

REVIEW COMMENTS, The Technical Support Document “Coral Reef Biological Criteria: Using the Clean Water Act to Protect a National Treasure”

Prepared by James R. Karr, June 5, 2010

CHARGE QUESTIONS

1) Does the report accurately convey the potential of the Clean Water Act to protect coral reefs? If not, why?

The report conveys much of the power within the Clean Water Act to improve the condition of the nation’s waters. It is refreshing to see a broader framework of water resource issues and opportunities laid out in broad terms yet with enough specifics that actions could actually accomplish much in the protection, restoration, and conservation of coral reefs. It is also refreshing to see the lessons of the past few decades of work in freshwaters applied thoughtfully to a marine system. This document sets the stage for a new and pioneering approach to accomplish the goals of the CWA and to use the power inherent in that law to protect coral reefs.

The detailed comments and suggestions that follow responses to these five questions provide more detailed suggestions for places where minor tuning of the document, including clarification of some concepts central to the CWA, is warranted.

2) Does the report provide a useful framework for coral reef managers to develop biocriteria? Please identify any deficiencies.

It does provide a framework to guide biocriteria development, and it does it in a way that should be easily understood by diverse audiences. That said, it does not provide enough detail so that the average reef manager could embark on such an effort with comprehensive understanding of the opportunities and pitfalls that lie ahead. To quote the report (page xv), it “describes the basis for biocriteria development under the CWA. . . . the manual is intended as informational, rather than a ‘how-to’ document . . .“ Leadership and action to fill the need for a how to manual will have to be shown by state and federal agencies responsible for water resource protection and coral reef conservation if the power of the CWA is to be effectively tapped. But there actions should be guided and informed by the insight of the scientists and managers with day-to-day knowledge of coral reef ecosystems.

Most important, the framework advocated in this important document can be best implemented by pooling the knowledge, energy, and resources of the many institutions, managers, and groups charged with protection of coral reef environments. It cannot, indeed should not, be done narrowly for each reef location or environment.

3) Are the steps necessary for biocriteria development clearly explained and logical? Please recommend improvements.

As hinted above, the steps outlined in Table P-2 provide an excellent introduction and framing of the challenges ahead. The individual chapters, cast to answer a sequence of simple questions, provide important and accessible guidance to audiences interested in advancing coral reef protection and restoration. I suspect that more people could be successfully enlisted to take the actions proposed here if a few simple examples from earlier work, conveyed through simple graphics, were developed to show how successful application of biocriteria concepts have improved CWA implementation in other situations. I am not speaking of the details of studies but brief synthesis of examples from earlier work and their key conclusions as well as explicit reference to how they have advanced the goals of the CWA.

4) Is the presentation, including tables and graphs, clear, relevant and concise? Please recommend improvements.

The total report seems to be of substantial size but in reality the core of the report (Chapters 1–10) include only 70 pages, less than half the report. The authors are to be commended for their brevity as well as the clarity throughout the report. Other important additions to the document include a representative bibliography that includes an reasonable balance of citations from EPA documents and from the peer-reviewed technical and scientific literature. A number of other appendices round out the document and thus provide ancillary material of great use to readers interested in more detail. I do suggest that a careful examination of the glossary might be in order. I comment on a number of glossary entries in my more detailed review comments. Unfortunately, I did not keep a list of the words that I looked for in the glossary but did not find; there were a number but that is not a very helpful comment.

Each of the major chapters does an excellent job of pulling out key concepts and lessons in “out quote” boxes that are very effective in guiding the reader to those concepts. In addition an excellent job is done in the many figures and tables, including effective use of photos and maps, to illustrate and clarify key concepts and lessons.

5) Has the appropriate literature been cited? Are there publically available, peer-reviewed papers that have not been included, but that should be? Please provide copies of any papers or reports for consideration.

An infinite variety of relevant sources could be cited to expand the literature cited. But it would not be wise to add citations because they are there. A key question is, “Do the authors provide the reader with a path into that literature?” I would answer that question with a yes.

I attempted to provide a summary of issues related to biological monitoring and assessment in a recent paper that the authors might find useful. That paper focuses on seven foundations that relate to development and use of biocriteria through biological monitoring and assessment. The full citation of that paper is as follows: Karr, J. R. 2006. Seven foundations of biological monitoring and assessment. *Biologia Ambientale* 20(2): 7-18. A pdf of that paper is sent with this

review. In addition to the framework of seven foundations, it provides an appendix of key papers on the subject published over the past several decades.

