.
    c. People seeking information about children, the elderly, or other specific groups (e.g., tribes) may find the dispersed information for them more readily through a single button on the home page, which would then provide links to the various places in the site with pertinent information.
    d. Communication should be two-way. The "Contact Us" link on the site is not yet set up, so this reviewer could not assess whether the intended contact mechanism/s will be appropriate for the intended audiences.

Question 6: Additional Indicator Recommendations

None at this time.

Amanda Rodewald

Charge Question 1: Please comment on the concept of sustainability as an overarching conceptual framework for representing the relationships between indicators. Please also comment on the clarity by which the framework is depicted and discussed in the draft ROE and provide any recommendations to improve its description and intended purpose of representing the relationship between indicators?

I like the idea of sustainability as a framework, but ROE does not actually address sustainability in any of the metrics and fails to bring together the information in a way that anything can be said about sustainability given that the trends are not placed within the context of limitations or availability of resources.

I might have missed it, but are the overarching questions articulated in the Conceptual Framework section ever answered in ROE? When one clicks on the hot-link for a question, the new page provides only background and contextual information as well as links to specific indicators. If the ROE is intended to address these overarching questions, then it would seem appropriate to provide a few summary / conclusion bullets about the overall findings. I acknowledge that this is far easier said than done, but it seems like a point to discuss in our upcoming meeting.

I also am curious why the ROE chose a particular framing for some of the guiding questions only to immediately state that the question could not be answered. For example, "*What are the trends in the condition of consumable fish and shellfish and their effects on human health*?" When I click on that question, the next page states the following:

> "*Two ROE indicators are available to describe the condition of consumable fish and shellfish. Coastal Fish Tissue examines the levels of contaminants in fish from coastal waters, while Lake Fish Tissue does the same for fish collected from lakes. Both are based on national surveys coordinated by EPA. There currently are no ROE indicators to describe the effects of fish and shellfish condition on human health.*"

Are the questions simply aspirational or actual questions that are to be addressed in the ROE? If they are aspirational (i.e., to be effective, the Agency ultimately needs to answer these questions and ROE moves us closer to answers), then this should be better explained.

Charge Question 2
2(a). Please comment the on the adequacy by which sustainability has been incorporated into the ROE. More specifically, please comment on the descriptions and explanations for the sustainability theme, question, and the four associated indicators.

ROE does not actually address sustainability in any of the metrics and fails to bring together the information in a way that anything can be said about sustainability given that the trends are not placed within the context of limitations or availability of resources.

Given that sustainability was the conceptual framework for the report, I found it strange that there was only a single question articulated for "Sustainability" (i.e., "*what are the trends in consumption of natural resources?*"). Moreover, this question and the associated indicators fail to provide much insight about sustainability.

2(b). Please address the utility of the four new sustainability indicators for informing the reader on the intensity of resource consumption and the relevance of these intensity metrics.

Sustainability is assessed only by trends in consumption, but by understanding use relative to availability/production/source over a specified time period (which isn't defined in ROE). A decline in rate of petroleum use, for example, might still be far from sustainable if the amount used exceeds the amount in our reserves over X time period. Indeed, the "Limitations" section for each metric includes some variation of the following sentence: *This indicator does not describe the extent to which U.S. energy use is truly "sustainable."* That the single "sustainability" question uses indicators that explicitly state that they cannot assess sustainability is discordant with the "Sustainability Framework".

2(c). EPA is anticipating expanding the sustainability theme with additional questions and indicators in future ROEs. Please provide any specific recommendations on additional sustainability topics, indicators, and extant data sources that are important to pursue. Please provide your rationale for prioritizing additional topics and indicators.

The use and/or trends need to put within the context of the availability of resources within a given time period.

Charge Question 3. Please comment on the approach used to incorporate statistical information into the 2014 ROE. Please provide any recommendations to enhance the presentation, including the clarity in describing uncertainty.

In terms of the statistics, it seems that they were seldom used. Rather, interpreting the extent to which the data do or do not reflect trends is largely left to the user. For example, Greenhouse Gas Emissions rose by 8%. Is that significant? Is that greater than the measurement error? In some cases the changes are so great as to be obvious without statistics (e.g., 500% increase), but other times I am concerned that what look like trends based on the figures are, in fact, not. For those indicators that were analyzed statistically, whether or not the trends or differences were significant was included below the graph.

The lack of formal trend analysis is especially striking when one places the indicators within the context of the 24 key questions that ROE is intended to address – each question is framed as "*What are the trends in…*" Indeed, I looked at each of the 86 indicators and found that statistical results were reported only for 12 (~14%; acid deposition, benthic macroinvertebrates, bird populations, coastal benthic communities, coastal sediment, global atmospheric concentrations, hypoxia, N & P in wadeable streams, concentrations of ozone-depleting substances, sea level, sea surface temperatures, and US & global mean temperatures and precipitation). I also was surprised at how few indicators had confidence intervals or standard error (or standard deviation) bars.

