

Comments from individual members of the Science Advisory Board (SAB) Panel for the Review of the EPA Water Body Connectivity Report to assist meeting deliberations. These comments do not represent consensus SAB advice or EPA policy. DO NOT CITE OR QUOTE

**List of Panel Member Comments on the 3/25/14 Draft of the
SAB Connectivity Panel Report
(As of 4/23/14)**

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Dr Allison Aldous

Comments on draft letter to EPA administrator

This letter misses the most important point of the SAB review, namely that the SAB *agrees* with two out of three of the EPA's major conclusions. The SAB only disagreed with the EPA in asserting that the EPA should have come to a more definitive conclusion related to the connectivity of unidirectional wetlands. Currently, the letter only states that the SAB *disagrees* with one of the conclusions. Furthermore, comments related to prose and organization of the document are secondary to the conclusions. I propose paragraph 3 (lines 33-38) of this letter be revised as follows (*insert text in red*):

The Report is a thorough and technically accurate review of the literature on the connectivity of streams and wetlands to downstream waters. The SAB agrees with two out of three of the EPA's major conclusions. The SAB agrees that the scientific literature supports the conclusion that streams and bidirectional (riparian and floodplain) wetlands are physically, chemically, and/or biologically connected to downstream navigable waters. The SAB disagrees with the Report's key conclusions concerning the connectivity of unidirectional (non-floodplain) wetlands. In this latter case, the SAB supports a more definitive statement that the scientific literature does provide adequate information describing the numerous functions of unidirectional wetlands that benefit downstream water quality. The SAB recommends some revisions to improve the clarity of the document, better reflect the scientific evidence, and make it more useful to decision-makers. Our major comments and recommendations are provided below.

Comments on executive summary

The point of an executive summary is to highlight major areas of agreement and disagreement with the report. This is done most effectively by listing comments in the order of importance rather than chronologically. The current format of the executive summary will make it confusing for the EPA staff, decision-makers, and the public to understand which issues must be resolved for an adequate technical report to be finalized, and which issues would be nice to resolve but are less critical.

Comments on responses to charge questions

1. The majority of the SAB charge questions were related to how well the EPA Report summarized the peer-reviewed literature. Any recommendations made by the SAB for text or concepts to insert or change should be accompanied by citable literature. This is done in many, but not all, sections. See attached edited document with sections highlighted that need citable literature. The original comments from SAB members submitted in 2013 contained many citations to relevant literature. Were these adequately carried forward to this report?

2. Section 3.1.4 contains a list of recommendations not related to the conceptual model and literature review which are (or should be) raised in appropriate sections elsewhere in the report. This section should be cross checked with the rest of the report and then deleted.
3. Section 3.2.3 is very long and could be summarized to capture the main points of a flowpath framework. See attached proposed edits. A sample diagram (e.g., a block diagram from a USGS report) would be helpful to illustrate what is described in the text.
4. Section 3.2.3 refers a number of times to *mapping* the proposed classification system onto the conceptual framework. This needs to be clarified; the SAB report never states what is intended in use of the word mapping. Similarly, section 3.2.5 refers to *layers of complexity* being represented in the conceptual model and *layering water and wetland function on the flowpath framework*. These words are confusing. *Mapping* should be clarified as, for example, “*the proposed classification framework should indicate how different wetlands correspond to discrete points along the continuous gradients described in the conceptual model*”. *Layering water and wetland function* should be clarified as, for example, “*more complex hydrological, biological, and other processes should be described in terms of how they relate to the continuous gradients described in the conceptual model*”.
5. Section 3.2.3 and 3.2.5 both discuss the conceptual framework so they should come one after the other. Section 3.2.4 (currently in the middle) is about terminology.
6. Section 3.2.4. The SAB proposes the terms “bidirectional” and “unidirectional” be replaced with more commonly understood terms: “waters and wetlands in riparian/floodplain settings” and “non-floodplain waters and wetlands”, respectively. I agree that the terminology is a problem but I disagree that these terms are easier to understand than “bidirectional” and “unidirectional” for two reasons. First, it is problematic to define a group of wetlands in terms of what they are not. This may be equally confusing to decision makers and the public as uni- or bi-directional. Second, there are many different wetland classification systems, and some that use the terms “riparian” and “floodplain”, but a classification system with only these two classes is not widely accepted or commonly understood. There is no one perfect wetland classification system that meets all needs. However, if a classification system is necessary for the purposes of this report, it might be worthwhile spending a small amount of time reviewing the classification systems currently in use and selecting one that is most appropriate for making a connectedness determination.
7. The terminology issue (uni- vs. bi-directional wetlands) is raised numerous times in the draft comments, including sections 3.5.2 and 3.7.2. It only needs to be raised once, in section 3.2.4.
8. Section 3.3.10 recommends that a case study that focuses on human-dominated systems should be added. I disagree with this recommendation; all of the case studies have a significant element of human alterations, thus no case study solely devoted to human-dominated systems is necessary. Additional case studies should discuss wetlands in regions not covered in the draft Report (e.g., Alaska).