DETAILED PAGE-BY-PAGE COMMENTS.

vii, Executive Summary, Paragraph 2, line 5: “Biological criteria can be. . .” Why not should be? Why just can be? Without biological criteria one cannot be sure that living systems are being protected and, thus, if the goal of the CWA is being attained.

vii, paragraph 3, line 3: “condition of reef organisms” Many will I fear interpret this to be a focus on individual organisms or species, leading to the selection of indicator species. Better choice of phrase might be “condition of reef living systems” in an effort to suggest a broader biological framework than species.

xi, last bullet of intended audience. Need to add close parenthesis at end

xii, bulleted list of stakeholders. I suggest that the document here misses the opportunity to clearly state that all U.S. citizens are key stakeholders. The bulleted list captures some of the specific groups, but the overarching group of stakeholders is all US citizens. I think that should be explicit with the bulleted list added to indicate especially active groups.

xvi. item 9 in table, first column. I see biological integrity as the endpoint of a condition gradient. Not all water bodies will be restored to that integrity level. That is simply a practical reality that is captured in the designated use component of water quality standards. Using integrity in this text here is not clear about that reality.

1-1, paragraph 1, lines 5-7. Lack of parallelism in these phrases is a bit jarring.

1-2, first sentence. I suggest deleting this sentence. It adds nothing of value. Same comment for sentence at top of page 1-5.

1-7, California example box. I have never understood the logic of saying that fishing is a factor of concern and habitat is a factor of concern but there is no simple statement that the biota is not only a factor of concern but the primary goal in the crafting of this list. As I see it, habitat is a new euphemism for that biota just like water quality, the old euphemism, we now know is a flawed euphemism for that goal. Why not state the goal in the form of the primary endpoint of interest: the biota! The same comment applies for the ALU box below.

1-8, second paragraph of water quality criteria, line 4. Add ‘s’ to first word to make “supports”

1-11, paragraph 4, last line. An interesting approach to getting around some complex subjects. Is anything being done, or should anything be done, to move important but presently ignored/neglected effects on water quality into the authority group? Why or why not? If not, is there any hope that we can accomplish the goals of the CWA?

1-12, paragraph 1, line 3. Why the copyright symbol here?

1-13, figure 1-3. Second frame. Serious problems with the bottom frame of this figure. The y-axis is not labelled; is it taxa richness? Also there is much wasted space. The values present rarely exceed 20 but the range on the y-axis goes to 100. This leaves much wasted space and limited ability to see the differences among the years.

1-15, paragraph 2, line 5. Here and elsewhere I suggest an effort to avoid this kind of vague antecedent construction (it is, there is, there are, etc.). Make important issue the subject of active sentences, an approach that leads to more direct communication and saves space. See also third line of next paragraph.

1-15, Figure 1-4 caption. Odd and a bit annoying font here that provides a peculiar looking (narrow) l and cap i.

2-3, paragraph 1, line 2. Here again I suggest noting that they provide diverse values to all citizens, not just local residents and tourists. Although not really ignored with the language here, I suggest an affirmative statement of importance to all citizens is warranted and wise.

2-3, definition box. This dichotomy ignores the parts of the system. They should be explicitly acknowledged as crucial to our success. See below for similar problems, and for other approaches that do not narrow the conceptual framework to functions or processes (e.g., the US Virgin Islands language on these topics is broader and stronger).

2-4, Table 2-1. The three classes here capture things in the language and concepts of economics. I suggest that an alternative non-economic perspective is also appropriate and in many respects better. Perhaps more appropriate they are complementary and without both one does not communicate as well and as broadly as is useful. An alternate framing, also that comes from MEA, places services in four classes: supporting, provisioning, regulating, and cultural. I slightly modified that framing in a recent paper in Encyclopedia of Ecology (Figure 2 (inserted as next page in this review); also see attached pdf file).

One final point on this. The “Charge” letter sent to reviewers (first sentence) says the following “Coral reef ecosystems are valuable economic, ecological, and aesthetic resources . . .” Here is the place to do the best we can to show efforts to capture the values (inclusive of money based but not only money based) that derive from the presence and persistence of healthy coral reefs.