The "statistical information button"  did not access any additional information or confidence intervals when on the left side of the page, where it was used only to indicate a line graph. Apparently, only when on the right side of the page does that symbol access other information. That was confusing to me. A different symbol should probably be used for the line graphs vs statistical information.

Below each indicator graphic, there are tabs that provide more detailed statistical information, including "*What the Data Show*" and also "*Limitations*". I like how these sections are clearly marked and provide much additional information about the indicator. That said, I think that the average user will find them cumbersome. The key points for a user seem somewhat buried in the information. I like that the technical

documentation is available on the metric page, but those documents are so dense that few people are likely to use them.

In the "Basic Information" section, the following statement is made: "*EPA has identified 24 areas where trend information is critical for the Agency to stay adequately informed about the condition of the environment.*" However, the approach used throughout most of ROE seems inconsistent with that statement for two primary reasons. One, the lack of formal trend analysis on most indicators leaves the Agency without actual information on trends (i.e., often it is explicitly stated that there was no trend analysis conducted). Two, the most appropriate reference period or temporal scale of the trends is not explicit. For example, some indicators are interpreted in the "*What The Data Show*" section over the longest time period (e.g., 100 years). Forest loss is a great example of this. I question the relevance of that time scale. Should the trends most emphasized be in the context of environmental interventions, actions and/or legislation so that the Agency can evaluate the effectiveness?

Charge Question 4.

4(a). Please comment on the scientific rigor and clarity of the ROE content with the transition from a printed document to an online presence.

The ROE website is impressive, straight-forward, and generally user-friendly. I applaud the Agency for the tremendous amount of work that has gone into the ROE! My major concerns are that it cannot be used offline and cannot be downloaded or browsed easily. The lack of offline use was difficult when I was traveling and without constant internet access. Some users, particularly those from disadvantaged communities, may only have brief windows of internet access at public libraries. Is there a way to provide the main information/results in a single PDF or some other downloadable format? Currently, one would have to download each metric separately, which would be a very time-consuming and cumbersome process. In my opinion, there are an excessive number of mouse clicks that are required to review all of the material.

4(b). Please provide suggestions on other factors that could be considered concerning the overall content, format, credibility, user friendliness and navigability of the site.

Additional synthesis and summarization would be very useful in ROE. There are some individuals that will not have the time to go through the different indicators separately. There should be an easy to find summary of the key findings of ROE. In addition, a 1-3 bullet/sentence summary of the findings at each nested level of indicators would be helpful. For example, at "AIR" summarize the overall status of air quality then at "OUTDOOR AIR QUALITY" summarize what the multiple metrics collectively tell us about outdoor air quality. Also, I would like to see the main finding highlighted at the start of each section and then followed by the supplementary and background information.

Charge Question 5.

5(a). Please provide feedback on the approaches used in the ROE to provide information such that audiences with varying interests can efficiently and reasonably find information concerning the status and trends of environmental conditions. Please provide any recommendations to enhance the access to information.

See comments above

5(b). Please comment on the accuracy of the ROE's presentations and their effectiveness in communicating complex scientific information to a broad range of technical and non-technical audiences. Please provide recommendations for specific components of the ROE as appropriate.

See comments above

Charge Question 6. Please provide suggestions concerning existing or potential future indicators so as to more fully address the questions of interest to the agency outlined in the ROE. Please provide specific recommendations concerning approaches to an integrated understanding of the status and trends for environmental and human health conditions related to the mission of the agency.

For the Global atmospheric concentrations indicator, the wording below the graph is quite different from other indicators: *"Authoritative scientific assessments have concluded that concentrations of carbon dioxide now substantially exceed the highest concentrations recorded in ice cores during the past 800,000 years."* I'm curious why "significantly" wasn't also used.

The ecological connectivity indicator has a couple of metrics that concern me. One is that the ecological hubs and corridor map is based on 2001 NLCD data; will this be updated as will some other indicators? At the very least, the Agency seems to have access to the 2006 NLCD given that it was used in the "Land Cover" indicator. Two is that the definition of hub (5,000 acres or more, as I understand) should be stated in the figure legend or below the map. The other is that the "Distribution of hubs and corridors" graphs doesn't show distribution spatially, which would be more interesting and useful, but only between "hub" and "corridor" category. It would be very interesting to compare data from 2001 to 2014 data and determine how many previously identified hubs and corridors have been lost and how many have been gained. That would be very useful.

The y-axis for Intensity of Freshwater Withdrawals – Exhibit 3 ("Index value (1950=1)" requires some additional explanation below the graph or on the axis label. The user shouldn't have to delve into the technical documentation.

I am concerned about the use of the term "biological balance" ("***Biological balance*** *refers to the interrelationships among organisms, including the structure of food webs and the ability of ecological systems to sustain themselves over time. Balance is a dynamic characteristic rather than a fixed state.")* I realize that the definition does say that it is a dynamic characteristic, the emphasis on "balance" may promote disregard of non-equilibrium or disturbance dependent ecosystems.

Air Quality Index: Days Above 100 - one cannot discern if only a couple or few cities of the 100 were responsible for the percent of days >100. That is where it might be more useful to look at average % days among cities with SE bars in the graph.

