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TABLE

2.3-1 Peer Reviewer Recommendations for Water Indicators 1

2.3 WATER INDICATORS[1]

This chapter summarizes reviewer discussions and presents consensus conclusions and recommendations for EPA's proposed water indicators for the ROE Technical Document. The chapter is divided into seven sections. The first six cover indicators in fresh surface waters, ground water, wetlands, coastal waters, drinking water, and consumption of fish and shellfish. The seventh discusses reviewers' responses to general questions. Table 2.3-1 shows the reviewers' overall recommendations for these indicators.

Table 2.3-1. Peer Reviewer Recommendations for Water Indicators

Indicators	Include with Suggested Modifications	Don't Include Unless Critical Modifications Are Made	Don't Include
Water and Watersheds: Fresh Surface Waters			
Lake and stream acidity	✔		
Nitrate, phosphorus, and pesticides in streams in agricultural watersheds	✔ (ecological group)		✔ (water group)
Nitrogen and phosphorus discharges from large rivers	✔		
Water and Watersheds: Groundwater			
Nitrate and pesticides in groundwater in agricultural watersheds	✔		
Water and Watersheds: Wetlands			
Wetland extent, change, and sources of change	✔		
Coastal habitat index	✔ (ecological group)		✔ (water group)
Water and Watersheds: Coastal Waters			
Coastal condition index	✔		
Coastal water quality index	✔		
Coastal sediment quality index			✔
Coastal benthic index	✔		
Extent of hypoxia in Gulf of Mexico and Long Island Sound	✔		
Harmful algal bloom outbreaks	✔ (water group)		✔ (ecological group)
Chesapeake Bay blue crabs			✔
Submerged aquatic vegetation in Chesapeake Bay	✔		
Drinking Water			
Population served by community water systems	✔		
Consumable Fish and Shellfish			
Coastal fish tissue contaminants index	✔		

[1] At the time of this peer review, EPA intended to publish the ROE Technical Document in 2006. Therefore, this summary of reviewer discussions refers to the "2006 Report on the Environment" and "ROE06." These terms are synonymous with all references to the "2007 Report on the Environment" and "ROE07" elsewhere in this report.

Many of the water indicators were also reviewed by the ecological condition review group. These reviewers ranked each indicator they reviewed in terms of its importance in answering the question it was proposed to answer. When ranking an indicator, the reviewers considered the indicator as it would be when revised according to the "critical" modifications they listed in the "Consensus" table. These rankings appear in the upper right-hand corner of each "Consensus" table prepared by the ecological condition reviewers. A "High" ranking represents the most important indicators. In cases where the ecological condition reviewers recommended not including an indicator, they did not assign a rank, and these indicators are labeled NA.

2.3.1 FRESH SURFACE WATERS

2.3.1.1 Lake and Stream Acidity

Reviewed by the Water Group and by the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	None.
Suggested modifications	• Explain EPA's decision to limit the indicator to the northeast and Mid-Atlantic. • Consider data available for other regions in the U.S., and incorporate the most recent available data. • Clearly define the population represented by this indicator, and explain that sampling was targeted to reflect the impacts of the Clean Air Act on acid sensitive areas. • Revise Figure 041-1 to include data from years pre-1990. Define the year that is considered "current." • Relate this indicator to appropriate air indicators to reflect the stressors or ambient conditions. • Define ANC and explain why/how it can be negative.
Other comments	• It is not appropriate to represent the existing dataset as a national indicator unless data are included for other areas of the U.S. • If other areas of the nation are not covered in the analysis, consider revising the question to specifically address the region and data included. It is not immediately clear what portion of the more general question this indicator answers.

The water indicators peer reviewers agreed that this indicator, *Lake and Stream Acidity*, should be included in the ROE 2006 even if all of the suggested modifications cannot be made. The reviewers were concerned that this indicator is represented as a national indicator even though major areas of the U.S. are

not represented. They recommended that EPA include datasets for the entire nation, or at least include an explanation of why this indicator focuses on the Ridge/Blue Ridge, Upper Midwest, Northern Appalachian Plateau, New England, and the Adirondack Mountains rather than other regions of the U.S.

The reviewers also stressed that EPA should better define the population of lakes and streams included in this indicator (e.g., the cutoff size and location of the lakes and streams studies). Furthermore, reviewers agreed that Figure 041-1 misrepresents the datasets, which span approximately 20 years. The map of the U.S. showing only 1990 levels and "current" levels does not represent trends or make use of the entire dataset. Therefore, EPA should consider an alternative method for displaying the data, although the map is helpful in showing the regions of the U.S. represented by the data. Finally, the reviewers concluded that EPA should examine whether more recent data are available for these regions and other parts of the U.S.; if available, these data should be incorporated into the ROE 2006.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: High)
Critical modifications	• Change the title to "Changes in Lake and Stream ANC." • In ROE, put the indicator back-to-back with Acid Deposition. • Complete the national map. Note that earlier surveys collected baseline data for other regions. • Modify the text and graphics to make the measures of ANC, alkalinity, pH, and acidity clear to the readers. Explain that ANC values less than zero reflect additional mineral acidity in the absence of carbonate and bicarbonate. Although "ANC" can be used to mean "acidity," the indicator writeup would be more clear if it used the term "susceptible" instead (second paragraph).

Many of the reviewers' individual comments concerned the need for greater clarity in terms of what the indicator actually measures. One reviewer suggested that "Lake and Stream ANC" would be a better title because the indicator measures acid neutralizing capacity (ANC), not acidity. Another reviewer suggested "Chronic acidity as measured by changes in ANC," since the indicator focuses on *changes* in ANC, not on the actual measurement of ANC. Ultimately, the reviewers agreed on the title listed in the critical modifications above.

The reviewers also discussed whether it is more appropriate to measure ANC or to measure acidity directly. One reviewer suggested that it would be better to measure pH directly, because it is acidification—not the *potential* for acidification—that actually hurts species. Another reviewer agreed, adding that some regions had very little ANC to begin with, so a slight change in ANC might be a more serious problem than it seems. A third reviewer disagreed, suggesting that from EPA's regulatory perspective, it would be better to look at changes in ANC in order to see where the potential trouble spots lie, and to take action accordingly. In any case, the reviewers agreed that as long as the indicator measures ANC and not acidity, the writeup should clarify that areas with low ANC are "susceptible," not necessarily "acidic"—even though the terms are sometimes used interchangeably.

Several reviewers expressed concern about the limited spatial extent of the proposed indicator. As one reviewer noted, even if acidification is not a problem in some regions not shown on the map, it would be

nice to at least show the audience that this is the case. Another reviewer pointed out that data were originally collected from across the nation, but subsequent surveys were focused only on regions that showed a low baseline ANC in the original survey. The reviewers agreed that all of the ANC data should be incorporated into a national map, even though some regions would only have baseline data, not trends.

One reviewer suggested completing the national map, then subsuming this indicator into the Acid Deposition indicator to provide context about susceptibility. Others agreed that at the very least, these two related indicators should be presented side-by-side in the ROE.

2.3.1.2 Nitrate, Phosphorus, and Pesticides in Streams in Agricultural Watersheds

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Do not include.**
Critical modifications	None.
Suggested modifications	None.
Other comments	• Adjust this indicator for future ROEs to represent 1st and 2nd order streams, include ecological rather than human health endpoints, and differentiate between agricultural and urban areas. • Compare contaminant levels with ecologically relevant endpoints rather than MCLs. • This indicator could be explored as a regional indicator for regions such as California, where agriculture takes place at lower elevations and along higher order streams. • Because stream conditions are typically temporal, it may be inappropriate to average data over long time periods.

The water indicators peer reviewers agreed that this indicator, *Nitrate, Phosphorus, and Pesticides in Streams in Agricultural Watersheds*, should **not** be included in the ROE 2006. While the reviewers agreed that this type of indicator is important, they felt that it should be adjusted for future ROEs to represent 1st and 2nd order streams, include ecological rather than human health endpoints, and differentiate between agricultural and urban areas.

The reviewers criticized the dataset used in this indicator because two-thirds of streams are not represented (USGS stations often are located on 3rd or higher order streams). They suggested that it would be more appropriate to apply this indicator to specific regions, such as California, where agriculture takes place at lower elevations and along higher order streams. Furthermore, the reviewers stated that it is inappropriate to compare contaminant levels with MCLs because the streams in agricultural watersheds typically are not sources of drinking water. Instead, the data should be compared with natural background levels or other ecologically relevant endpoints (e.g., aggregate nutrient criteria) developed by EPA. Finally, EPA should acknowledge that any pollutants detected in the streams are not necessarily attributable to agriculture; they could be linked to other sources, such as urban areas.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: High)
Critical modifications	• Change the categories for nitrogen so they reflect levels of concern for algal growth (e.g., 0-0.25 mg/L, 0.25-0.5 mg/L, 0.5-2 mg/L, greater than 2 mg/L). • Express nitrogen and phosphorus as either *Total N and Total P* or *inorganic N and inorganic P*. • To prevent misinterpretation, explain that thresholds for pesticide exceedances are designed to be fully protective of aquatic life, and are therefore not comparable to the toxicity thresholds for sediments (e.g., Coastal Sediment Index). • Explore ways to display data spatially (e.g., a concentration map) in addition to the present histograms. The map and histogram could share the same color scheme, to communicate the data more effectively.

Individually, the reviewers elaborated on several of the critical modifications listed above. Regarding the thresholds for nitrate, one reviewer explained that anything over 2 mg/L of nitrate can contribute to excess algal growth. Thus, to be consistent with the approach used to characterize phosphorus—which is presented in terms of levels that affect algal growth—nitrate concentrations should be classified more precisely within the range of 0-2 mg/L. As two reviewers pointed out, it is appropriate to discuss nitrate from an algal growth perspective because many streams are actually nitrogen-limited, particularly in the Northwest. Thus, the indicator is inaccurate in suggesting that phosphorus is always the limiting nutrient for algal growth.

In recommending that the indicator be revised to measure either *Total N and Total P* or *inorganic N and inorganic P*, several reviewers referred back to comments they made on the indicator Nitrogen and Phosphorus Discharge from Large Rivers, regarding the need for a consistent and thorough approach. These comments are explained in greater detail under the Large Rivers indicator. After consulting the original USGS dataset, one reviewer noted that USGS has data on the different forms of nitrogen and phosphorus, so it would be possible to represent the comparable forms of nitrogen and phosphorus.