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9. Section 3.3.10 asks for clarification of how case studies were selected. This belongs in earlier section 3.1.5 because it is not specific to streams.
10. Figure 1 in Section 3.7.3 (and all of this section) is redundant and confusing. The gradients portrayed here are a subset of those described in the conceptual framework, thus the figure is redundant and the text should refer back to the conceptual model described previously. The figure is confusing: it is not clear what is meant by the two lines with black dots at the end; groups of information in the two halves of the diagram are not conceptually parallel to one another; this is a section on unidirectional wetlands but it is not clear if these gradients apply to both uni- and bi-directional wetlands.
11. Format of recommendations in section 3.8.2 should be the same as the other sections. The current format is confusing.

See other specific comments in 4/23/14 redline-strikeout draft of the Panel's report.

Dr. Genevieve Ali

The SAB report captures well the essence of the discussions that took place last December in Washington D.C. Its structure is appropriate and the writing style rather consistent, despite the fact that it was written by different individuals. In general:

- With regards to reaching consensus: I am very comfortable with 90-95% of the recommendations provided in the report and do not see the rest I do not agree with as deal breakers. I am only worried that our (the panel's) recommendations to the EPA could lead to an already long report being even longer; however this issue could be addressed in a revised connectivity report by moving the full case studies to appendices, building summary tables and matrices and having a more consistent writing style throughout. I am happy that such recommendations are made by the SAB and I fully agree with them.
- With regards to elements that might be inaccurate or problematic: the SAB report sometimes refers to the "strength, duration and magnitude" of connectivity: I do not understand the (subtle?) difference between strength and magnitude, and I would argue that the "frequency" aspect is not taken into account with that formulation. There are other statements in the SAB report that refer to the "frequency, duration and magnitude" of connections and I fully agree with those. For the sake of consistency, I would like our panel to discuss the aspects of frequency, duration, strength, degree and magnitude of connectivity so that we can agree on a single formulation and use it consistently throughout the SAB report.
- With regards to the writing style: Some parts of the SAB report are written using the third person (e.g., "the panel recommends") while others are written using the first person

(e.g., “our major comments”). I am assuming that a consistent style will be applied prior to submission of the SAB report to the Administrator.

- With regards to elements requiring additional explanation or context: several parts of the SAB report refer to the graphical and tabular ways of better organizing information as per the IPCC reports. It would probably be worth being more specific as to what we (the Panel) want. There are currently three references to IPCC reports in the SAB report:
 - a) P7 L36-37: The suggestion is to build a summary table of key findings (similar to those included in IPCC reports) and include it in the executive summary.
 - b) P8 L19-21: The recommendation is that an IPCC-like “matrix” be built to quantify the relative certainty of connectivity or an effect.
 - c) P30 L5-8: The use of IPCC-like “graphical methods” is suggested in order to convey the level of confidence in the Report’s conclusions.

While I understand the rationale behind all three suggestions/recommendations, they include additional work to be done at different “levels”: suggestion (c) implies that the confidence or uncertainty needs to be assessed only at the conclusion stage (Chapters 1 and 6 of the connectivity report) while suggestion (b) could be interpreted as concerning individual chapters. We (the panel) might want to clarify what we mean by suggestions (b) and (c). I agree with suggestion (a) and suspect it is in fact very similar to (c) but worded differently.

See other specific comments in 4/23/14 redline-strikeout draft of the Panel’s report.

Dr. J. David Allan

The SAB Review is excellent and comprehensive – very well explained and clearly written. Congratulations to the various writing teams and committee leadership for their hard work. Although I am in strong agreement overall with in this report, I believe that discussion of some issues may further improve and clarify the SAB Review.