Many indicators were based on older datasets, which is understandable. It seems useful to have a document under the indicators section that lists (in one place – not >100 individual links) the most recent year of data. This might help agencies, organizations, and other institutions to identify types of data that are needed.

Sujoy Roy

Overview comment: It will be helpful to understand the level of effort and/or time frame involved in the development of the web-based ROE to this point, so that we can be realistic in our review comments of the current work product and suggestions for new work to be included in future updates. The topics being considered are broad, and as reviewers we need to understand the level of resources that are available to implement any suggestions or ideas that are presented. If there was a scope document to plan the study, I think it would be helpful for reviewers to compare against.

CHARGE QUESTIONS
Charge Question 1. Sustainability as the ROE 2014 Conceptual Framework

1. Please comment on the concept of sustainability as an overarching conceptual framework for representing the relationships between indicators. Please also comment on the clarity by which the framework is depicted and discussed in the draft ROE and provide any recommendations to improve its description and intended purpose of representing the relationship between indicators?

I am in agreement with the concept of sustainability as a framework for evaluating different indicators. The main diagram on the website (reproduced below as figure 1) was helpful as were the overview diagrams for individual issues. I expect these to be useful as a framework for a broad audience. The diagrams with indicator-specific information seemed a bit too cluttered (reproduced below as figure 2); a simpler visual representation may be considered.

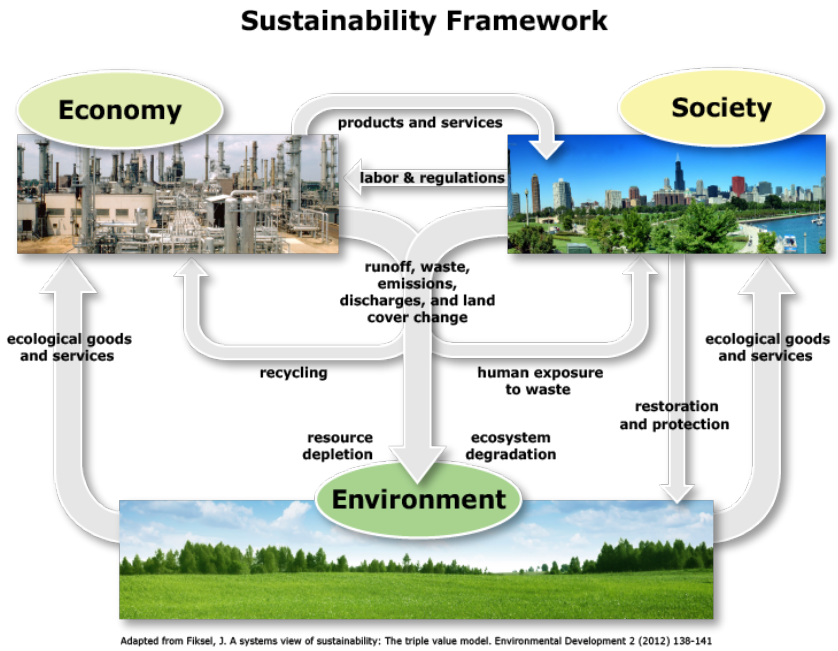

Figure 1. Overview diagram.