Several reviewers raised concerns about the way the indicator covers pesticides. One reviewer pointed out that many pesticides—particularly newer compounds—have such short half-lives that they would not show up in a sample unless it was collected immediately after pesticide application. This reviewer suggested that the "limitations" section of the writeup should address the issue of half-lives. Another reviewer noted that the large number of pesticide exceedances could be misleading, since several other indicators (e.g., sediment quality) use toxicity benchmarks instead of the more conservative, protective standards used in this indicator. In response to this comment, one reviewer suggested that it might be nice to know the *extent* to which samples exceeded the standards, yet this might also lead to too many data points on the graphic. As an alternative, reviewers suggested adding a caveat to the writeup, explaining the nature of the standards (i.e., protective levels that suggest a need for further investigation if they are exceeded) and noting that the indicator says nothing about the *extent* of the exceedances (see the third critical modification, above).

After consulting the original dataset, one reviewer noted that USGS has used maps to display NAWQA stream quality data; thus, it could be feasible to use a map to improve the presentation of this indicator, as suggested in the list of modifications above.

Overall, the reviewers agreed that there are limitations to the proposed indicator. For example, as one reviewer noted, it is hard to interpret the risks associated with the pesticide contamination that the indicator appears to reveal. However, some reviewers also pointed out strengths of the indicator, including the fact that it reports nitrogen, phosphorus, and pesticide levels separately instead of trying to meld the three measures into a complicated composite. Another reviewer agreed that while there are technical issues with the indicator, it still says something useful.

2.3.1.3 Nitrogen and Phosphorus Discharges from Large Rivers

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	• Include data for ammonium, total nitrogen, and organic nitrogen in this indicator. • Revise the indicator to reflect circumstances in which certain systems are co-limited by nitrogen and phosphorus. To this end, EPA should consider including a nitrogen to phosphorus ratio. • Define "large" rivers and include data from additional large river systems.
Suggested modifications	• Include total nitrogen and total phosphorus in the public report, and present all nitrogen species and dissolved inorganic phosphorus in the technical document.
Other comments	• In certain systems with natural sources of phosphorus, elevated levels may not represent an anthropogenic stressor; therefore, management strategies targeting these systems would be inappropriate.

The water indicators peer reviewers agreed that this indicator, *Nitrogen and Phosphorous Discharges from Large Rivers*, should be included in the ROE 2006 even if all of the critical and suggested modifications cannot be made. However, EPA should **place high priority on the critical modifications** included in the table above. The reviewers' discussion focused on three main issues: 1) the species of nitrogen included in the indicator, 2) co-limitation of nitrogen and phosphorus, and 3) the river systems chosen for inclusion in the report.

The reviewers agreed that ammonium, total nitrogen, and organic nitrogen should be included in this indicator because nitrate is not necessarily a surrogate for the behavior of all nitrogen species. Furthermore, certain types of biota respond differently to different sources of nitrogen. The reviewers also emphasized that many systems are co-limited by nitrogen and phosphorus; therefore, management decisions aimed at reducing the concentration of only one of these constituents may not ameliorate an existing water quality problem. For example, the Saint Lawrence and Susquehanna Rivers display a

noticeable downward trend in total phosphorus discharges, while the Mississippi and Columbia do not. Furthermore, some rivers contain phosphorus from substantial natural sources (this may be the case for the Columbia, as many of its groundwater sources arise from volcanic materials). In most estuarine and coastal environments, both constituents must be managed, and some systems may even vacillate between being nitrogen- or phosphorus-limited. In addition, the reviewers encouraged EPA to include data from additional large river systems to make this indicator more robust at the national level. Finally, they noted that the indicator text does not adequately define "large" rivers and does not provide a clear explanation of the rationale behind choosing the four river systems that appear in this indicator.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: High)
Critical modifications	• Change to either *Total N and Total P* or *inorganic N and inorganic P*, both for consistency and for interpretation of the important forms for primary production or eutrophication. • If possible, capture more than just these four major rivers. If this is not possible, work with USGS to explore the possibility of analyzing additional rivers in the future. It would be nice to include an arid river system. • Report the average annual load for each river over the full period of record.
Suggested modifications	• If the average annual discharge and/or average N and P concentrations were provided, it would allow for better comparison among rivers.

One reviewer elaborated on the decision to include this indicator by highlighting several of its strong points:

- It covers two nutrients with definite links to eutrophication and hypoxia.
- Although it is limited to four rivers, they are important rivers that represent major portions of the nation.
- Records date back 30-50 years.
- The indicator will likely continue to be important in the future.

Regarding the first critical modification listed above (the choice of nitrogen and phosphorus species), one reviewer explained that the indicator is currently inconsistent because it compares total phosphorus with only the nitrate fraction of nitrogen. At the very least, the indicator should include ammonia along with nitrate. To be consistent, the indicator should use either *Total N and Total P* or *inorganic N and inorganic P*—and because bacteria can break down organic forms of both nitrogen and phosphorus, the *Total N and Total P* comparison would be the better of the two. Otherwise, if left as is, the indicator could make a river system appear to be nitrogen-limited when it is really co-limited, for example.

Reviewers also elaborated on some of the other modifications suggested above. For example, one reviewer explained that it would help to know each river's average annual load over the full period because it would put changes in a longer-term context. A reviewer also observed that the current graphics provide no sense of nutrient *concentrations*. While it is useful to know about the total nutrient flux, it is

also worth noting that while the Columbia River's nutrient flux is similar to that of the St. Lawrence and the Susquehanna, the Columbia actually has a much greater discharge—and thus a much lower concentration of nitrogen and phosphorus. This reviewer suggested adding at least a footnote with either the average annual discharge or the average annual nitrogen or phosphorus concentration for each river.

On a graphical note, a reviewer suggested that the x-axis in the "detail" section of each figure should be the same length as the x-axis in the full graph to the left.

Reviewers noted a few factors that complicate the interpretation of this indicator. As one reviewer noted, trends in nutrient loadings can be confounded by detergent bans or changes in sewage treatment (e.g., tertiary treatment for phosphorus, which is required in some regions but not in others). Another reviewer noted that there are significant natural sources of some nutrients, such as phosphorus from basaltic bedrock in the Columbia basin.

Finally, although the reviewers agreed that this is a good indicator to include in ROE, individual reviewers did note some limitations, including:

- The indicator still only includes four rivers.
- The indicator provides no information about nitrogen and phosphorus in lakes and reservoirs.
- In order to make any interpretations about specific sources of nitrogen and phosphorus, the indicator would have to include measurements from upstream river segments.

2.3.2 GROUNDWATER

2.3.2.1 Nitrate and Pesticides in Groundwater in Agricultural Watersheds

Reviewed by the Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	None.
Suggested modifications	• Include trends for this indicator rather than data grouped over several years. Revise Figure 033-2 to reflect these trends. • Compare contaminant levels against natural background levels as well as drinking water standards. • Instead of a count of pesticides detected, examine and present the magnitude, frequency, and scope of any exceedances. • Specify the target population for Figure 033-1.
Other comments	• EPA should emphasize the importance of this indicator because it could be a stressor contributing to health and ecosystem effects. • Groundwater sampling in agricultural watersheds does not necessarily reflect agricultural stressors.

The water indicators peer reviewers agreed that this indicator, *Nitrate and Pesticides in Groundwater in Agricultural Watersheds*, should be included in the ROE 2006 even if all of the suggested modifications cannot be made. The reviewers maintained that a groundwater indicator is a critical component of the ROE 2006, and including one in the document would serve to foster additional groundwater monitoring programs. The reviewers also offered several suggestions for improving the presentation of the data chosen for this indicator.

First, the reviewers recommended that the indicator include trends rather than data grouped over several years, and that Figure 033-2 should be revised to reflect these trends. A simple count of the number of pesticides detected does not reflect the magnitude, frequency, or scope of exceedances. EPA also should consider comparing contaminant concentrations to natural background levels rather than or in addition to MCLs. In this way, it would serve as an effective ecological health indicator.

Next, the reviewers commented that the data presented in Figure 033-1 are misleading, as the percentage of wells with detects would not reflect the proportion of groundwater with detects if the sampling rates in different areas of the country are different (this information was not readily available to the reviewers). Therefore, EPA should specify the target population, perhaps by including a map of the U.S. showing sampling locations. A preferable alternative would involve quantifying the percentage of groundwater (by volume or area) represented by each sampling point (i.e., well) and modifying the data presentation accordingly.

Finally, the reviewers encouraged EPA to acknowledge that contaminants detected in groundwater in agricultural watersheds are not necessarily attributable to agricultural stressors. Many pollutants may be

discharged from agricultural lands without percolating into the groundwater, and aquifers in one watershed may not have any connection to surface water. Aquifers in some areas of the country even run at right angles to surface waters.

2.3.3 WETLANDS

2.3.3.1 Wetland Extent, Change, and Sources of Change

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	None.
Suggested modifications	• Update indicator text to reflect that National Wetlands Inventory (NWI) data are compiled on a five-year (not ten-year) cycle. • Revise or replace Figure 020-4, and present the causes for wetland extent change as a trend. • If the data allow, present the indicator on a regional basis for extent, change, and sources of change rather than only for sources of change. • Include a map of NWI plots across the entire country to show geographic coverage of the inventory.
Other comments	• Updated procedures used to detect changes in wetland extent do not affect the statistical validity of the indicator. • The West Coast is not as well represented as other regions because original survey design was based on preliminary estimates of the extent of wetlands in every state. • Wetlands may represent indirect ecosystem effects, and they often respond non-linearly to stressors. EPA should acknowledge that not all wetlands process nutrients and pollutants similarly. • NWI revises its count of wetlands every 5 years, not every 10 years.

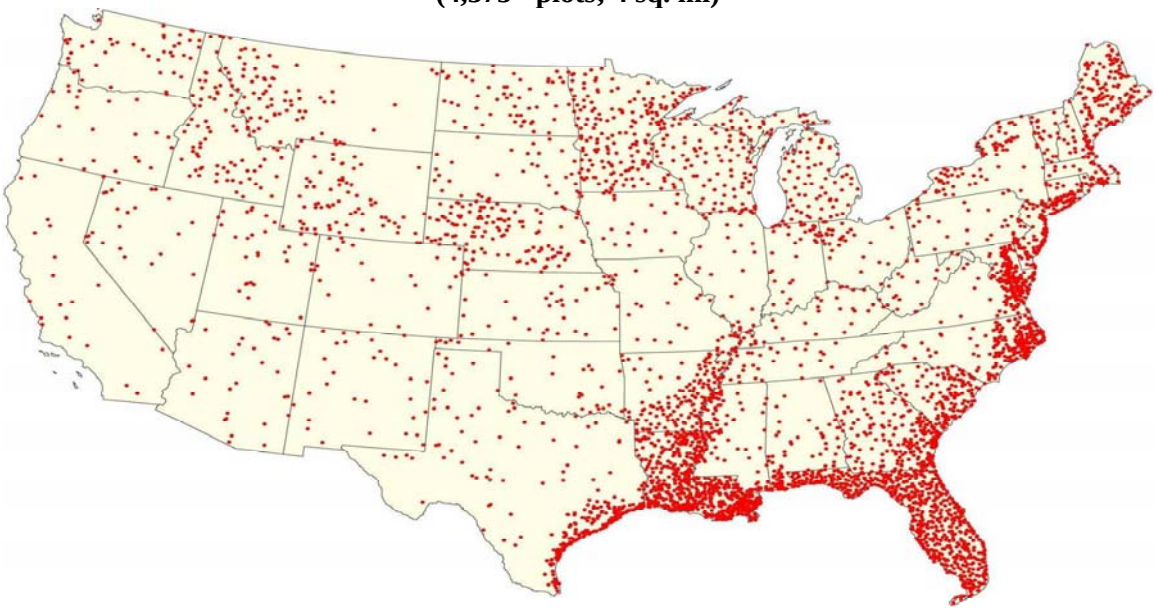
The water indicators peer reviewers agreed that this indicator, *Wetland Extent, Change, and Sources of Change*, should be included in the ROE 2006 even if all of the suggested modifications cannot be made. The reviewers noted that the NWI revises its count of wetlands every five years, and a new round of data for the most recent five years should be available in the near future. In addition, updated procedures used to detect changes in wetland extent do not affect the statistical validity of the indicator. NWI personnel did not adjust wetland boundaries as the result of new technologies unless there was compelling evidence that the extent of the wetland had changed.