2-5, Quantifying ecosystem services box. This box provides justification for the economic view and approach. As far as it goes, it does that but equally important in my view is the need to ensure that readers understand more comprehensively what is left out of this approach. One weakness is the dependence on numeric values provided in dollar terms. In reality, many things cannot be valued in those terms at all (so they are often then left out of the discussion), and others can be valued in those terms but the foundation for those values is at best a slippery slope or distortion of their importance to human society and to life on earth writ large. I think it is essential that another box be added that captures these kinds of things, perhaps using the above

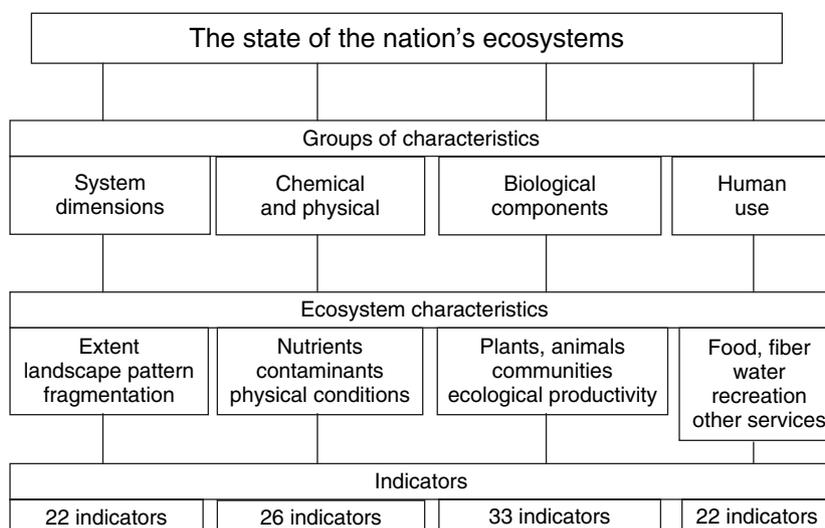


Figure 1 Example ecosystem characteristics and number of indicators examined in the *State of the Nation's Ecosystems* report. Modified from Heinz Center (The H. John Heinz III Center for Science, Economics and the Environment) (2002) *The State of The Nation's Ecosystems: Measuring the Lands, Waters, and Living Resources of the United States*. New York: Cambridge University Press.

chemical and physical condition, status of biological components, and goods and services that human society receives from the ecosystems being measured – comprises about 22–33 specific indicators. As of 2002, the data needed to report on the 103 identified indicators in the four classes were available at a national scale for only one-third of the indicators; some data were available for an additional one-fourth of the indicators. Nearly a third were supported by inadequate data, and about one-seventh needed further development.

Two areas of indicator development have been especially active in the past two decades: the development and use of multimetric biological indexes as measures of divergence from biological integrity and the cataloging and documenting of ecosystems services, a crucial component of the fourth group of Heinz indicators. Perhaps the best framing of the ecological services concept and the importance of those services to human well-being was produced by the Millennium Ecosystem Assessment (**Figure 2**). Rather than providing a simple listing, this project carefully defined four major types of services supplied to humans by healthy ecosystems: supporting (e.g., soil formation), provisioning (e.g., food and water), regulating (e.g., climate, flood control), and cultural (e.g., esthetic and recreational values). This framework offers both a constructive way to organize ecological thinking and a means to communicate with disparate groups of people.

How Ecological Indicators Are Used

Whether the issue is endangered species and threatened water supplies or newly emerging diseases and national security, understanding patterns and trends in Earth's ecosystems is essential to informed public policy. Consider that despite well-orchestrated efforts to