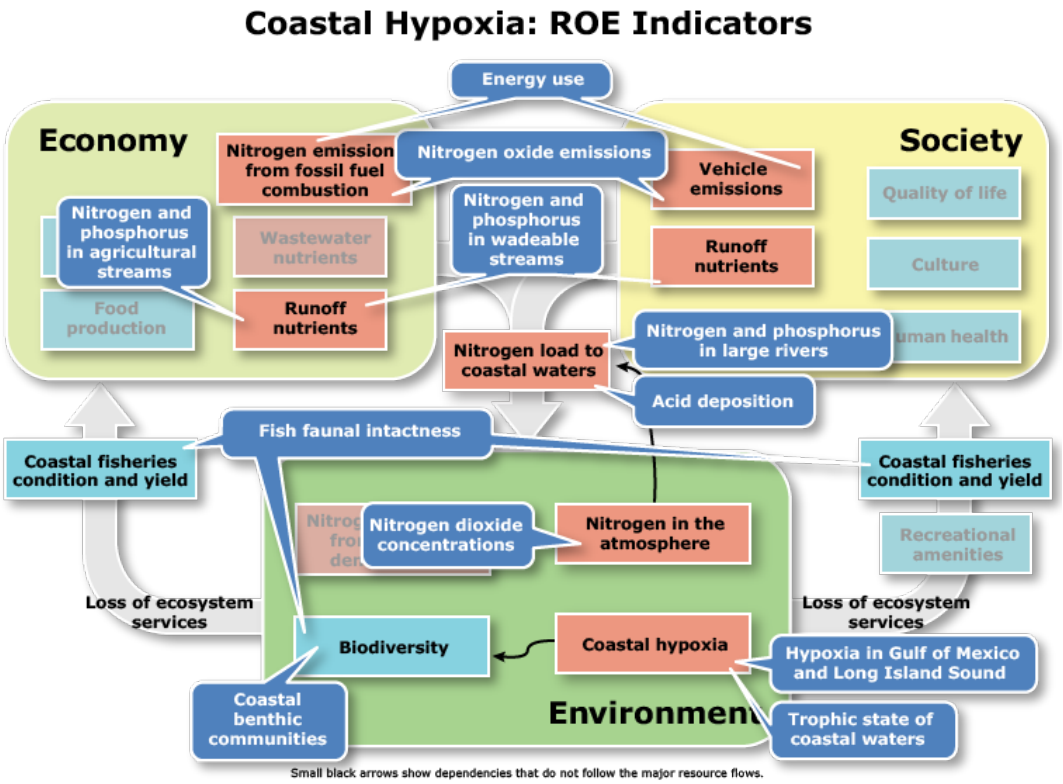

Figure 2. Detail diagram from website.

A first concern relates to the spatial scale at which ROE indicators are defined and the manner in which the data are quantified. For many of the indicators, but not all, the level at which the data are summarized are national or in one of several large regions. However, the underlying impacts shown here rarely act at that level of aggregation, especially for indicators that are related to aquatic systems. Thus, in the above example shown graphically in Figure 2, one might expect, and want to test a relationship between nitrogen and phosphorus in large rivers and wadeable streams and the trophic state of coastal waters. The nitrate and phosphorus data for large rivers (4 rivers) and wadeable streams (defined as high, moderate, or low in streams in different regions) are insufficient to allow such an analysis. One can think of several other examples, where the indicator values are aggregated in a manner that neither spatial patterns nor temporal trends can be explored.

A second concern relates to the selection of the indicators in each of the areas. Why were these indicators chosen and not others? For example, for costal fisheries, could the coastal fisheries yield be a possible indicator of some relevance to sustainability than fish faunal intactness? A description of the factors that constrained indicator selection would be helpful. This should ideally be done for each of the six areas for which indicators are presented.

Charge Question 2. Sustainability Indicators

2(a). Please comment the on the adequacy by which sustainability has been incorporated into the ROE. More specifically, please comment on the descriptions and explanations for the sustainability theme, question, and the four associated indicators.

2(b). Please address the utility of the four new sustainability indicators for informing the reader on the intensity of resource consumption and the relevance of these intensity metrics.

2(c). EPA is anticipating expanding the sustainability theme with additional questions and indicators in future ROEs. Please provide any specific recommendations on additional sustainability topics, indicators, and extant data sources that are important to pursue. Please provide your rationale for prioritizing additional topics and indicators.

The concept of using sustainability indicators is good, but the four that are selected seem inadequate in number and in the spatial detail at which they are presented. Also, I would not call these indicators new; these data have been reported for some time.

For most indicators, there is merit is providing more regionally detailed information. Because information at the 4-digit HUC watershed level is presented for some of the indicators (not the sustainability indicators but the general ROE indicators), a question that follows is: Why not show the spatially resolved data for all of the indicators? Sometimes, a great deal of information is lost in the aggregation of data nationally or in large regions.

As a general recommendation for other indicators, it would help to show per capita resource use for some key sectors: per capita energy use in all forms, per capita electricity generation, per capita gasoline/diesel consumption, per capita municipal water consumption, per capita wastewater generation, per capita recycled water use, renewable energy use per capita or at a spatially disaggregated level.

For other sectors that are not meaningful on a per capita basis, the ones I think that are important are: irrigation water use per unit area, groundwater overdraft (acre-feet per unit area in key aquifers), industrial wastewater discharge, and power plant cooling water discharge.

Data on the above metrics are reported by the USGS and the Energy Information Administration of the Department of Energy

One might further consider other indicators of material use that indicate sustainability, include quantities of goods that are obtained through trade. One area that could be considered is how some of the environmental impacts of the US economy (such as energy use and greenhouse emissions) are being exported through the import of manufactured goods instead. This class of indicators is meaningfully evaluated on a national aggregate basis.

Charge Question 3. Statistical Information
Please comment on the approach used to incorporate statistical information into the 2014 ROE. Please provide any recommendations to enhance .the presentation, including the clarity in describing uncertainty.

There are only a small number of indicators, as presented, where statistical analysis could be performed. The statistical analysis appears appropriate but the quantity of data they are applied to is limited. Uncertainty is described adequately in the technical documentation sub-sections. In some areas the statistics appear weak or irrelevant. I am specifically alluding to information such as on streamflows, where national aggregation and subsequent evaluation of metrics is of little value. Stream flows are an inherently local phenomenon, in both impact and the state of practice of their analysis, and I have deep reservations about showing national plots as done here.

Charge Question 4. ROE 2014 Web-based Product

4(a). Please comment on the scientific rigor and clarity of the ROE content with the transition from a printed document to an online presence.
4(b). Please provide suggestions on other factors that could be considered concerning the overall content, format, credibility, user friendliness and navigability of the site.