The reviewers advocated for the revision of Figure 020-4, which presents sources of wetland change in various regions of the U.S. At the very least, EPA should define the terms used in the figure and should

strive to present regional data consistently across indicators. The reviewers agreed on the importance of presenting the pressures contributing to wetland changes, but they felt that the information presented in the figure does meet the criteria of an indicator. In addition, the source of change determination seems subjective, is only available for recent time periods, and is not adequate to show trends. It was suggested that NWI data be used (rather than the National Resources Inventory data) to indirectly measure the cause of change and present trends over time.

The reviewers recommended that EPA include a better depiction of the locations represented in the NWI dataset. EPA could include a figure like the one below to show the locations of NWI sample plots across the U.S. This figure presents data from the year 2000; EPA should include NWI plots for the most recent dataset used to calculate the indicator.

National Sample Plots
(4,375+ plots; 4 sq. mi)



Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: High)
Critical modifications	None.
Suggested modifications	• The reviewers encourage EPA to consult with other federal agencies to expand the NWI to Alaska and Hawaii in the future.
Other comments	• Although there are limitations to the NWI methodology (as noted in the writeup), this is a critical indicator.

The reviewers agreed that while there are limitations to the indicator's methodology and spatial extent (i.e., no data from Alaska and Hawaii), the limitations are adequately documented and the indicator is certainly an important one to include in ROE. Individual comments reflected the consensus statements listed above.

2.3.3.2 Coastal Habitat Index

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Do not include as a separate indicator.**
Critical modifications	• Include the index score as part of the *Coastal Condition Index* indicator but not as a separate indicator. • Present the dataset for this indicator in conjunction with the NWI data in the indicator for *Wetland Extent, Change, and Sources of Change*.
Suggested modifications	• Rename this dataset more appropriately, such as "annual coastal wetland loss."
Other comments	None.

The water indicators peer reviewers agreed that this indicator, *Coastal Habitat Index*, should **not** be included in the ROE 2006 **unless the critical modifications can be made**. The reviewers had a difficult time distinguishing this indicator from the *Wetland Extent, Change, and Sources of Change* indicator and felt that EPA did not justify the inclusion of the coastal wetland data as a separate indicator. They concluded that this indicator was duplicative and should not appear on its own.

The reviewers agreed that representing coastal wetland change was appropriate but did not advocate calculating a coastal habitat index from the data and including the index as a separate indicator. Instead, they recommended that EPA use the index to calculate the *Coastal Condition Index* and move the coastal wetland data to the *Wetland Extent, Change, and Sources of Change* indicator. The two datasets (i.e., coastal wetland data and NWI data) should not be combined, however; the coastal wetland data should be shown in conjunction with, but separate from, the NWI data. The coastal wetland data should be represented as extent or percentage loss or gain rather than being aggregated into an index. The reviewers

acknowledged that historical data for coastal wetland extent and condition are not available at this time to show a trend.

The reviewers commented generally about all of the indices in the report. They agreed that presenting the data themselves is more effective than calculating an index, at least for the technical document. For the public report, however, indices may be more appropriate. If EPA decides to continue using indices in the ROE 2006, the reviewers recommended that EPA strive to calculate all indices using consistent approaches; the *Coastal Condition Index* was not calculated or presented using the same methodology as the other indices. Furthermore, EPA should provide enough information in the indicator text to allow for the recalculation of the index if desired. This especially applies to the scores given to the Great Lakes region, which were not explained or justified.

The reviewers also made the following general comments that apply to all of the indices:

- EPA must define what is meant by "coastal" or "near coastal" and apply this term consistently.
- EPA should be consistent in how it calculates the four different indices (the *Coastal Sediment Quality Index* should be excluded from the report at this time). The technical document should include sufficient information to recalculate the indices without consulting the original data reports.
- Data for the Great Lakes should be presented separately because different datasets were used to calculate an index for this region. EPA should explicitly describe how scores were calculated for the Great Lakes.
- EPA must weigh the trade-off between presenting the more technically defensible data versus aggregated indices when it is communicating to the public. The technical document could focus on the technical data, and the public report could use indices for ease of communication.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: High)
Critical modifications	• Change the title to "Coastal Wetland Index" to more accurately reflect indicator content/focus. Note that coastal areas include more than just wetlands. This indicator characterizes *wetlands*, not *habitats*. • The baseline period (1780-1990) is inappropriate for the West Coast, which was not developed until after 1850. Adjust the baseline accordingly.
Suggested modifications	• As written, this index is very difficult to understand, and a less technical audience may have additional difficulty. The inverse relationship between condition and overall index is particularly confusing. The use of this index may be worth revisiting. • Instead of the current metric, consider simply reporting the decadal loss rate (e.g., by region and/or on a map). • The reviewers encourage EPA to consult with other federal agencies to expand the NWI to Alaska and Hawaii in the future. • Correct the typo in footnote b (*areally*, not *aerially*).

In their individual comments, reviewers expanded upon several of the modifications recommended above. Regarding the indicator title, one reviewer emphasized that the indicator should not be considered a habitat characterization unless the index explicitly identifies target species. Otherwise, the indicator is more accurately a "coastal wetland" characterization.

Several reviewers found parts of the indicator presentation to be confusing, and warned that it could seem even more confusing to a less technical audience. For example, one reviewer noted that there is an inverse relationship between the condition score and the score on the overall index, which may cause confusion. Others wondered why the indicator does not just report numerical values of the index, noting that much of the confusion comes from converting a composite score into another score, etc. Another reviewer noted that numerical values would still allow the indicator to be normalized across regions, which is important given that reference conditions vary by region.

Finally, one reviewer expressed concern that the Great Lakes are given a partial score, without the same treatment received by the nation's other (ocean) coastal systems.

2.3.4 COASTAL WATERS

2.3.4.1 Coastal Condition Index

Reviewed by the Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	• Exclude the *Coastal Sediment Quality Index* from the calculation of the *Coastal Condition Index* at this time. • Include the calculation of the *Coastal Habitat Index* in this section rather than as a separate indicator.
Suggested modifications	• Distinguish the Great Lakes score from the other regional scores, and fully explain the rationale used to develop this score. • Evaluate whether this indicator should be presented as an effects indicator or "hyper-indicator," since it aggregates several different categories of indicators. • Develop a conceptual diagram and a more effective means for communicating the different factors that contribute to this indicator. Refer to the two figures below for examples. • Assess other coastal habitat types (e.g., mudflats) in future ROEs. The conditions of other communities (e.g., fish or shellfish) also should be considered for inclusion in this index.
Other comments	• This indicator does not add value to the technical document, but it may be helpful to communicate overall coastal condition in the public report. • This indicator could highlight how the contributing indices agree or disagree and may point to the causes of any observed discrepancies for a particular region. • It may not be logical to calculate the *Coastal Condition Index* by aggregating ambient, exposures, and effects indicators.

The water indicators peer reviewers agreed that this indicator, *Coastal Condition Index*, should **not** be included in the ROE 2006 **unless the critical modifications can be made**. The reviewers acknowledged the usefulness of this indicator because it provides an overall assessment of coastal conditions in various regions across the country. However, they recommended several major modifications if the index is to be presented in the ROE 2006.

The two critical modifications were captured during discussion of the *Coastal Habitat Index* and the *Coastal Sediment Quality Index*. First, the reviewers reiterated that EPA should continue to include the *Coastal Habitat Index* in the calculation of the *Coastal Condition Index* but should not include the *Coastal Habitat Index* as a separate indicator. Second, they emphasized that EPA should exclude the *Coastal Sediment Quality Index* from the calculation of the *Coastal Condition Index*, at least until a more appropriate sediment indicator is developed.

As with the other coastal indices, the reviewers recommended that EPA include additional details on the methodology used to calculate the scores and, in particular, how it calculated the score for the Great Lakes region. Because a different dataset was used to calculate the score for the Great Lakes, the score should be fully justified and distinguished from the other regional scores.

The reviewers commented that this indicator has the potential to evaluate the extent of agreement or disagreement among the regional scores calculated for each of the contributing indices. The *Coastal Condition Index* aggregates these scores into one comprehensive assessment of coastal conditions, and shows whether and why a mismatch might exist among the different scores for a particular region. While this "umbrella" index can provide a general sense of coastal conditions, the reviewers noted that it cannot demonstrate trends in its current form.

The reviewers pointed out that it might be appropriate to present this indicator as an effects indicator or "hyper-indicator," since it aggregates several different categories of indicators. In addition, the reviewers suggested that EPA include additional indices to calculate *Coastal Condition Index* scores in future versions of the ROE 2006. Different coastal habitats besides wetlands could be represented (e.g., mudflats), and an assessment of other large species (e.g., fish or shellfish) also could be included. One reviewer also questioned the validity of using ambient (sediment quality, water quality, coastal habitat), exposures (fish tissue contaminants), and effects (benthic) indicators to calculate the *Coastal Condition Index*.

The reviewers proposed that this indicator would benefit from a conceptual diagram and a more effective means for communicating the different regional scores that contribute to this indicator. The reviewers offered the two figures below as examples. Figure 2-1 from the *National Coastal Condition Report* is an example of how EPA could present this indicator as an aggregate of other indicators. Figure 1-4, also from the *National Coastal Condition Report*, could be adapted and included with this indicator to show how stressors, ambient conditions, exposures, and effects are connected. Freshwater inflow, groundwater discharge, and deposition from the air should be added to the figure.