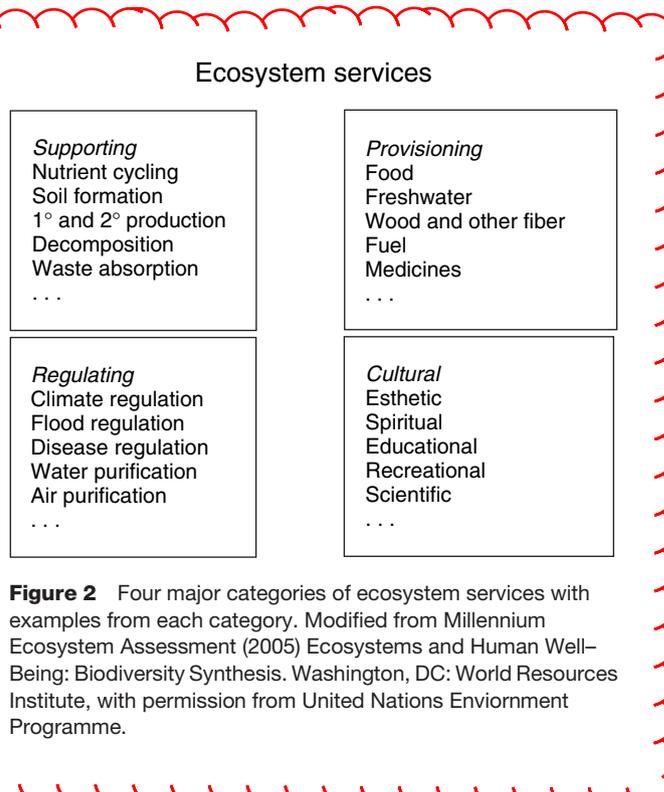


Figure 2 Four major categories of ecosystem services with examples from each category. Modified from Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-Being: Biodiversity Synthesis*. Washington, DC: World Resources Institute, with permission from United Nations Environment Programme.

downplay the potentially deadly effects of tobacco and excessive alcohol consumption, health indicators have helped mobilize changes in individual and collective behavior. Similarly, improved ecological indicators can help overcome special interests that insist on denying the importance of ecological concerns or the need for ecological indicators.

Ecological indicators can do more than simply describe or characterize the condition, or trends in condition, of places. From a technical and scientific perspective, monitoring ecological indicators provides a

mentioned MEA classification as a complement to this box. The title of this box perhaps even implies that valuing (quantifying) can only be in dollar/economic terms.

3-1, paragraph 1, line 1. We not only “care about” these things, we also and perhaps more important, depend upon them for our very existence.

3-1, paragraph 1, last two lines. ARGH! It also reflects the presence of the native species/biota characteristic of the region. It is about more than functions in support of human needs. This leaves off half of the core components/contexts of the integrity definition used earlier. The glossary, for example, notes that integrity is defined as the extent to which “all (1) parts or elements of a system . . . are present and (2) functioning.

3-1, second paragraph, last line. What does it mean to have an intact ecosystem function? How would one recognize an ecosystem function that is not intact? Is that like saying a place meets the integrity goal or does not, with the latter failing to recognize the rather broad gradient of biological condition that ranges from slight divergence from integrity to nothing alive.

3-2, table 3-2. This set of ecosystem services does not seem coherent relative to the earlier comments re economic context. Internal consistency in the document on these and related subjects seems essential in my view. Note that the economic perspective is necessary but not sufficient. Also language not coherent among the segments of the table.

3-4, paragraph 3, biocriteria discussion, line 12. Refers to metrics but I don’t remember seeing much on metrics before this in the report. Seems it needs some foundation of definition and context if the language here is to help the naïve reader. Here is where a simple graphic from the coral reef work, or from freshwater systems that shows the concordance among good metrics, between metrics and dose-response curves in toxicology, and effective indicators of biological condition.

3-4, proposed WQS, class b waters. Wisely, this language captures contexts beyond ecosystem functions that I have already commented upon. Surely if the USVI can cover this full range, this report can be revised to ensure that the dimensions of biological integrity (living systems; parts and processes) is captured beyond the constraining concept of functions. See earlier comments.

Checking the dictionary definition of function the key phrase seems to be “the normal or characteristic action.” We can restore ecosystem function in water resources by adding wastewater treatment to break down organic material. Or by introducing non-indigenous fish in the Columbia River to make fish biomass (of carp instead of salmon). But the accomplishment of the action (function) is simply not enough in my view if the normal actors (diverse native assemblage of invertebrates, fungi, bacteria; salmon) responsible for that action are replaced by an artificial and narrow set of non-indigenous actors. Function is simply not enough, to paraphrase a paper from 15 years ago titled “Clean Water is Not Enough.”