The web presentation is good and largely intuitive. I like the approach where maps are used, with the ability to zoom into specific regions. What would be good to have would be the ability to map multiple indicators such that they could be related. How does water withdrawal by region compare to population growth? Which regions are doing a better job at managing per capita water use than others? There are other mapping tools (developed by the USGS for example) where one can do such comparative exploration of the data, and this may be beyond the scope of the ROE update. However, I would think this would be of great value to researchers.

I think the overall site is well laid out and one can transition from one indicator topic to another in an intuitive manner. I have no comments about the user-friendliness of the web site. I think the interface has been well presented and is consistently organized through the different areas.

I do have a significant concern about the technical content of the site for different indicators as outlined in my responses to other questions. I feel the national aggregation of many of the numeric values limit the richness and insight that could be derived from the data. An important benefit of having an electronic framework is to allow different levels of depth in the analysis. This benefit is touched upon, but not fully implemented. I would have liked to see the ability to start with a national aggregate time series and then drill down into the data at the state, county, or HUC watershed level, perhaps match related indicators together, and/or download the data for additional analysis. In most cases this type of drill-down analysis is not implemented in this product. I recognize this may be beyond the scope and resources available, but I think it is a worthwhile goal for the long-term, and to the extent, it allows a multidisciplinary exploration of different indicators, it offers enormously added value to users.

Charge Question 5. Communication

5(a). Please provide feedback on the approaches used in the ROE to provide information such that audiences with varying interests can efficiently and reasonably find information concerning the status and trends of environmental conditions. Please provide any recommendations to enhance the access to information.
5(b). Please comment on the accuracy of the ROE's presentations and their effectiveness in communicating complex scientific information to a broad range of technical and non-technical audiences. Please provide recommendations for specific components of the ROE as appropriate.

The ROE does a good job of presenting high level information and I think it will be useful for some basic analysis, and perhaps for students and educators. There is information to be drilled down in selected menus, but the drill-down primarily consists of text and links to other websites. I don't think the contents of the ROE as presented are of benefit to the environmental research community. For that to happen there would need to be more data detail included in this product. I have several comments related to this aspect of the product in preceding questions.

Charge Question 6. Additional Indicator Recommendations

Please provide suggestions concerning existing or potential future indicators so as to more fully address the questions of interest to the agency outlined in the ROE. Please provide specific recommendations concerning approaches to an integrated understanding of the status and trends for environmental and human health conditions related to the mission of the agency.

For sustainability metrics, several different metrics may also be considered:

- Groundwater overdraft (especially important in some parts of the country)
- Energy production and consumption (all forms) (total and per capita)
- Electricity generation (total and per capita)
- Renewable electricity production and as a percent of total electricity production
- Food production and irrigation water withdrawal
- Wastewater recycling
- Greenhouse gas emissions (total and per capita)
- Industrial water discharge
- Thermal discharge

James Sanders

Charge Question 1. Sustainability as the ROE 2014 Conceptual Framework
1. Please comment on the concept of sustainability as an overarching conceptual framework for representing the relationships between indicators. Please also comment on the clarity by which the framework is depicted and discussed in the draft ROE and provide any recommendations to improve its description and intended purpose of representing the relationship between indicators?

In 2009, we recommended that EPA develop a clear, overarching conceptual framework for the indicators that comprise ROE. The agency has selected sustainability, which is central to the EPA's strategic plan, and is embedded in its work plans. Thus, its selection here is logical and I support it. However, it is unclear just what sustainability is (in the context of ROE), and the indicators are not indicators of sustainability per se (see comments below).

Charge Question 2. Sustainability Indicators
2(a). Please comment the on the adequacy by which sustainability has been incorporated into the ROE. More specifically, please comment on the descriptions and explanations for the sustainability theme, question, and the four associated indicators.

The explanation for the theme is very good, see above. The indicators, however, do not cover much of the concept of sustainability. There are four, all dealing with some aspect of resource consumption. That's fine, but coverage of this topic requires much more. Ecosystem services, issues with population growth, health of human and organismal populations, loss of species diversity and other aspects of biodiversity…Sustainability requires us to balance use with production, resource recovery. I understand that this is an initial attempt, but hope that the agency can work to increase the indicators in this area in very short order.

2(b). Please address the utility of the four new sustainability indicators for informing the reader on the intensity of resource consumption and the relevance of these intensity metrics.

The four chosen indicators are logical, and cover different aspects of the human/built environment. Is there a comparable indicator or indicators for ecosystem services that could be developed rapidly? Right now, the topic does not relate at all to the non-human world.

2(c). EPA is anticipating expanding the sustainability theme with additional questions and indicators in future ROEs. Please provide any specific recommendations on additional sustainability topics, indicators, and extant data sources that are important to pursue. Please provide your rationale for prioritizing additional topics and indicators.

See above. Further details will require extensive panel discussion.

Charge Question 3. Statistical Information
3. Please comment on the approach used to incorporate statistical information into the 2014 ROE. Please provide any recommendations to enhance the presentation, including the clarity in describing uncertainty.