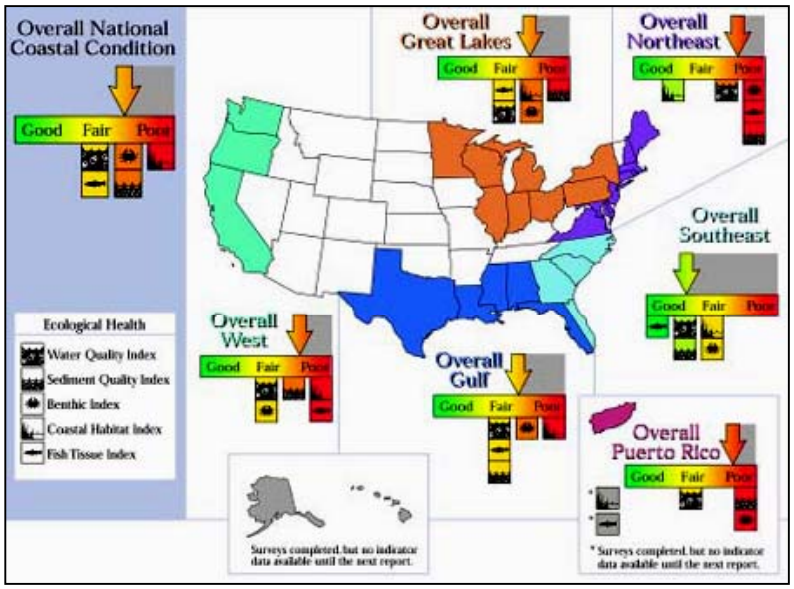


Figure 2-1. Overall national and regional coastal condition between 1997 and 2000.

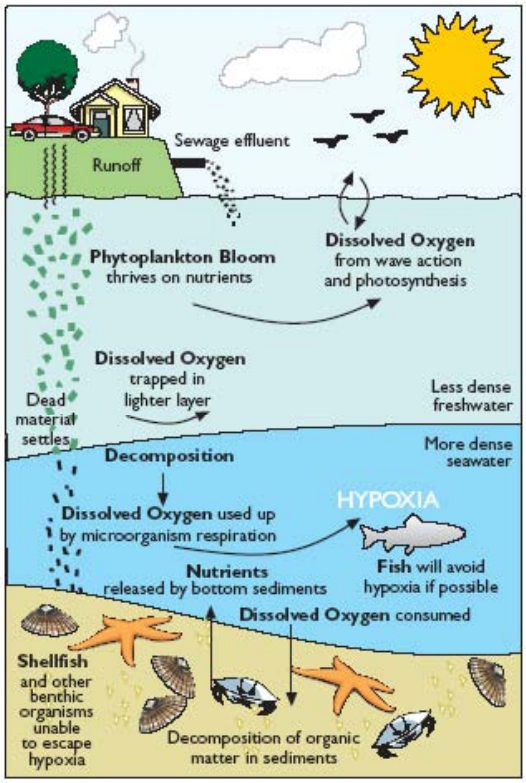


Figure 1-4. Eutrophication can occur when the concentration of available nutrients increases beyond normal levels.

2.3.4.2 Coastal Water Quality Index

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	• Incorporate a factor in this index to reflect physical drivers that affect the system (i.e., freshwater discharge/residence time). • Include total nutrients in the indicator, not merely the dissolved species. • Present the score for the Great Lakes separately and fully explain the methodology used to calculate the score.
Suggested modifications	• Pesticides and heavy metals are not represented if the *Coastal Sediment Quality Index* is removed from the report; therefore, EPA should consider including pesticide and heavy metal data in its calculation of this index. • Develop other associated stressor and biological effects indicators to accompany this indicator. • Caveat the data by cautioning against drawing broad conclusions from spatially specific, short-term data. • Identify and describe the deficiencies and gaps of the data included in the index. • Revise Figure 332-2 so that all of the pie charts are the same size.
Other comments	None.

The water indicators peer reviewers agreed that this indicator, *Coastal Water Quality Index*, should be included in the ROE 2006 even if all of the critical and suggested modifications cannot be made. However, EPA should **place high priority on the critical modifications** included in the table above.

For the first critical modification, the reviewers proposed that this index should incorporate an ecosystem specificity factor to represent physical drivers that affect the system. This factor should reflect freshwater discharge/residence time and would provide context for this indicator. The reviewers also suggested that EPA consider how to account for episodic events that affect water quality. EPA could improve the indicator further by describing the stressors and effects that relate to coastal water quality.

Next, the reviewers urged EPA to consider total nutrients, not merely dissolved species, in its calculation of this index. In systems with long residence times, different chemical forms of the nutrients are recycled and retained; therefore, they should be accounted for in the index.

The last critical modification suggested by the reviewers stemmed from the observation that the dataset used to calculate the score for the Great Lakes represents open water conditions, while scores for other areas of the country reflect coastal conditions. Consequently, EPA should either exclude the Great Lakes score or present the score separately from the other regional scores. Furthermore, EPA should fully explain how the score for the Great Lakes region was calculated and should provide a clear definition for

"coastal." On the whole, the reviewers stated that the methodology used to calculate scores for this index should be applied consistently across regions (this was not the case for dissolved oxygen).

Aside from the critical modifications, the reviewers cautioned that if the *Coastal Sediment Quality Index* is excluded from the calculation of the *Coastal Condition Index*, then pesticides and heavy metals would not be represented. Therefore, EPA should consider including pesticide and heavy metal data in its calculation of the *Coastal Water Quality Index*. The reviewers also suggested that EPA should appropriately caveat this indicator to prevent readers from drawing broad conclusions where they are not supported with significant trends data.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: High)
Critical modifications	• This indicator needs to be better presented. The nature of the analyses and summary needs to be more explicitly described. (See individual suggestions below.) • Clarify what is meant by regional reference conditions. • In Figure 2, make sure the color scheme is consistent across the five pie charts, and explain what it means. Consider replacing *less than*/*greater than* with *worse than*/*better than*.
Suggested modifications	• Present more of the regional data (i.e., reference conditions, regional exceedances), perhaps in the form of a table. • Graphics note: make the pie charts in Figure 2 the same size or, if there is a reason why they should remain different sizes, explain it. • Correct the typo in the footnote to Figure 1 (*areally*, not *aerially*).

Individual reviewers elaborated on a number of problems with the way the indicator is presented (see the critical modifications above). Comments and suggestions included the following:

- Like the *Coastal Benthic Index,* the indicator brings a lot of different measures together into a single score, which may be too aggregated to provide much meaningful information. In particular, the mix of chemical and biological components means that regions can get the same score for many different reasons. However, another reviewer emphasized that it is fine to have a multivariate index, as long as its derivation is consistent.
- Figure 2 is more informative than Figure 1, for reasons including those outlined in the previous comment.
- "Lumping" of regions is also a problem in Figure 2 because it can lead to misimpressions. It might be better to present tables with regional data, perhaps as an addition to the current Figure 2 (and perhaps in place of Figure 1). This approach would stay closer to the original data.
- In the pie charts, the indicator should be clearer about whether it is good/bad to be more/less than the reference condition. In the current presentation, this is not immediately clear.

- It is unclear whether water clarity is measured in terms of depth. In any case, the meaning of measurements like these must be clarified.

One reviewer also noted a limitation to the proposed indicator: that its "low" and "high" categories do not necessarily reflect the range of historical variation. Nonetheless, several reviewers expressed hope that the indicator can be improved to the point where it can be included in ROE, because as one reviewer noted, it is important for ROE to address coastal quality.

2.3.4.3 Coastal Sediment Quality Index

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Do not include.**
Critical modifications	None.
Suggested modifications	• Include a placeholder in the ROE 2006 for a sediment quality indicator, but do not present this index.
Other comments	• There are fundamental problems inherent in aggregating sediment toxicity, sediment contaminant concentrations, and TOC. • The sediment quality guidelines used are more effective as screening tools and do not necessarily relate to biological effects. • Toxicity tests are not always reliable, and the indicator does not include any microbial or plant toxicity tests.

The water indicators peer reviewers agreed that this indicator, *Coastal Sediment Quality Index*, should **not** be included in the ROE 2006. They agreed that a measure of coastal sediment quality is an important indicator, but the data presented are not appropriate. There are fundamental problems inherent in aggregating sediment toxicity, sediment contaminant concentrations, and TOC. For these reasons, EPA should include a placeholder in the ROE 2006 for a sediment quality indicator, but it should not present this index.

The sediment quality guideline exceedances may not correlate with biological exposures or effects and are typically only applied at the screening level. Furthermore, sediment toxicity tests are not always reliable, and the organisms used in these tests do not apply to all ecosystems. A lack of microbial and plant toxicity tests also weakens this indicator.

The reviewers concluded that although it is too early to include this indicator, EPA should continue to investigate methods for measuring and comparing sediment quality. Currently, a strong conceptual model for associating sediment contamination levels with a biological response is not available. While the index does show that the majority of sediments do not present an environmental problem, it does not rise to the level of a national indicator at present.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Do not include.** (Rank: NA)
Reasons for exclusion	• Indicator is difficult to understand. • Indicator would require many major changes. These include (but are not limited to): o This indicator needs to be better presented. Like the *Coastal Benthic Index* and the *Coastal Water Quality Index*, the nature of the analyses and summary needs to be more explicitly described. o Eliminate Figure 1. o Eliminate TOC from Figure 2. Include text to explain the impact of TOC on the bioavailability of contaminants. o Present graphics for toxicity and contaminants, and include text to explain possible reasons why the two are not exactly equivalent (e.g., indicate that contaminants are not necessarily toxic). o In Figure 2, correct the color scheme, which is inconsistent among the different pie charts. o If toxicity is included in Figure 2, consider improved definitions for toxicity (e.g., "not statistically different from reference condition," "low toxicity," and "high toxicity"). o Present regional information.
Suggested alternatives	• Explore ways to develop a better indicator of coastal sediment contamination, as there is still a need for such an indicator.

Although at least one reviewer emphasized that ROE should ideally include an indicator describing coastal sediment contamination, all four reviewers agreed that the proposed indicator has too many shortcomings to be fixable.

Several reviewers commented on the relationships among TOC, contamination, and toxicity. One reviewer explained that there are important distinctions between toxicity and contamination, and that it would be best to present both. Meanwhile, as several reviewers noted, TOC is a less important chemical attribute for ecosystems, and a snapshot of TOC does not always correlate with toxicity in a consistent way. Thus, it may not be necessary to include TOC.