3-4. The language from USVI materials (and elsewhere in the use of the biological condition gradient graphic) there is heavy dependence on recent work from EPA that seems to set up expectations grounded in fuzzy ecological theory. The thresholds of diversity change and

maintenance of ecological functions are at best fuzzy, at worst grounded in ecological theory that has not been empirically demonstrated and tested. In my view, it shows confidence in vague ecological theory in much the same way that use of diversity indexes did nearly 40 years ago. As we know now, they became key parts of state agency rules (e.g., Florida and elsewhere), a problem that is still vexing societal movements toward better approaches.

4-1, Indicator guidelines box. Note that both structure and function (or alternately phrased, parts and processes) are mentioned here. This important duality should be emphasized throughout the document, not just in random places making considerable inconsistencies in this important conceptual foundation through the document.

4,2, line 1. More vague antecedents.

4-3, first full paragraph, next to last line. Delete “that”

4-3, Figure 4-1. The nature of and interactions of the three levels (stations, replicates, habitats) is not clear to me from this figure.

4-3, second paragraph, line 3. Might be useful to add something here about the context of properly selected metrics. The connections between metrics, metric behavior, and these patterns should/could perhaps be clearer.

4-3, last paragraph, line 1: “consider if” seems an odd phrase here. How about "ensure that"?

4-6, first paragraph, line 2. Why only functional?

4-6, figure section 3. Nothing provided here to suggest why and how the 52 threshold was selected and the effects of that judgment. This may not be the place but it should be present someplace in the document. I especially suggest that it must be grounded in biological context and terms, not some arbitrary statistical threshold. Perhaps something of this kind, taking experience from recent coral reef work in Caribbean and the more extensive freshwater work could be added as a short appendix.

These comments for the first 4 chapters were prepared using the early copy sent to me originally. The rest of the comments will come from reading the final revised version sent a week or so later. I think they are pretty much the same but didn't check every comment to be sure.

5-1, paragraph 2, line 2: Period after al. in citation.

5-1, third paragraph: One needs to be careful about only including rocky areas. To what extent have past human actions caused sedimentation or other alteration of substrates in areas that were historically occupied by corals. I suggest this point should at least be identified. An analog is sediment-laden streams with no rocky substrates although they did occur in abundance before altered land use provided the heavy silt loads to embed the stream substrate. This comment is also relevant to the next paragraph, if hard bottom is used in area based evaluations but some hard bottom has been lost due to a history of human actions in the region. A similar point could

be made in coastal marine systems that only evaluated areas currently occupied by eelgrass. We know that many good eelgrass areas have been obliterated by human actions.

5-3, first full paragraph, line 2: Are you sure about the statement that “they yield statistics for all water bodies.” Doesn’t one need to make sure that there is a stratified sampling array that ensures the all water body types are sampled at appropriate levels? How can you be sure that all water bodies (including all water body types) are represented? Would it be better to clarify that this is true only for all water body types designed into the sampling program? Or am I missing something here? To some extent the discussion in Figure 5-2 deals with this issue.

5-6, last paragraph, lines 3-4. I agree with comments here about individuals. But household unit is a very heterogeneous thing: single, married, two sexes, single sex couple, with or without children, and so on is more like the various kinds of reefs.

5-8, last paragraph, line 3. Replace “for example” with “such as”

6-1, paragraph 2, last line. I suggest that it can also be instrumental in diagnosing the cause(s) of degradation if done properly.

6-1, paragraph 4, last line. I suggest it is important here to note that this measures condition and in the end must be interpreted in the context of divergence (or not) from the reference condition or standard. The raw numbers just described in the last sentence have no meaning, are not useful without inclusion of that interpretative context.

6-1, last paragraph, first line. Vague antecedent again. Rephrase to say: “Many challenges remain for insightful definition of impairment thresholds.”

6-2, first paragraph, line 4. Not for “all other sites in the region” as stated here but for all other sites of the same ecological class.

6-2, last paragraph, next to last line. Should it be “meet” instead of “mean” near the end of the line.

6-3, paragraph 2. I am not enthusiastic about this 25% and 75% approach to thresholds. I suggest the thresholds should be based on explicit biological context rather than an arbitrary statistical percentage. I know, “this train has already left the platform.” My prediction is it will be corrected in the future as we are now trying to correct use of diversity indexes.

6-3, Figure 6-2. I am not convinced that the presentation of a sigmoid shaped line is the best presentation. What is the evidence of that shape to the curve? And the words re changes in structure and function are in my view simple wishful thinking without any empirical foundation. Again, this train has already left the station for good or evil.