The SAB recommends that the interpretation of connectivity be revised from a dichotomous, categorical distinction (connected versus not connected) to a gradient approach that recognizes variation in the strength, duration and magnitude and effect of those connections. I believe the SAB Review makes a strong and appropriate case for considering connectivity as a gradient. Parenthetically, I do not agree that the EPA Report actually uses a binary, “connected-not connected” categorization – degrees of connectivity were apparent to me within the unidirectional category (e.g., EPA Draft Report Fig 3-18). In advocating for a gradient approach, I think the SAB Review needs to urge that the Draft EPA Report very explicitly address the strength of connectivity along that gradient. Otherwise the SAB Review and Draft EPA Report risk the criticism that we find everything to be connected, with no clarity on the gradation. It sometimes seemed to me that the SAB Review shifted back and forth between an “everything is connected” perspective and a “gradient of connectivity” perspective. While I do believe these are compatible, I wonder if subtle shifts in emphasis between these two perspectives with the SAB Review might be better minimized.

For example, on P 14 line 23, I really like how this discussion and raising the concept of variable source areas helps to explain transitions between, say, a wetland during drier periods becoming a flowing stream during wetter periods. But I wonder if the closing claim in this paragraph of no fixed lines between categories is over-stated, in light of other recommendations by the SAB to acknowledge a gradient of connectivity – this might be perceived as trying to have it both ways.

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P 16 lines 31ff: I believe we did not reach consensus on this sentence: “In other words, there are no isolated wetlands; rather, all waters and wetlands are connected, differing only in the degree of connection and the degree to which those connections matter to the chemical, physical, and biological integrity of downgradient waters.” Moreover, at least within this paragraph, this sentence acknowledges a gradient but does not help to clarify the strength of connectivity. Perhaps this is the place to insert a sentence or two to the effect that the strength of connectivity will vary and can only be assessed on a case by case basis. (Later in my comments I ask whether the SAB Review is discarding the EPA Report’s recommendation for case by case evaluation when the degree of connectivity is weak.)

P 17 line 18: “all waters and wetlands are connected at sufficiently long time scales” troubles me given that nowhere to this point has the SAB Review indicated what time scale it is considering (and later in the SAB Review the timeline is extend to thousands of years)

P 17: layers of complexity – all very good and helpful. Under “spatial and temporal scales” might be an opportunity to clarify some important timeframes for freshwater connectivity, such as 100-year floods (while acknowledging that events on even longer timeframes, such as debris

movements, can be important). I am uncomfortable with an open-ended temporal scale that might appear to embrace very long time frames.

P 49 line 26: The same issue arises with the argument that everything is connected if the time scale is long enough (lines 39-40 “sufficiently long time scales”; P 49 line 36 “thousands of years”). I feel this seemingly side-steps the issue of degree of connectivity and the gradient concept.

P 49 line 40: *“Over sufficiently long time scales all aquatic habitats are connected to downstream waters through the transfer of water, chemicals or biota, yet the magnitude and effects of these connections vary widely across wetlands.”* Although this statement acknowledges variation in magnitude of connectivity, I think the SAB Review should direct the EPA Report towards greater specificity, rather than towards very general statements that provide little guidance on the degree of connectivity. Might this be an opportunity to suggest that, while all systems are connected, the strength of connectivity is affected by many variables and is best decided on a case by case basis?

P 48 Figure 1: This diagram is terrific!

The SAB disagrees with the EPA’s conclusion that the literature reviewed did not provide sufficient information to evaluate or generalize about the degree of connectivity (absolute or relative) or the downstream effects of wetlands in unidirectional landscape settings. The SAB finds that the scientific literature does provide information to support a more definitive statement and recommends that the EPA revise the conclusion to better articulate those aspects that are clearly supported by the literature and the issues that still need to be resolved

P 5 line 14: “To the contrary, the SAB finds that the scientific literature does provide information to support a more definitive statement (i.e., numerous functions of unidirectional wetlands have been shown to benefit downstream water quality)”. It would be helpful if the SAB Review could be more explicit on these numerous functions.

P 16 lines 31ff: To repeat my comment also given above, I do not believe we reached consensus on this sentence: “In other words, there are no isolated wetlands; rather, all waters and wetlands are connected, differing only in the degree of connection and the degree to which those connections matter to the chemical, physical, and biological integrity of downgradient waters.” It also appears that the notion of a ‘case by case’ evaluation, prominent in the EPA Report, is implicitly being rejected by the SAB Review. If true, I think this needs careful consideration.

The SAB finds that these terms do not adequately describe the four-dimensional nature of connectivity and recommends that they be replaced with more commonly understood terms that are grounded in the peer-reviewed literature.