The incorporation of statistical information is a good first start. The website is clear about why it has been included, and why it isn't available for all indicators. It appears to be developed more for scientific

audiences, and not the general public. However, the concept of uncertainty is an extremely important one, particularly in helping citizens to understand predictions and models, and the uncertainty discussion here is inadequate to help resolve this important concept for the public.

Charge Question 4. ROE 2014 Web-based Product
4(a). Please comment on the scientific rigor and clarity of the ROE content with the transition from a printed document to an online presence.

I strongly support the development of the online version. I pulled out the last printed version, and spent some time with it, but quickly "tired" of the process. The online version is attractive, reasonably easy to use (see other comments, below), and allows the viewer to drill down to the level of detail they require.
4(b). Please provide suggestions on other factors that could be considered concerning the overall content, format, credibility, user friendliness and navigability of the site.

- Please see the comments below concerning use of the website by teachers and non-scientists.
- The buttons at the top of the page (learn the issues, Science and Technology, Laws…) take you to the main EPA site and away from ROE. That is not obvious at first glance.
- The where you live concept is very well considered, although a minor quibble is that some of the maps are a bit difficult to navigate, with +/-, N/S/E/W buttons, but they work.
- The conceptual framework pages and their examples are well written and clearly understandable.
- In the FAQs, I note the question "what is the ROE?" is never answered, you provide a few examples of what it is not. A simple descriptor could be added to the beginning of this section.

Charge Question 5. Communication
5(a). Please provide feedback on the approaches used in the ROE to provide information such that audiences with varying interests can efficiently and reasonably find information concerning the status and trends of environmental conditions. Please provide any recommendations to enhance the access to information.

It appears to me that the ROE is best attacked by a scientist, or professional. To that end, it achieves its purpose well (with the caveats we have developed).

To gain perspective, I asked two individuals to view and comment on the ROE website. I gave them no information about the site, other than to tell them that it was a "go-to" website to gain perspective about the state of the environment. One individual was a non-scientist, with little understanding of environmental concepts (but interested in natural systems and environmental protection). The second was an educator, with a bachelor's degree in the sciences. Their comments are below. Admittedly, this is a very non-scientific exploration, but their comments are of value, I believe.

Non-Scientist, public citizen:

- First thing I noticed! – Easy to navigate. That's always a big plus.
- RJ's ("Regular Joes") like me can find environmental data easily; regional & state trends, etc. It has a nice US map that you can simply click on whatever state you're interested in & get info on a number of things. (i.e. Disease, Forest Fragmentation, Lead Emissions, Regional Haze, Sea Level, etc.)
- I particularly liked the "What You Can Do on This Site". Everything from cleaning up, to protecting yourself & your family, to where/whom to contact for certain aspects of each category.
- I can see where a lot of the information given would only be of interest to people looking for THAT specific data, RJ wouldn't necessarily find good information in the data charts. The charts read more "scientific" than "RJ" if that makes sense.

• One thing I DIDN'T LIKE: there was no "Home" button that is CLEARLY marked EPA HOME. There is a place to click to get to "home", but it's not a button, and it's at the bottom of the page… VERY SMALL font. In my personal opinion, that is "hidden too well." It should be easily seen, at the top of the page.

Science Teacher:
• Overall, website is really good—I liked the listing of categories, teachers can align them with their state learning standards. Plus, the ability to use the where you live function allows them to focus down on their own state.
• I felt the indicators were heavy on physical/chemical information. The lack of information on living resources was a gap that should be filled.
• One modern issue that should be considered is marine debris, and debris in feeder streams and rivers. Data are being developed now that could inform the public about this important issue.
• The interactive charts, maps were excellent, and allowed me to focus on my interests.
• Teachers will make good use of the technical sections and literature citations. The ability to download data makes this a good tool to engage students.
• I found the selection of a few topics, seemingly at random, such as Chesapeake Bay SAVs, Gulf of Mexico hypoxia, apparently arbitrary. Why were they selected? Did I miss the explanation for these?

5(b). Please comment on the accuracy of the ROE's presentations and their effectiveness in communicating complex scientific information to a broad range of technical and non-technical audiences. Please provide recommendations for specific components of the ROE as appropriate.

See comments, above. Others will be developed in panel discussions.

Charge Question 6. Additional Indicator Recommendations
6. Please provide suggestions concerning existing or potential future indicators so as to more fully address the questions of interest to the agency outlined in the ROE. Please provide specific recommendations concerning approaches to an integrated understanding of the status and trends for environmental and human health conditions related to the mission of the agency.

Requires panel discussion.

Thomas Theis

The ROE 2014 draft sustainability indicators are a good start, but fall short of the comprehensive nature of the sustainability paradigm. In addition they are mostly indirect indicators. The table below suggests additional indicators that are more direct measures of sustainability trends. In most cases these can be computed for past intervals thus creating a trend line. Those indicators listed are not exhaustive: e.g. more consideration of social indicators, integrated into environmental and economic indicators, is needed.