6-4, paragraph 1, line 2. What is the thinking behind the “increasing pollution and human disturbance” language. Is the intent that pollution is things added to water (equals pollutant from CWA)? Or is it meant to convey the larger context as the word pollution is defined in CWA? If

the latter, then human disturbance is redundant in the sense that human disturbance is the generator of pollution. I suggest this should be clarified.

6-4, paragraph 2, line 4. These two papers were not the first to use the concept of a graphical display of human influence gradient vs a biological condition gradient. See, for example, figure 3 in Karr and Chu, *Restoring Life in Running Waters* and Karr *Freshwater Biology* 1999, p.223 and any number of other papers from that period as well.

6-6, paragraph below 1, 2, 3 list, next to last line. Should it say “to set” rather than “for set”?

6-6, paragraph before heading 6.3. Are we back to the standard that all (physical, chemical, and biological) must exceed some threshold before we conclude that a water body is not impaired? I thought there was some movement toward a hierarchy here when multiple types of data are available. What about the study we did in WA (see attached) that showed biology impaired but chemical standard not giving an impaired signal? Would we use this to say that the water bodies are not impaired because both chemical and biological are not below established standard levels? This is a problem in my view, although my example is backwards from the text here.

6-7. This discussion and the figure provide a solid intro to the importance of sampling design for regional (or other similar) condition assessment. In addition, it illustrates the important components of this with specific discussion of a model approach.

7-3, third full paragraph, lines 3-4. The sentence here seems to be missing words, a verb.

7-4, Table 7-1. A bit simplistic and narrow in description of both strengths and weakness but a good first effort.

7-4, last two paragraphs. These last paragraphs each have important points to make but the connections between them and lessons are not clear to me. I suggest deleting the last short paragraph and move on to the paragraph on the next page.

7-5, paragraph 1, line 5. Delete “are attaining the goals to”

7-5, paragraph 2, line 1. Is the intent here to be pollution in the broad CWA sense or the narrow pollutant CWA sense?

The rest of paragraph 2 is very good with illustration to make a very important point!

8-1, paragraph 3, lines 1-2. The dichotomy here between global climate change and local human disturbance is a bit simplistic and I suggest inadequate. What is the meaning of local? Changes in coastal environments from say damming a river such as the Elwha may alter the pattern of sediment transport to coastal areas that have influences far down the coast as point bars (e.g. Dungeness Spit) affect things for some distance down the coast. Same could be said about overharvest of fish across a region rather than just local. I am sure that many other examples could be cited that are not just local and are not global climate change. What about changes in land use in the Columbia basin far from the sea? It is not local it seems to me for its influence on

coastal areas and salmon; it is not global climate change. What does local mean here? Does it mislead the reader as implied in these illustrations and examples?

The next sentence begins with coastal development. The Columbia River example just mentioned does not include coastal development but with major consequences on the coastal environment. What about the effects of agricultural land management across the Mississippi Basin (e.g., Iowa, Illinois, etc.) and its effect on the lower reaches of the Mississippi delta in Louisiana and in the developing dead zone in the Gulf of Mexico. Although these examples do not directly relate to coral reef situations the principles still apply.

I suggest broadening the sentence to note that development wherever it is often connects through a chain of effects from areas remote from the location of a coral reef to degrade that coral reef in ways that are not just tied to global climate change.

8-1, Add period after “al” in citation in the caption to Figure 8-1.

8-3, Table. Might be useful to add changes in flow of freshwater to coastal environments due to land use change.

9-1, paragraph 1, lines 1-3. Don't near coastal coral reefs also fall under the jurisdiction of relevant state agencies tasked to implement the CWA at the state level? This text seems to disempower or neglect the role of states. Many of the items noted in Figure 9-1 (page 9-2) involve state action.

9-2 and 9-3, Table 9-1. Isn't this table and some of the associated discussion more or less a direct outtake of a published paper (Fore et al. 2009, *Marine Pollution Bulletin*). Isn't proper citation of that source appropriate? Wasn't this table drafted but excluded from a manuscript submitted by the same group of authors to *Science*? The provision of foundation papers and sources in publications give credit where due and guide readers to a broader literature on a subject.