P 16 lines 24-29: “Therefore, the SAB recommends that bidirectional wetlands be called “waters and wetlands in riparian/floodplain settings” and unidirectional wetlands be called “waters and wetlands in non-riparian/non-floodplain settings.”

If “non-floodplain waters and wetlands” is to become the preferred term, I’d like to see this section of the SAB report expanded to more fully explain the reasoning. I think a reader would gather that “unidirectional” is to be avoided because it is incorrect – flow paths are multidirectional and multi-dimensional; and “geographically isolated wetland” is to be avoided because it is misleading – perhaps accurate in terms of surface topography, but again fails to convey that flow paths are multidirectional and multi-dimensional. Nonetheless, “non-floodplain waters and wetlands” feels like a grab-bag and the reader likely will wonder what is included (or not included). A table would help, listing all the categories (prairie potholes, playa lakes, and those wetlands without a visible and permanent flowing water connection, often referred to as “geographically isolated” because of surface topography). In short, this key recommendation is inadequately explained.

What will become of Fig 3-18 from the EPA Draft Report? (“Types of hydrologic connections between unidirectional wetlands and streams or rivers”). In my opinion, this figure serves a useful purpose by illustrating the gradient of connectivity (also, this is why I think it oversimplifies the EPA Report’s arguments for the SAB Review to say it uses a binary “connected/not connected” framework).

The discussion of how to deal with geographically isolated wetlands might restrict itself to simply making the case that the usage implies isolated in landscape position, but that both hydrologic and biological (and perhaps chemical?) connections exist. Perhaps we should put more emphasis on placing the term “geographically isolated wetland” within “non-floodplain waters and wetlands” and recognize that this term is widely used in the peer-reviewed and government report literature, rather than criticize it. A quick google search pulled up 70,000 hits for this term, including publications of the USFWS and Tiner (2003) at the top of the list.

The SAB also recommends that the Report more explicitly address the cumulative effects of streams and wetlands on downstream waters, particularly the spatial and temporal scales at which streams and wetlands are functionally aggregated.

P 8 line 45: “the Report should contain a discussion of the spatial and temporal scales at which streams and wetlands are functionally aggregated.” A good recommendation but perhaps could be clarified with some supporting language.

P 50 line 12: I am not sure that the aggregate effect of wetland complexes is analogous to the aggregate effect of ephemeral headwater streams (this parallel is not stated as such but the reference to wetland complexes seems to parallel earlier treatment of stream networks). Are wetlands always in complexes? Should a ‘lone’ wetland be protected?

The SAB Review makes explicit mention of human alterations in a number of places, following the rationale that many if not most freshwater systems have experienced human alteration. I understand and agree with this rationale, but wonder if we might inadvertently give the impression that the alterations we mention (dams, ditches, levees, etc.) should be considered under the CWA.

P 18 line 18: I think we should discuss what we wish to achieve by acknowledging human alterations, particularly because of our examples. Consider the sentence: “Therefore, downgradient waters might suffer consequences if the degree of connectivity is altered by human

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activities.” Isn’t this for the regulatory process to address? And aren’t we giving the impression here that perhaps ditches and dams, if they influence connectivity, should be addressed by the CWA? In short, what is the purpose of this section, and does it stray into identifying human actions that should be regulated?

P 25 line 15: the human alterations are again described. In addition, the SAB Review suggests a review of all the ways that human activities alter connectivity, which is quite a large task. Perhaps a table could be developed that listed main categories of alterations to connectivity, with brief description and examples. If this direction is pursued, a useful citation is:

Blann, K. L., J. Anderson, G. Sands, and B. Vondracek. 2009. Effects of agricultural drainage on aquatic ecosystems: a review. *Critical Reviews in Environmental Science and Technology* 39(11):909-1001.

P 40 Line 27: human alterations again brought into discussion - levees

P 44 line 44: ditches and levees

P 50 Line 39: human alterations here focus on man-made wetlands rather than human alterations to waters – quite different from previous sections on human alterations.

In summary, I wonder if it is appropriate for the SAB Review to encourage the EPA Report to make repeated reference to human alterations, with specific examples. I am concerned that the use of specific examples could lead to the conclusion that any such alteration should be considered in violation of the CWA, or, conversely, that systems are already so altered that any additional alteration may be unimportant. I think it might be better to bring up this topic early in the conceptual framing, and then not return to it.