Another area of concern was the selection of 20% as a threshold for "toxicity." One reviewer noted that 20% may be beyond typical amphipod acceptance levels, as control acceptances are typically closer to 5-10%. Another reviewer suggested that it would be helpful if the ">20%" category actually indicated how far above 20% a given sample was. With this comment in mind, one reviewer suggested that it might be better to have three categories for toxicity: *not toxic*, *low toxicity*, and *high toxicity*.

Still, despite providing many suggestions, the reviewers emphasized that they do not feel it would be practical to try to make all the changes that would be needed to include this indicator in ROE.

2.3.4.4 Coastal Benthic Index

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	None.
Suggested modifications	• Revise the indicator text to include more detail on the methodology used to calculate the scores for each region. • Acknowledge that episodic effects, climatic perturbations, and other disturbances such as trawling, could significantly impact benthic populations. • To the extent possible, be consistent when calculating the index across regions. • Exercise caution when extrapolating across broad regions based on a relatively few number of samples collected at a limited number of locations or over a short time period (e.g., on the West Coast).
Other comments	None.

The water indicators peer reviewers agreed that this indicator, *Coastal Benthic Index*, should be included in the ROE 2006 even if all of the suggested modifications cannot be made. As with the other coastal indices, the reviewers felt that the indicator text should include more detail on how the scores were developed so that the reader does not need to consult the original data reports in order to understand the underlying datasets. Similarly, the reviewers criticized that the indicator text did not sufficiently explain or rationalize the Great Lakes score. They recommended that EPA present the Great Lakes score separately from the other regions, since a different dataset and methodology were used to calculate this score and include an adequate discussion of how the scores were calculated.

One major issue discussed hinged on the ability of this indicator to show spatial and temporal trends. The reviewers found it difficult to determine whether or how episodic effects and climatic perturbations were reflected in the regional scores. These types of fluctuations, along with other disturbances such as trawling, can significantly impact benthic populations, and the reviewers encouraged EPA to acknowledge these other factors and reflect them in the calculated scores.

The reviewers characterized this indicator as a “coarse-grained” approach, meaning that the index would capture large changes or trends but would miss slight differences between regions or unique localized conditions. Furthermore, the indicator would not provide insight into the causes of any observed trends or changes. For ease of comparison between regions, the reviewers suggested that to the extent possible, EPA should be consistent when calculating the scores (the West Coast score was calculated differently from other regions). New research may allow for more consistent calculation methods.

Finally, the reviewers cautioned EPA against extrapolating across broad regions based on a relatively few number of samples collected at a limited number of locations or over a short time period (e.g., on the West Coast).

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: Medium)
Critical modifications	• The index is a potentially useful indicator. However, it needs to be better presented. The nature of the analyses and summary needs to be more explicitly described. (See individual suggestions below.) • The use of regional information to set thresholds needs to be more explicitly described. The indicator does not describe how "professional judgment" was applied in deriving the condition scores across regions. • Make sure terminology is consistent between the text and the graphics. • Fix typos: o footnote to Figure 1: *aerially* → *areally* o paragraph 3 of writeup: *sediment* → *benthic*

Several individual comments focused on the first critical modification above: the need to improve the indicator presentation. One reviewer observed that there is some ambiguity in the way the index is formulated, without a clear explanation of what the categories represent (low, high, etc.). Another reviewer suggested that the high/medium/low and 1/3/5 scores might also be too simplistic, and that the indicator might lose useful information by trying too hard to aggregate data. In their discussion, reviewers also noted that the condition scores of 2 and 4 are not clearly defined in the text.

The reviewers also pointed out some inconsistencies between the text and the graphics, which they felt should be resolved. One reviewer noted that the text does not use the term "condition score," which makes it hard to understand how the 1/3/5 scores were derived. A reviewer also noted that the scoring criteria are complex and not immediately apparent from the graph – and that it is hard to understand why Region 3 earns a low condition score while it also scores 72% in the "high" category, for example.

On a related note, one reviewer noted that the indicator is inconsistent in its treatment of the Great Lakes. While data are "unavailable" on the high/medium/low scale, the region somehow earns a condition score of 2. Another reviewer expressed concern that the Great Lakes are compared with other regions and combined into the total score even though they apparently reflect a different survey methodology.

Individual reviewers also suggested several ways the indicator presentation could be improved. One reviewer suggested a more spatially explicit presentation (e.g., a map), while another added that because the sampling program ensures at least 50 samples per state, the results could be broken out on a map using colored bands along each state's coastline. However, as another reviewer noted, a map could not show condition scores at a higher resolution because the exact location of the samples is not known. One reviewer suggested that it might be useful just to display the high/medium/low graphic as a bar graph showing the percentage in each category, and not to bother distilling these scores into the condition score, which is confusing.

Several reviewers discussed limitations to the indicator, including the fact that it is aggregated by region, so the index cannot convey any information about different estuaries within a given region. One reviewer noted that the index is somewhat subjective because it is adjusted differently for each region, although

this is appropriate because each region does have different baseline conditions. Further, while the indicator currently provides only a snapshot, it is a useful and scientifically credible indicator that measures an important property.

One reviewer suggested that estuarine EMAP data would also be interesting to see as an indicator.

2.3.4.5 Extent of Hypoxia in Gulf of Mexico and Long Island Sound

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	• Include additional regional indicators to bolster hypoxia as an important multi-regional indicator of ecological condition.
Suggested modifications	• Link or associate this indicator with the physical and chemical characteristics of the system. • Clearly define hypoxia with respect to dissolved oxygen levels, and apply this definition consistently across regional datasets. • Revise the figures to reflect the timing, extent, and target populations of the surveys. • Present this indicator as an ambient indicator rather than an effects indicator.
Other comments	• Other pressures or ambient indicators could be linked to the hypoxia indicator, such as nutrient loads and freshwater discharge.

The water indicators peer reviewers agreed that this indicator, *Extent of Hypoxia in the Gulf of Mexico and Long Island Sound*, should be included in the ROE 2006 even if all of the critical and suggested modifications cannot be made. However, EPA should **place high priority on the critical modifications** included in the table above. Overall, the reviewers agreed that hypoxia is an important indicator that eventually could be scaled from the regional to the national level.

The majority of the reviewers' discussion focused on the need to include better regional datasets to emphasize the importance of hypoxia as a multi-regional indicator of ecological condition. The reviewers commented that the two regional datasets presented do not represent well-established linkages between anthropogenic stressors and hypoxia. In addition, sampling in the Gulf of Mexico is complicated by logistical issues, which often limit monitoring efforts to small, short surveys. Therefore, EPA should include data from other consistently well monitored systems such as the following: Central Lake Erie, Chesapeake Bay, Hudson River/Bight, Chesapeake Bay and tributaries, Albemarle-Pamlico Sound, Mobile Bay, Apalachicola Bay, Texas bays, South San Francisco Bay, and Puget Sound.

The reviewers observed that this indicator is limited by the location of where hypoxia can occur, much like the indicator for *Lake and Stream Acidity*. In order to have the potential for hypoxia, a body of water must have physical characteristics allowing for stratification. EPA should strive to link this indicator with

nutrient loading, trophic state, and physical characteristics of the system in order to discern between natural and anthropogenic stressors.

The reviewers also expressed concern over the effectiveness of the figures. They observed that the figures are not consistent across the two regions, and the target populations are ill-defined. The reviewers suggested that the figures be revised to reflect the timing and extent of the surveys, as hypoxia is a dynamic state that cannot necessarily be captured accurately with infrequent or inconsistent monitoring.

The reviewers recommended that EPA clearly define "hypoxia" and also advocated that this definition be applied consistently across different regions. Furthermore, this indicator should be presented as an ambient indicator rather than an effects indicator; the effects related to hypoxia are seen in biotic responses in the system.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: High)
Critical modifications	• Explain why Long Island Sound and the Gulf of Mexico use different thresholds for hypoxia. • Explain other differences between the two approaches, noting that these are two separate regional pilots with different sampling protocols. • Modify the graphical presentation: o Label the y-axis in Figure 1. o Provide comparable graphics for each region. o Trend lines in Figure 3 may be misleading. Eliminate trend lines or perform a more thorough statistical analysis of possible trends.
Suggested modifications	• Extend the indicator to include other regions/systems/seasons.

In their individual comments, reviewers agreed that the text needs to explain that the indicator is actually two separate regional pilots, each with a different approach and a different set of graphics. Several reviewers also expressed concern that the indicator uses two different thresholds to define hypoxia—one for the Gulf of Mexico and one for Long Island Sound. One reviewer noted that there is a single national standard of 2 mg/L. However, when questioned by the reviewers, EPA explained that some members of the Science Advisory Board believe the threshold varies because fauna in different regions are adapted to different levels of dissolved oxygen (DO)—in part because of the relationship between DO and temperature.

One reviewer expressed concern over the Gulf of Mexico map, noting that the only reason the yellow hypoxic zone does not extend closer to shore appears to be the lack of samples between the shore and the supposed edge of the hypoxic zone. Reviewers also noted other problems with the graphics, many of which are listed above under "critical modifications." Regarding Figure 3, one reviewer observed that the figure seems "busy," and wondered whether the trendline is really important. Another added that the trendline may not be meaningful without more statistical information, noting that it is not clear what

"linear" really means in this case. A reviewer also recommended that the two sets of figures be made to look more compatible, even though they come from two different studies.

Other comments reflected the reviewers' interest in extending this regional pilot to be a national indicator in the future. One reviewer mentioned having seen maps of hypoxia across the U.S., but was not sure how systematic the analyses were. This reviewer emphasized the need for a standardized metric. Another reviewer raised concerns about the seasonal variability of hypoxia, noting that some lake hypoxia events in the Northern U.S. occur in winter, while the present indicator focuses only on summer. Several reviewers pointed out that the Gulf of Mexico portion of the indicator is only a snapshot, while the Long Island Sound portion includes multiple samples and can therefore reflect the duration of hypoxic events.

One reviewer mentioned that it would be interesting to look at the effects of hypoxic events on fishing, although others noted that there are many variables that affect fish catch.

2.3.4.6 Harmful Algal Bloom Outbreaks

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	• Include data for estuarine and riverine systems where HABs can be attributed to anthropogenic or other stressors rather than physical forcing mechanisms that tend to control red tides. • Acknowledge that any trends observed in HABs depend on the number, frequency, and timing of sampling efforts because the blooms are episodic events.
Suggested modifications	None.
Other comments	None.

The water indicators peer reviewers agreed that this indicator, *Harmful Algal Bloom Outbreaks*, should **not** be included in the ROE 2006 **unless the critical modification can be made.** The reviewers agreed that HABs are an important indicator of ecological health and potentially could be scaled to the national level in the future. The indicator also could be linked to other indicators like hypoxia, nutrient loadings, and pigments (chlorophyll). Despite the importance of HABs, the reviewers expressed that the Gulf of Mexico was not the most appropriate example of this indicator.