Direct Sustainability Indicators

INDICATOR	MEASURE OF	SUSTAINABILITY CRITERIA
Ecological Footprint	Consumption of ecological resources	EF does not increase over time
Exergy	Energy availability	Minimize exergy use
Emergy (embodied energy)	The sum of all of the different kinds of energy previously used up, directly and indirectly, to make an item	(Total Emergy Use) → Maximum (Renewable Emergy Use) / (Total Emergy Use) →1
Net Domestic Production	Economic activity	
Net Green Regional (National) Product	(Value of All Market Transactions) – (Loss of Value of Human-Made and Natural Capital)	GreenNRP is positive
Fisher Information	System function: measure of dynamic order that changes when system regimes changes	**Sustainability Criteria I**: if the system dynamic regime is sustainable, then the time averaged Fisher Information must be constant. **Sustainability Criteria II**: steadily decreasing Fisher information signifies progressive loss of dynamic order and a system that is becoming disorganized and ceasing to function. **Sustainability Criteria III**: the interval or shift between two dynamic regimes is characterized by a steep drop in dynamic order and Fisher information.

Stephen Weisberg

Charge Question 1. Sustainability as the ROE 2014 Conceptual Framework
Please comment on the concept of sustainability as an overarching conceptual framework for representing the relationships between indicators. Please also comment on the clarity by which the framework is depicted and discussed in the draft ROE and provide any recommendations to improve its description and intended purpose of representing the relationship between indicators?

Answer: Sustainability is a good structuring mechanism. It provides a mechanism for integrating the effectiveness of the organization as a whole, moving past the stovepiping that naturally results from the multiple regulatory programs that otherwise define the agency. I particularly like that the framework is closely tied to the agency's research plan and links back to the mandates of NEPA (and the origins of the agency): "to create and maintain conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations."

The presentation is clear. I had no difficulty following the rationale for the approach. The drop-down boxes are wonderful for sequentially visualizing the conceptual model, the relevant attributes and the performance metrics. I also had little difficulty in conceptualizing how the framework would apply to other outcomes beyond the six they selected so far as examples.

I particularly like the selection of at least one topic area, acidic precipitation, that links the activities of EPA's Office of Water and Office of Air. These offices tend to work fairly independently, driven by their separate regulatory mandates, yet their success is linked and the framework allows the agency to highlight that linkage. One area of potential improvement is to more explicitly recognize the linkage between EPA and other federal agencies. At present the material presented, and the indicators selected, are EPA-centric, with the wetlands piece being a good example. There are many other agencies that have an effect on the wetlands outcome, including those involved in wetlands purchasing, restoration, etc.

Charge Question 2. Sustainability Indicators
2(a). Please comment the on the adequacy by which sustainability has been incorporated into the ROE. More specifically, please comment on the descriptions and explanations for the sustainability theme, question, and the four associated indicators.
2(b). Please address the utility of the four new sustainability indicators for informing the reader on the intensity of resource consumption and the relevance of these intensity metrics.
2(c). EPA is anticipating expanding the sustainability theme with additional questions and indicators in future ROEs. Please provide any specific recommendations on additional sustainability topics, indicators, and extant data sources that are important to pursue. Please provide your rationale for prioritizing additional topics and indicators.

Answer: Incorporation of trends in consumption into the reporting structure makes considerable sense, but the indicators selected are not intuitive. Water withdrawal is clearly use of a resource and assessing how much water is consumed fits with the theme. In contrast, RCRA hazardous waste generation is not a resource. It is the endpoint of resource consumption and is indicative of the pressures placed on the environment by resource consumption. I think it still fits in the report, as stressor reduction can be a preferable management approach to subsequent engineering fixes or mitigation. However, the terminology needs to be reconsidered. The charge question asks for additional sustainability indicators, but I need more clarity as to whether these are intended to be stressor or true consumption measures before making specific suggestions.

Charge Question 3. Statistical Information
Please comment on the approach used to incorporate statistical information into the 2014 ROE. Please provide any recommendations to enhance the presentation, including the clarity in describing uncertainty.

This version of the ROE is far improved from earlier versions, which provided almost no uncertainty information, but it remains an area for potential improvement. The report will have two types of audiences: People with technical knowledge (e.g. scientists) and the average members of the public. These two audiences will have different needs. The scientist will want to drill down to gather additional detail, allowing them to make up their own mind as to whether the patterns are real. The average public will just want to know if the trend they are seeing visually is real. The present material is not entirely meeting the need for either of them.

What has been added, a footnote clarifying whether the analysis was statistically significant or not, is closer to meeting the needs of the general public. However, the verbiage needs to be clearer. Most of the general public is unfamiliar with the jargon and so there is a need to better explain what is meant and what are the interpretation implications of the text about statistical significance. For instance, when the text says that a pattern is statistically insignificant, their natural thought may be to disregard the pattern. That may be appropriate in some circumstances, but would be unfortunate in circumstances such as when the pattern is significant at p=0.06. Similarly, error bars are provided for some graphics, but there is no explanation of what they are.

I think the problem is more severe for the technically-minded. The drop down information at the bottom of each indicator page includes sections on sources of uncertainty, sources of variability, and statistical/trend analysis, which are the right things to include. Unfortunately, the content in these sections is at an insufficient technical level to meet this audience's need. Moreover, sophisticated users may want access to the original data so they can make their own assessment. Citations to the original reports exist for most indicators, but those can be improved by providing hyperlinks to the reports and even providing links to the underlying data, when available.