10-2, second full paragraph. Also, one doesn't know if factor(s) other than nutrients and pathogens were the culprit causing coral reef decline. Must keep in mind that many times these standard pollutants are much less important than non-pollutant activities of humans.

10-2, third paragraph. Good question and topic sentence to convey this important concept (reporting that empowers people to understand what is happening in terms that they can understand).

10-4, fourth paragraph. Here and elsewhere it seems appropriate to give specific examples from freshwater systems how these things have been done. I think of Ohio EPA's effort to evaluate the causes of degradation across landscapes and watersheds. Perhaps there is some EPA prohibition against citing this kind of work too much.

10-3, first partial paragraph. I would reiterate the point made earlier that the MEA and others have also noted that appeal to noneconomic thinking and frameworks is also useful because it is

also relevant and important to many people. The next paragraph illustrates why this larger context is important and should be made explicit here and elsewhere in this report.

A2-3 and beyond for glossary:

Definitions of attribute, metric, multimetric, and so on are nearly identical to what was originally proposed by Karr and Chu 1999, Table 3, page 47. Many other definitions in this section are nearly identical to those used in other publications by non-EPA people, yet all are cited as if new in EPA, 2009b. Note also that biomass definition cites non-EPA document. The biological integrity definition here was popularized by its use in Karr and Dudley 1981 (Environmental Management), having been developed in a paper by David Frey in *The Integrity of Water* 1977.

Ecological integrity definition too comes directly from Karr and Dudley 1981.

Nonpoint source (NPS) pollution. This definition constrains the word pollution to the CWA definition of pollutant. As such it glosses over, even ignores, the non-pollutant contexts of NPS such as those effects that come from changes in flow regime. The last sentence says that the cumulative impact of nonpoint source pollution is significant. Sadly, this definition and explanation misses the mark in leaving out many of the most important contributors to biological degradation that derive from nonpoint source pollution. It narrows the scope of the concept to nonpoint source pollutants. How can we expect the states and the citizens to frame these issues comprehensively if this kind of federal document doesn't do it? Sorry but this text pushes one of my soapbox buttons. Similar effort should be made in my view to clean up the use of point pollution definitions as well.

Nutrient management. I suggest that nutrient management is not a BMP but an action employed to alter the delivery of nutrients to a water body. Many different BMPs can be used to accomplish that goal.

Nutrients. Might be useful to mention the importance of both macronutrients and micronutrients to plant growth and reproduction.

Pollutant. I think the quotation of language from CWA as done here is a good idea. Perhaps it might also be useful to simplify that with language such as "pollutant, then, the addition of anything to water as a result of human actions." Should that be stated here to make the connection clearer and simple as a brief simple English summary to the long quote from CWA. Also, I find it interesting how the CWA explicitly leaves some things out of the pollutant definition such as oil field waste.

Resilience. I am amused by the standard approach to this word with the implication that we want things to be resilient. Isn't a tubificid (sewage sludge worm) assemblage downstream of a poorly operated WWTP a very resilient community? But I don't think we can make a case for wanting that kind of biota because of its resilience.

Responses. This word seems to come in two contexts in the report. First the responses of humans as defined in this glossary and second the responses of organisms to the presence of a stressor from the actions of humans. But only one is defined here.

Risk. I suggest looking at the President's Commission on Risk and other document to find a cleaner definition of risk. I found this a bit convoluted and came away not having a clear view of the perspective this report wants to convey.

Runoff. But some water that is absorbed into the soil and moves to subsurface levels also will runoff through subsurface flows. This definition needs some clarification.

Scale. Recall my comments earlier about inadequacy of the dichotomy of global vs. local. This definition leaves open considerations of regional and other scales, including microscales.

Stakeholder. Going back to an earlier comment above, all citizens of the nation are stakeholders with respect to the protection of their interests in the quality of water resources.

State of the environment. Why is biology or "living systems" not included in the initial parenthetical list of environmental compartments?

Stormwater. I like the expanded discussion of stormwater from the 2008 NRC report on the subject better than the one here. It is clearly too long but contains some key concepts and context that are at best ambiguous by the glossary definition here.

URBAN STORMWATER MANAGEMENT IN THE UNITED STATES. Committee on Reducing Stormwater Discharge Contributions to Water Pollution, Water Science and Technology Board, Division on Earth and Life Studies, NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES, THE NATIONAL ACADEMIES PRESS, Washington, D.C. www.nap.edu

From that report:

BOX 1-1

What Is "Stormwater"?