The reviewers contended that HABs in the Gulf of Mexico are not the best case study for linking anthropogenic and other drivers to ambient indicators. While highly visible, these red tides are not clearly linked to anthropogenic stressors and instead are largely the products of physical circulation concentration mechanisms. EPA should include more appropriate regional indicators for HABs in freshwater rivers and estuaries, such as blooms in the Chesapeake Bay, Albemarle-Pamlico Sound, San Francisco Bay, Long Island Sound, and inland waters. Blue-green algae (cyanobacterial) blooms in freshwater and some brackish systems can be linked to nutrient loading and have been mitigated by reducing nutrient inputs.

The reviewers questioned the statistical validity of the indicator dataset as well. They observed that any trends revealed might be relative to the sampling effort rather than a reflection of changes in the frequency or severity of HABs. The indicator text does not specify whether different monitoring episodes covered a consistent area, nor does it define "near shore."

One reviewer noted that although this indicator has several shortfalls, it represents a strong effort to merge varied datasets and monitoring regimes. This type of technique could be used to scale the indicator up to the national level in the future.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Do not include.** (Rank: NA)
Reasons for exclusion	• Though this is an important phenomenon, the present indicator is deficient in that standardized methods are not employed across the Gulf States Region, and the spatial distribution of the event is not charted. EPA and perhaps CDC should be working with the States to standardize sampling and reporting methods in order to improve the charting of this class of environmental problem. • The interpretation of harmful outbreaks is somewhat vague. These events are undesirable, but their link directly to environmental degradation or undesirable change is questionable. The patterns shown in the graphics may be fully in balance with historical patterns both temporally and geographically. The indicator does not reveal whether outbreaks are indicators of pollution, species change, or any other altered ecological condition other than algal growth. • The period of record is relatively short, and the local spatial dynamics of HABs occur on a comparatively short time scale. These factors reduce the usefulness of this indicator for the ROE.

As reflected in the consensus statements above, the reviewers agreed that the proposed indicator is inadequate in its spatial and temporal coverage. Several reviewers emphasized that HABs can occur for many reasons, and one noted that the species covered by this indicator—*K. brevis*—is an offshore species whose prevalence reflects open ocean conditions more than human influences.

2.3.4.7 Chesapeake Bay Blue Crabs: Mature Females—Spawning Stock Abundance

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Do not include.**
Critical modifications	None.
Suggested modifications	None.
Other comments	• EPA did not justify choosing this dataset as an aggregate indicator for the Chesapeake Bay; there are better regional examples of this type of indicator. • It is difficult to associate this indicator with specific ambient conditions and stressors. • Figure 320R-1 does not illustrate any trends and is not an effective means of communicating this indicator.

The water indicators peer reviewers agreed that this indicator, *Chesapeake Bay Blue Crabs: Mature Females – Spawning Stock Abundance*, should **not** be included in the ROE 2006. The reviewers agreed that this indicator may be an adequate aggregate indicator for the Chesapeake Bay, but EPA did not make a compelling case for the inclusion of this indicator in the ROE 2006. The reviewers found it difficult to associate this indicator with specific ambient conditions and stressors and suggested that if relationships to stressors are available, then EPA should present them to justify the inclusion of this indicator. If this justification is available and presented, this indicator may be appropriate to include.

The reviewers offered several better regional examples for population or community level indicators. A suite of indicators is available for the Great Lakes, San Francisco Bay, and other regions. Fish abundance for some systems may be a better example of a regional indicator (e.g., delta smelt in the San Francisco Bay). The reviewers suggested that in future ROEs, EPA should include other appropriate examples from different regions of the country and clearly caveat this indicator as a regional indicator. They noted that this indicator could potentially be aggregated across the nation if population trends for indicator species from a variety of regions are statistically analyzed.

The reviewers criticized Figure 320R-1, which they felt does not illustrate any trends and is not an effective means of communicating this indicator. Furthermore, the vertical axis is not adequately defined.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Do not include.** (Rank: NA)
Reasons for exclusion	• The causes for the changes in crab abundance include human harvest as well as environmental change. Interpretation of these trends would face the same challenge as any other commercial species abundance trend.
Other comments	• Many other species have longer records and have more well-established assessment techniques (e.g., coho salmon, Chinook salmon, Atlantic salmon, sockeye, cod, halibut, and others). Several of these species on the East Coast (e.g., cod, lobster) would show different trends.

The reviewers' individual comments largely reflect the consensus statements above. For example, one reviewer noted that like any commercial fishery species, the blue crab population is driven by both harvesting and ecological conditions. Although one reviewer noted that harvesting is really a form of human impact on the environment—i.e., just another stressor—another reviewer suggested that the numbers are meaningless with respect to environmental condition because they are so closely tied to administrative controls.

Individual reviewers noted several other problems with the indicator, including the fact that the data are noisy, and this one species does not necessarily reflect trends in other fishery species. One reviewer suggested that blue crab harvest might be a more useful indicator, although another reviewer noted that indices of catch per unit effort could be biased toward areas of greater abundance, since those are where people generally choose to fish.

2.3.4.8 Submerged Aquatic Vegetation in Chesapeake Bay

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	None.
Suggested modifications	• Explain the crosshatched area on Figure 317R-1. • Expand this indicator to other regions where possible (e.g., Hawaii, Florida, San Francisco Bay, Puget Sound, Mobile Bay, Gulf of Mexico bays and estuaries, Mid-Atlantic, and Northeast). • If other regions cannot be represented in the 2006 ROE, the indicator text should be clearer about its status as a regional indicator and explain that there are other appropriate regional indicators. • The importance of this indicator is understated and should be better emphasized. It can be applied to a variety of locations and ecosystem types and is useful to reflect habitat condition and change.
Other comments	None.

The water indicators peer reviewers agreed that this indicator, *Submerged Aquatic Vegetation in Chesapeake Bay*, should be included in the ROE 2006 even if all of the suggested modifications cannot be made. Overall, they strongly supported including this indictor in the ROE 2006 and emphasized its importance due to its applicability to multiple regions of the U.S. and because it is an indicator of habitat condition changes. The reviewers encouraged EPA to expand this indicator to other regions and apply it to a variety of ecosystems, including estuarine, sea grass, coastal, and freshwater systems.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: LOW)
Critical modifications	None.
Suggested modifications	• It would be interesting to know if any data/descriptive sources are available to characterize the spatial extent of SAV prior to 1930-1950. • It would be interesting to explore whether patterns in species composition can be determined. • In the future, explore how an indicator of SAV can be expanded to other regions. Look for data from other regions (e.g., Puget Sound, Florida Bay, or areas where SAV may be invasive).
Other comments	• Note that several pre-meeting comments were based on the assumption that the indicator should be national in scale.

Reviewers asked EPA about the cross-hatch pattern on some of the bars in the figure, noting that the figure has no legend and the patterns are not explained in the writeup. EPA clarified that the pattern reflects estimates; several reviewers agreed that this should be made clear in the graphic.

One reviewer pointed to a bigger question of interpretation—namely, what does SAV represent? Does it reflect natural processes? Storm events? Nutrient loading? Human activities? The reviewer suggested that if increases in SAV are indeed due to restoration, this should be made clear in the writeup.

Another reviewer suggested that it would be nice to expand this regional indicator to include other coastal areas, noting that Wayne Landis has already done some related work on herring populations at Cherry Point, Washington. Others suggested looking at SAV in Florida Bay or in places where SAV may be ecologically detrimental.

Although several reviewers noted that they were glad to see the indicator present a reference condition, one noted that it would also be interesting to see the variance within the reference period (1930s-1950s), since it spans several decades. A reviewer also expressed interest in the species composition of SAV.

2.3.5 DRINKING WATER

2.3.5.1 Population Served by Community Water Systems with No Reported Violations of Health-Based Standards

Reviewed by the Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	None.
Suggested modifications	• Explain the methods EPA will use to update this indicator as MCLs change over time. • Include a figure that presents violation trends by type of exceedance instead of grouping types of exceedances together, like Figure 049-3. • Consider deleting Figure 049-4 or including a similar figure for the entire U.S. population as well. • Re-scale the vertical axis of Figure 049-2 to 50-100; the data also could be presented as a table. • Present this indicator as an exposure indicator rather than an ambient indicator.
Other comments	None.

The water indicators peer reviewers agreed that this indicator, *Population Served by Community Water Systems that Meet All Standards*, should be included in the ROE 2006 even if all of the suggested modifications cannot be made. The reviewers observed that this indicator is slightly different from the other indicators, because it essentially represents the effectiveness of drinking water treatment rather than ambient conditions. Therefore, they recommended that EPA present this indicator as an exposure indicator rather than as an ambient indicator.

The reviewers emphasized that EPA must consider how it will update this indicator as MCLs change over time. If overall percentages continue to be presented for this indicator, then it will appear as though exposures have increased or that treatment effectiveness has declined when, in reality, this change is due to the introduction of a new MCL. This distinction could be made by showing MCL violation types as separate pieces of a pie chart or bar graph for each region of the U.S.

The reviewers recommended that EPA present more of the data available in the dataset by including a figure that shows violation trends by type of exceedance instead of grouping types of exceedances together. With respect to the existing figures, the reviewers suggested that EPA delete Figure 049-4 if the Agency is trying to reduce the number of indicators presented in the ROE 2006. If this figure remains in the report, however, then a similar figure should appear for the entire U.S. population, not just the tribal subset. In addition, the reviewers proposed that the vertical axis in Figure 049-02 be re-scaled to 50-100; alternatively, the data could be presented in tabular format.

2.3.6 CONSUMPTION OF FISH AND SHELLFISH

2.3.6.1 Coastal Fish Tissue Contaminants Index

Reviewed by the Water Group and the Ecological Condition Group (as a Referenced Indicator)

Water Group

Consensus Statements	
Overall recommendation	**Include with modifications.**
Critical modifications	None.
Suggested modifications	• Present contaminant concentrations, for PCB and mercury especially, rather than aggregating the data into an index. This will eliminate the issue with different assumptions in the index, like fish consumption rates. • Consider including examples from different regions or ecosystems (e.g., San Francisco Bay) in addition to overall, national data. • Explicitly state the assumptions made in developing the indicator (if it is to remain as an index), especially since fish consumption varies widely across the country. The calculations of scores should be consistent across various regions of the U.S. • Show trends data for the concentrations of contaminants. There exists a wealth of trend data for some contaminants, like PCB and mercury, that could easily be displayed to represent temporal trends. • Better represent freshwater data in this indicator. • If EPA includes Great Lakes data in this indicator, it should present the data separately because they originate from a different data source. • Consider whether the factor used to correct whole-body concentrations (3.0) is appropriate for mercury. In the Great Lakes fish, this is not an appropriate factor. Include textual information on emerging contaminants and provide examples (PDBEs).
Other comments	• Indicators for pressures, ambient conditions, and effects related to the accumulation of contaminants in fish tissue (especially for PCB and mercury) should be discussed and related to this indicator.