Charge Question 4. ROE 2014 Web-based Product
4(a). Please comment on the scientific rigor and clarity of the ROE content with the transition from a printed document to an online presence.
4(b). Please provide suggestions on other factors that could be considered concerning the overall content, format, credibility, user friendliness and navigability of the site.

Answer: The use of a web-based format is a big improvement over the print version. The authors have taken good advantage of the web format, using mouseovers and other graphic enhancement tools to provide additional detail, while leaving the initial presentation simple and visually appealing. Numerous links have been added throughout the ROE, allowing the reader to get more information. I like the simple icons on each page for downloading or printing the graphics, as well as for downloading the underlying data. The web version also makes it easy to reach answers from multiple entry points, allowing people to find information in the way that they ask the questions, rather than in a hard-wired linear fashion associated with the print version.

I found the clarity to be outstanding. Once you take the time to understand the tabs across the top, it is easy to find information on any theme. The tabs make it all accessible from the initial page.

The scientific rigor of the document is uneven and highlights a question of whether the goal of the document is to give the best information possible on the most relevant questions, or to provide answers to questions for which they have the best answers. For example, one of the indicators used is condition of the estuarine benthic infauna. This is a good measure for assessing condition, but EPA is still in the process of developing a nationally-consistent interpretational tool for these types of data. As such, the report provides interpretation based on a set of regionally

developed indices that are scaled differently and are therefore inappropriate for cross-regional comparison. As such, the report provides the best answer possible with current techniques, but the underlying answer about relative condition across regions is probably incorrect. The report alludes to this problem in the supporting text, but not clearly or strongly enough. This kind of problem is not pervasive, but it is cautionary because low credibility associated with any indicator leads to concerns about the others.

One portion of the site that needs considerable attention is the "where you live" section. The concept is great, but the execution is poor. The present site seems focused on subsetting data out of the national data base, but the necessity for national consistency means that those data bases miss out on a lot of local high quality data systems. To be effective, the report needs to also point the reader to those local information sources, which will generally have higher data density and provide a more precise answer. For example, California has created the "my water quality" web site (http://www.mywaterquality.ca.gov/index.shtml) that includes information for many of the same indicators used in the ROE, but has the advantage of using state and regional data sets that contain an order of magnitude or more data than the national data base. The ROE needs to embrace these local information sources, perhaps through links, rather than placing themselves in competition by providing alternative answers based on a less robust data set.

Charge Question 5. Communication
5(a). Please provide feedback on the approaches used in the ROE to provide information such that audiences with varying interests can efficiently and reasonably find information concerning the status and trends of environmental conditions. Please provide any recommendations to enhance the access to information.
5(b). Please comment on the accuracy of the ROE's presentations and their effectiveness in communicating complex scientific information to a broad range of technical and non-technical audiences. Please provide recommendations for specific components of the ROE as appropriate.

Answer: Overall, the ROE does this well. There is plenty of documentation at varying levels to address multiple audiences (with exception of the statistical issues identified above). One small area for potential improvement is to create more pop-up boxes describing obscure parts of graphics or indicator descriptions. For example, the graphic "Exhibit 3. U.S. population served by community water systems with reported violations of EPA health-based standards, by type of violation, fiscal year 2012" contains row headings for "Stage 1 Disinfection Byproducts Rule" and "Surface Water Treatment Rules". The novice user will need explanation of what these are.

Charge Question 6. Additional Indicator Recommendations
Please provide suggestions concerning existing or potential future indicators so as to more fully address the questions of interest to the agency outlined in the ROE. Please provide specific recommendations concerning approaches to an integrated understanding of the status and trends for environmental and human health conditions related to the mission of the agency.

Answer: The array of indicators covered is good, though there are several indicators that would be nice additions to the ROE. The first is beach water quality. One of the key provisions of the Clean Water Act is to ensure that the water is safe to swim in. EPA puts considerable emphasis in facilitating state monitoring programs to assess their effectiveness in this area and has a comprehensive national data base that lends itself well to the ROE.

The second is ocean acidification (and a few other climate change-related measures). The ROE includes greenhouse gas measures, but those focus mostly on nitrogen and sulfur based atmospheric contamination. The section is light on the connection between CO2 concentrations in the atmosphere, CO2 concentrations in estuaries and oceans (that result primarily from equilibrium with atmospheric concentrations), the resulting pH changes in the water and

the ultimate acidification effects on biota. The reduction in shellfish survival from this mechanism has become a national story and one that should be reflected in the ROE.

The third is expansion of the drinking water indicators. The ROE should address three different types of drinking water questions: 1) Quality of the water delivered through municipal systems, 2) Quality of water from wells, and 3) Quality of the source water (e.g. how much treatment is needed and is the need for additional treatment growing). The present drinking water measures are focused only on municipal systems, which is relevant to only a subset of the nation. Adding information about the quality of well water would improve this indicator group.