"Stormwater" is a term that is used widely in both scientific literature and regulatory documents. It is also used frequently throughout this report. Although all of these usages share much in common, there are important differences that benefit from an explicit discussion.

Most broadly, stormwater runoff is the water associated with a rain or snow storm that can be measured in a downstream river, stream, ditch, gutter, or pipe shortly after the precipitation has reached the ground. What constitutes "shortly" depends on the size of the watershed and the

efficiency of the drainage system, and a number of techniques exist to precisely separate stormwater runoff from its more languid counterpart, “baseflow.” For small and highly urban watersheds, the interval between rainfall and measured stormwater discharges may be only a few minutes. For watersheds of many tens or hundreds of square miles, the lag between these two components of storm response may be hours or even a day.

From a regulatory perspective, stormwater must pass through some sort of engineered conveyance, be it a gutter, a pipe, or a concrete canal. If it simply runs over the ground surface, or soaks into the soil and soon reemerges as seeps into a nearby stream, it may be water generated by the storm but it is not regulated stormwater.

This report emphasizes the first, more hydrologically oriented definition. However, attention is focused mainly on that component of stormwater that emanates from those parts of a landscape that have been affected in some fashion by human activities (“urban stormwater”). Mostly this includes water that flows over the ground surface and is subsequently collected by natural channels or artificial conveyance systems, but it can also include water that has infiltrated into the ground but nonetheless reaches a stream channel relatively rapidly and that contributes to the increased stream discharge that commonly accompanies almost any rainfall event in a human-disturbed watershed.

Threshold. Shouldn't it be at either higher or lower levels. Line 3

Water pollution. Better to use the definition as provided in the CWA. The one here emphasizes water the fluid or discharge of pollutant rather than the broader context of water resource in the CWA section 502(19).

Water is used in several of the definitions here that could be construed to be the fluid water rather than the larger context of water bodies or the multiple dimensions of water resources.

Appendix A4

A4-1, first question right column. I suggest replacing “biological expectations” in the last line with something that ties more directly to CWA language. E.g., “biological condition as defined by defined designated uses”

A4-1, last question right column. I have resisted making this point a number of times, but will add it here. Line 3 from bottom states “the biological integrity of resident biota.” This is an awkward phrasing that could be cleaned up with the following goal in mind. Distinguish the measurement of biological condition, the goal of biological monitoring, from assessment of whether that condition approximates the endpoint of the biological condition gradient, biological integrity.

This sentence might then say something like: “Because biosurveys provide both integrative evaluations of current biological condition and the information needed to determine if that condition diverges from the biological integrity goal, permit writers can make informed decisions on whether to maintain or modify permits.”

A4-2, first question left column. This answer represents a substantial advance in thinking in the last couple decades. I can remember when the party line from EPA was to make biomonitoring/biocriteria a volunteer/citizen program, largely in my experience to marginalize it as a scientific endeavor. I am glad to see that we have come so far since the 1970s.

A4-2, answer in top right column, line 7. I suggest inserting a comment before “Alternative forms . . .” to convey the following important point. In fact, this larger biological context and diagnostic analysis may even spread the responsibility more broadly than the current focus on point source dischargers. In that way it would be more able to address the most important causes of degradation, rather than all the regulatory attention being given to point dischargers. This is not the correct final language but the point is perhaps worth making to provide a more balanced framework of thinking. It would also serve to help permit holders to understand that they might even be relieved of some regulatory pressure if/when the broader framework of analysis does a better job of identifying causes of degradation.

A5-1, paragraph 2, line 3. ES is not defined. I assume it is ecosystem services, but better to define upon first use here than assume the reader will figure it out. If it is not in fact used again, then get rid of it entirely.

A5-2, paragraph 1, line 9. Delete “single”. Better yet get rid of the vague antecedent with the following: “. . . suggests that no current programs are capable of delivering overall support . . .”

A6-1, first paragraph, line 6. Shift CO₂ to the same notation as other appearances in this paragraph. That is, with the subscript 2.

A7-1, top of right column, box 2. Here is a place where I think it would be more appropriate to say “outstanding biological condition” rather than “outstanding biological integrity.” See note above (A4-1) re this same point. See other places in this same column for this point.