The water indicators peer reviewers agreed that this indicator, *Coastal Fish Tissue Contaminant Index*, should be included in the ROE 2006 even if all of the suggested modifications cannot be made. Rather than presenting the data as an index, however, the reviewers recommended that actual concentrations of the contaminants be presented over time. This would allow for a better trends analysis and would provide for consistent ratings across various regions of the U.S. Reviewers emphasized that data from the West Coast should be included in the indicator, and freshwater systems should be better represented. Datasets for the Great Lakes could be used to represent freshwater systems but should be presented separately since they originate from a different data source. Finally, the reviewers encouraged EPA to relate this indicator to other pressure, ambient, and effects indicators, especially for PCB and mercury, in order to

represent the full spectrum of environmental interactions and promote understanding of overall trends for these contaminants.

Ecological Condition Group

Consensus Statements	
Overall recommendation	**Include with modifications.** (Rank: MEDIUM)
Critical modifications	• Eliminate Fig. 1 and the "condition score." This is confusing. • Add a table of regional values for those chemicals which show >0 exceedances in Figure 2 (e.g., Hg, PCBs, PAHs, DDT). • Data are currently presented in the context of human health factors. Unless the presentation can be changed to include comparable wildlife benchmark values, the indicator is too constrained to help us answer this question of biomeasures of exposure. **If this modification is not made, the indicator can still be presented in ROE (assuming the previous two modifications are made), but should not be discussed in the Eco chapter.**
Suggested modifications	• Continue to explore opportunities to include Great Lakes data.

In their individual comments, reviewers echoed many of their thoughts on the suite of indicators derived from the Coastal Condition Report. In particular, several reviewers agreed that the "condition score" is a confusing and unnecessary step, as it produces an index that is too far removed from the original data to be of any real value as an indicator. In this case, reviewers agreed that Figure 1 should be eliminated entirely. For more of the Ecological Condition reviewers' comments on Coastal Condition Report indicators, see discussion under the Coastal Habitat Index, Coastal Benthic Index and Coastal Water Quality Index indicators.

In addition to removing Figure 1, reviewers suggested modifying Figure 2 to include regional data. Several reviewers suggested adding regional tables for clarity, at least for the few chemicals that show exceedances. Another reviewer suggested that it might be nice to plot exceedances on a map.

The reviewers' main concern with this indicator—at least in relation to its appearance in the Ecological Condition chapter—was that it does not provide an ecological context for the levels of contaminants measured in fish tissue. As one reviewer noted, ecological effects vary from chemical to chemical and do not always occur in parallel with human health effects. Thus, it would be wrong to try to infer information about ecological condition from a dataset that only looks at human health benchmarks. The reviewers agreed that this indicator should only be discussed in the Ecological Condition chapter if it can be modified to include comparable wildlife benchmark values, which have been derived for many of the chemicals on the list.

2.3.7 RESPONSE TO GENERAL QUESTIONS

2.3.7.1 General Question 1: Relative Value and Importance of Indicators

The table below summarizes the reviewers' consensus on the relative appropriateness, adequacy, and usefulness of the water indicators presented by EPA for inclusion in the ROE 2006. These comments

should not be interpreted as a prioritization of the importance of the indicator type; rather, they reflect the relative appropriateness, adequacy, and usefulness of the datasets chosen by EPA to represent each indicator.

Indicator No.	Indicator Name	Primary Data Source	Assessment of Appropriateness, Adequacy, and Usefulness
041	Lake and Stream Acidity	EPA 620/R-03/001	HIGH
040	Nitrate, Phosphorus, and Pesticides in Streams in Agricultural Watersheds	USGS	LOW TO MODERATE *(two reviewers said "LOW TO MODERATE"; two reviewers said "LOW")*
146	Nitrogen and Phosphorus Discharges from Large Rivers	USGS	MODERATE
033	Nitrates and Pesticides in Groundwater in Agricultural Watersheds	USGS	MODERATE
020	Wetland Extent, Change, and Sources of Change	NWI	HIGH
334	Coastal Habitat Index	NWI and EPA 620/R-03/002	HIGH *(if data are presented in combination with wetland extent and the index is included in the Coastal Condition Index)*
350	Coastal Condition Index	EPA 620/R-03/002	HIGH *(remove sediment index)*
332	Coastal Water Quality Index	EPA 620/R-03/002	HIGH
333	Coastal Sediment Quality Index	EPA 620/R-03/002	LOW
048	Coastal Benthic Index	EPA 620/R-03/002	HIGH
238R	Extent of Hypoxia in Gulf of Mexico and Long Island Sound	CENR/States	MODERATE
327R	Harmful Algal Bloom Outbreaks	HABSOS/States	MODERATE
320R	Chesapeake Bay Blue Crabs: Mature Females—Spawning Stock Abundance	Chesapeake Bay Commission	LOW TO MODERATE *(three reviewers said "LOW TO MODERATE"; one reviewer said "LOW")*
317R	Submerged Aquatic Vegetation in Chesapeake Bay	Report to EPA Chesapeake Bay Program	MODERATE TO HIGH *(Potentially applicable nationally) (Two reviewers said "MODERATE TO HIGH"; two reviewers said "MODERATE.")*
049	Population Served by Community Water Systems That Meet All Standards	EPA	MODERATE TO HIGH
335	Coastal Fish Tissue Contaminants Index	EPA 620/R-03/001	HIGH *(If presented by contaminant concentrations)*
221	Contaminated Groundwater Under Control on Contaminated Lands	EPA	HIGH

The reviewers offered several additional comments about the regional indicators in general. They proposed that certain regional indicators (e.g., SAVs) have the potential to become national indicators because the parameters can be measured across the country. HABs potentially could fit this model, but the reviewers criticized the Gulf of Mexico example as inappropriate for relating effects to anthropogenic stressors. Other HAB datasets should be included, especially for freshwater systems (e.g., cyanobacteria blooms). There are also better examples of regional hypoxia indicators (e.g., Chesapeake Bay, Albemarle-Pamlico Sound, San Francisco Bay, and Puget Sound) that could serve as the basis for scaling up to a national indicator.

The following statements summarize additional recommendations related to the regional indicators that were made throughout the three-day peer review:

- EPA should consider dividing the U.S. into regions based on environmentally appropriate boundaries rather than EPA regions. When possible, EPA should use consistent regional delineations across indicators.
- EPA should include additional justification or explanation for selecting the proposed regional indicators.
- The report should clearly state which indicators are considered pilot regional indicators versus those that are considered nationally representative.
- Some regional indicators (e.g., blue crabs and HABs) are not applicable to all ecosystems or all regions of the country. However, EPA should examine ways in which to normalize similar regional indicators to scale up to a national level.
- EPA is not taking advantage of the most robust, readily available, regional datasets, especially those in smaller, more tractable estuarine and coastal systems. In addition, the indicators chosen are not necessarily representative of the regional ecosystems. A broader array of indicators should be included to represent additional aquatic habitats.
- EPA should consider developing regional editions of the ROE. Each regional edition could include indicators appropriate to that region.

2.3.7.2 General Question 2: Proposed New Indicators

Responses to General Question 2 are organized below into three categories: 1) Comments Related to Indicators Withdrawn from the ROE 2003, 2) New Indicators Proposed for Inclusion in the ROE 2006, and 3) New Indicators Proposed for Inclusion in Future ROEs. Refer to the water reviewers' pre- and post-meeting comments for additional details about suggested indicators.

Comments Related to Indicators Withdrawn from the ROE 2003

The reviewers considered which of the indicators withdrawn from the ROE 2003 should be reconsidered for inclusion in the ROE 2006. They offered the following suggestions and comments:

- One reviewer chose three withdrawn indicators that should be included: 1) *Contaminants in Fresh Water Fish* (needed to represent contaminants), 2) *Macroinvertebrate IBI* (needed to combine various regional/state datasets), and 3) *Chemical Contamination in Streams and Groundwater*. Because the *Fish IBI* would not offer much additional information compared to the *Macroinvertebrate IBI*, this reviewer felt that it was appropriate to exclude the former.

- Another reviewer, on the other hand, believed that some version of the *Fish IBI* would be appropriate for a pilot study because fish data are applicable for regional level evaluation. This reviewer suggested examining data for streams in California, Ohio, and the southern states (refer to post-meeting comments for details).
- One reviewer suggested that EPA could present the *Fish IBI* developed for Region 3 (MIAI Report) that applies to multiple states in that region. The reviewer expressed that *Contaminants in Fresh Water Fish* should be included, especially since new datasets are available for inland waters (e.g. current fish contaminants survey of lakes).
- One reviewer proposed that *Altered Fresh Water Ecosystems* be included in the ROE. The number of river miles behind dams could be calculated on a national and regional basis, and data also are available on the number of dams removed (refer to post-meeting comments for details).
- One reviewer agreed that the indicator for *Number of Watersheds Exceeding Criteria for Mercury, PCBs, and Dioxin* is not appropriate and felt that EPA was justified in its exclusion of this indicator from the ROE 2006. However, these types of contaminants in watersheds should be represented by another indicator, such as regional data gathered by the San Francisco Estuary Institute (http://www.sfei.org/rmp/pulse/2005/RMP05_PulseoftheEstuary.pdf).
- The reviewers discussed an appropriate recreational indicator and noted that the number of beach days open could provide a good basis. However, the level of monitoring and the change in monitoring efforts over time must be represented, and the reviewers suggested that fecal coliform levels be presented rather than number of beach days open.
- One reviewer suggested that a regional example be developed for *Nitrate in Farmland, Forested and Urban Streams and Groundwater* because urban streams should be represented in the ROE.

New Indicators Proposed for Inclusion in the ROE 2006

The reviewers proposed several additional indicators and datasets that are readily available and could be included in the ROE 2006. These include the following data types and sources:

- *Riparian Areas*. EPA should include an indicator for the extent of alteration of riparian areas (refer to post-meeting comments for details). The Heinz Center offers national level data for this indicator (http://www.heinzctr.org/ecosystems/fr_water/datasets/freshwater_altered_riparian.shtml).
- *PCB and Mercury Suite of Indicators*. If EPA elects to follow the peer reviewers' comments and exclude the *Sediment Quality Index* from the ROE 2006, then it should consider other indicators for PCBs and mercury. One reviewer suggested several datasets in his comments (p. 2-25 of the Consolidated Pre-Meeting Comments) that represent stressors, ambient conditions, exposure, and effects for these contaminants. This suite could be presented in detail in the technical document and either removed in the public document or presented in a simplified form. This indicator could be linked with indicators from other chapters such as air and human health.
- *Status of Commercially Important Fish Stocks*. One reviewer suggested that the ROE include an indicator that reflects the percentage of commercially important fish species, or "stocks," that are increasing or decreasing in size. The NOAA National Marine Fisheries Service and the Heinz Center both have datasets for this indicator (refer to post-meeting comments for details).
- *Other Additional Indicators*. The following additional indicators were included in pre-meeting comments and should be considered for inclusion in the ROE 2006: 1) Abundance of Wild and Hatchery Trout in Lake Superior, 2) Abundance of Diporeia in the Great Lakes, 3) Central Lake Erie Phosphorus Trends (to accompany Hypoxia in Central Lake Erie), 4) Lead Accumulation Rates in

Michigan Lakes (to accompany the other indicators of lead), 5) Great Lakes Water Levels, 6) Great Lakes Trophic State, 7) Brominated Diphenyl Ethers in Various Biota, such as herring gulls (as an emerging issue indicator) and 8) Combined Sewer Overflow Discharges (as a pressure indicator for Recreation).

New Indicators Proposed for Inclusion in Future ROEs

The reviewers offered several indicators and datasets that are not fully developed at this time but that could be included in future ROEs. These indicators include the following:

- *Sea Level*. One reviewer suggested that EPA begin to plan for the inclusion of defensible measures of sea level in future ROEs. Long-term trends in global sea level fluctuations will be a major issue in the future if the global warming phenomenon is real. A dataset for Great Lakes water levels, which dates back to 1865, is available (see p. 2-20 of Consolidated Pre-Meeting Comments). Changes in water levels could be a predictor of coastal wetland disappearance.
- *Mine Spoils*. One reviewer noted that mine spoils and mine drainage are a legacy issue from mining activities that have an effect on water quality around the country. EPA should attempt to characterize the degree of water contamination represented by mine spoils and how it has changed over time. EPA could differentiate between current and legacy mine spoils and mine drainage and could scale up from regional data to the national level. This indicator has ramifications for land as well as water.
- *Restored Lands*. EPA should present an indicator that tracks the extent of restored lands, such as restored wetlands. Because databases are currently inconsistent across states, regions, and localities, this indicator could be presented at the regional level until data can be normalized across regions. One reviewer provided a regional example of this indicator for the San Francisco Bay (refer to post-meeting comments for details). The NWI survey notes changes between its land classes; changes from any non-wetland class to any wetland class ordinarily would reflect restored or constructed wetlands.
- *Water Quantity/Flow*. One reviewer noted that changes in the amount and timing of river and stream flow are important indicators of ecosystem health that should be tracked over time. USGS has collected data on the percentage of monitored streams and rivers with major, moderate, and minimal changes in low flow, high flow, and the timing of these two extreme events. The Heinz Center also has published data on dam removals in the 20th century (refer to post-meeting comments for details).
- *Sensitive Species*. The reviewers agreed that an indicator for rare, threatened, and endangered species would be appropriate for the ROE but commented that this indicator was not presented well in the *Threatened and Endangered Species* indicator in the Ecological Condition chapter.
- *Groundwater Levels*. The reviewers suggested that groundwater levels be represented in the ROE in addition to groundwater quality. Deeper groundwater typically is not rechargeable and is therefore a non-renewable resource that should be tracked. Along the coast of the U.S., salt-water intrusion may contaminate drinking water supplies, and the channelization of surface waters also has decreased the potential for groundwater recharge. Therefore, EPA should develop an indicator that addresses trends in hydrologic and chemical characteristics of the groundwater supply.
- *Pigment Indicators*. One reviewer proposed that diagnostic pigments could be used as indicators for the total amount and types of phytoplankton in surface waters. This indicator could link to HABs and provide qualitative information on eutrophication. Datasets are available for the Albemarle-Pamlico Sound, the Chesapeake Bay, some South Carolina and Texas estuaries where these pigments are being measured routinely. While it currently would be most appropriate to apply this indicator on a regional basis, the technology is constantly improving and being used over a larger range.

Furthermore, this technique can be linked to certain types of remote sensing (i.e., hyper-spectral imagery). (Refer to a paper on New Indicators of Coastal Ecosystem Condition, available at http://www.epa.gov/maia/html/indicators.html.) The EPA-EaGLe Atlantic Coastal Environmental Indicators Consortium (ACE INC: http://www.aceinc.org) is applying diagnostic pigment indicators for detecting and characterizing human nutrient and climatically-induced changes in estuarine and coastal phytoplankton and higher plant communities, water quality, and habitat condition (refer to http://www.aceinc.org/aceinc_y4_progress_report.pdf). Also see *Paerl, J. Dyble, J, .L. Pinckney, L.M. Valdes, D.F. Millie, P.H. Moisander, J.T. Morris, B. Bendis, B., and M.F. Piehler. 2005. Using microalgal indicators to assess human and climactically-induced ecological change in estuaries. Pp. 145-174, In S. Bortone (Ed.) Proceedings of the Estuarine Indicators Workshop. Boca Raton, Florida: CRC Press.*

- *Size-Spectral Analyses*. The reviewers discussed potential indicators for biomass and bio-volumes in the food web. Regression models using size-spectra analysis reveal relationships and changes in trophic state and the food web over time (refer to http://www.aceinc.org/aceinc_y4_progress_report.pdf).

- *LIght Detection And Ranging (LIDAR)*. A technique based on LIDAR measurement has been used to delineate salt marsh elevation changes and sea level change in regions of South Carolina, North Carolina, Massachusetts, and California. LIDAR allows remote sensing to be linked with other indicators of marsh health (e.g., pigment content and salt stress) and could be used to enhance or relate indicators in future ROEs. LIDAR is not limited to coastal regions and has produced a promising prediction of stream quality in Maryland (refer to *Creed, I.F., S.E. Sanford, F.D. Beall, L.A. Molot, P.J. Dillon. 2003. Cryptic wetlands: Integrating hidden wetlands into models of dissolved organic carbon export. Hydrol. Processes 17: 3629-3648*).

- *Bioindicators*. The Pacific Estuarine Ecosystem Indicator Research (PEEIR) Consortium is developing a bioindicator approach that examines DNA strand breaks and other endpoints in key species to detect contaminant stress on an ecosystem. This indicator could eventually be applied at the national level for both freshwater and marine systems. The PEEIR Year 3 Annual Report provides additional information (available at http://www.bml.ucdavis.edu/peeir/annualrep.html). The Consortium for Estuarine Ecoindicator Research for the Gulf of Mexico (CEER-GOM) also has published data from the Gulf of Mexico related to oxygen stress in fish and the induction of certain genes.

- *Bio-Optical Indicators*. A collaborative project between the Atlantic Coast Environmental Indicators Consortium (ACEINC) and the Atlantic Slope Consortium (ASC) uses bio-optical indicators to predict the effects of environmental stressors (refer to http://www.marine.unc.edu/Paerllab/research/seagrass/index.html). These indicators measure turbidity, color, chlorophyll, and other pigments to calculate the relative importance of each optical component and predict how a stressor would impact downstream conditions. This technique could be used to examine the habitability of SAVs and is already being used in the Chesapeake Bay, Indian River Lagoon in Florida, and North River System in the Albemarle-Pamlico Sound. It is slated for use in some estuaries of the Gulf of Mexico as well.

- *Fecundity indicators*. EPA should consider including fecundity indicators in future ROEs; these indicators can be powerful measures of population health.

- *Wetland Condition*. EPA should consider not only the quantity of wetlands but also the quality of wetlands in its indicator measuring *Wetland Extent, Change, and Sources of Change*. This distinction will become more important as the number of constructed and restored wetlands continues to grow.

2.3.7.3 Other General Comments

Throughout the length of the peer review, the reviewers offered additional recommendations for improving the ROE as a whole. These recommendations include the following:

- EPA should more explicitly state the conceptual framework used to develop the questions and choose the indicators for the ROE 2006. EPA should examine the various aquatic media and determine a consistent methodology for investigating those media. For certain indicators, it is unclear why EPA characterized them as stressor, ambient, exposure, or effects indicators.
- EPA should reexamine the questions it asks with the understanding that they may be used to identify data gaps and to influence the development of indicators to fill these gaps.
- EPA should step back from the definition of an indicator to examine how future indicators should be developed and future studies designed. The Agency also should be consistent in its application of the definition of an indicator when determining which indicators to include in the report.
- EPA should explicitly state the target population represented by each indicator.
- There was confusion over the difference between a national indicator and a regional indicator. With surface waters, there are a wide variety of systems (e.g., lake, coastal, estuarine, riverine), and it is difficult to paint an aggregate, national picture of the condition of these diverse systems. EPA should investigate appropriate methods for defining various populations of water bodies, such as inland lakes, Great Lakes, coastal waters, small rivers, wetlands, and large rivers, and developing indicators as appropriate for these water bodies.
- EPA should include more, rather than fewer, indicators in the ROE 2006.
- Contextual information was largely absent from the indicators. This information should appear at the beginning of the ROE 2006. Sufficient background study information should be presented so that the reader does not need to consult the original reports to understand the data.
- EPA should develop conceptual models for describing the linkages between stressors, ambient conditions, exposure, and effects for each type of water ecosystem. When indicators are proposed, EPA should present other related indicators to show the linkages between stressors, ambient conditions, exposures, and effects. When an indicator like the blue crab is presented, the potential stressors also should be discussed even if there are no data presented or if the linkages are poorly understood.
- EPA should consider whether the Great Lakes region should truly be characterized as a coastal region and whether the Great Lakes should be broken out separately as their own region (or water body type) across all relevant indicators.
- EPA and the states should develop additional appropriate groundwater indicators. EPA's surface water experience can be used to determine relevant parameters for designing a groundwater monitoring program.
- Graphics and figures should be more consistent across indicators and should be accompanied by a map indicating sampling locations.
- It would be useful to begin to develop indicators that reflect management issues and the stressors that agencies are attempting to control.
- EPA should consider locations in the water section where it would be appropriate to cross-reference to other indicator groups.

- With all indicators that present a trend, EPA should make clear where the trends are statistically significant and where an apparent trend may not necessarily exist. This will help inform and revise methodologies for monitoring programs and study designs. This issue of "significance" is most applicable to the technical document rather than the public report, but should be acknowledged in both to ensure that the public interprets the data appropriately.
- Except for the large river systems, data for freshwater systems are lacking from the document. Additional studies should be initiated to examine how to use archival data as indicators for freshwater condition and trends. This particularly relevant with regard to nutrient-based and HAB-related indicators.
- Some of the indicators were scored and some were not; EPA should adopt a consistent approach.
- EPA should leave empty graphs or data boxes to demonstrate where data gaps exist, where work needs to be done, or where efforts are already ongoing.