See specific comments in 4/23/14 redline-strikeout draft of the Panel’s report.

Dr. Lee Benda

Overall I found the SAB’s review document to be a concise and well organized reporting of the panel’s written reviews and in person (meeting) consultations regarding EPA’s Draft Report of stream and wetland connectivity. I particularly liked how the review’s structure included an executive summary and how the responses to the EPA’s Charge Questions included both an in-depth discussion followed by bulleted recommendations.

See specific comments in 4/23/14 redline-strikeout draft of the Panel’s report and the following general comments

In numerous places in the SAB review document, the term “hydrological”, specifically referring to flowpaths and connectivity, subsumes related physical watershed processes, specifically erosion and the flux of sediment and organic material. I think that if “hydrological” is to be understood to be all encompassing, then here and at a few other strategic locations in the SAB

review document, this should be clarified. For example, the term “hydrological” could be followed with “(*inclusive of geomorphic processes such as erosion, sediment transport and deposition*)”. Alternatively, geomorphic processes could be added to the other three core components (hydrologic, geomorphic, chemical, biological).

General Comment. The flowpath framework is recommended to encompass processes such as groundwater, hillslope hydrology and variable source areas, basic ingredients underlying in-channel flow. We could include in this mix the concept(s) involved in generating a flow hydrograph from the many upstream point sources of water or individual tributary sources of water; the Geomorphic Unit Hydrograph (GUH) approach (Rodriguez Iturbe and Valdes 1979) could be useful for that purpose. The GUH (or something similar) could be identified in the SAB review document (see later) as one of the characterizations underlying the concept of aggregation or cumulative effects regarding flow generation in river networks. A similar conceptual framework will be suggested for the supply, routing and mixing of many point sources of sediment (and from tributary streams) that create the full in-stream sediment budget anywhere along a river network.

Pg. 43, 3.6.2, lines 23-41. Although this section deals with waters and wetlands in riparian/floodplain settings (Charge Question 4b), this paragraph contains the more general comment of adding the temporal perspective of connectivity using the well-developed science of flood forecasting (addressing vertical and lateral connectivity onto the floodplain-wetlands, and more generally onto other non wetland floodplains (riparian areas and even upslope non riparian areas)).

In the SAB document, and in my comments herein, there exist recommendations to characterize or quantify the strength of connectivity and thus the significance of the connectivity effect in the EPA Draft Connectivity Report. More generally, the strength of connectivity that includes the temporal dimension (frequency-magnitude) and the spatial dimension (proximity but also the cumulative and aggregate effect) should be discussed and perhaps illustrated for *each* of the main EPA Connectivity Report components (tributaries, floodplains/riparian areas/migration zones, floodplain wetlands and non floodplain wetlands). The SAB could provide some useful illustrations to help guide EPA, such as what was done in the Figure 1 on Pg. 48. For example, illustrations could cover:

- 1) channel-floodplain connectivity via flood frequency forecasting technology (as mentioned in 3.6.2), inclusive of the concept of the flood pulse,
- 2) role of aggregate floodplain storage of water on flood attenuation,
- 3) channel migration,
- 4) tributary aggregate effects on flow hydrographs via the GUH or something similar,

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- 5) tributary aggregate effects of erosion and sediment supply (and organic material supply), including from ephemeral channels, on larger channel sediment supply and storage (habitat maintaining sediment flux) based on space-time convolution via stochastic simulation models (Benda and Dunne 1997a,b) and
- 6) the aggregate hydrological effects of non floodplain wetlands on basin hydrology (as previously cited Johnston 1990).

Perhaps because of the apparent utility of including the riparian processes in the discussion of connectivity and including the issue of flood frequency-magnitude including impacting non riparian areas, and channel migration zones, that the warnings issued in 3.6.1 and 3.6.2 about refraining from including non wetland riparian areas in the EPA Connectivity Report (of which I am one of the sources of this warning) should be tabled, with concurrence from EPA.

If so, then this issue needs revising as it is mentioned again under “Recommendations” on Pg. 45.

Dr. Kurt Fausch

See specific comments in 4/23/14 redline-strikeout draft of the Panel’s report.

Dr. Siobhan Fennessy

See specific comments in 4/23/14 redline-strikeout draft of the Panel’s report.

Dr. Michael Gooseff

1. I know the difference between the draft report that we were reviewing on connectivity, and our report, but it gets a bit confusing to refer to both as 'reports' (i.e., the SAB report, as noted in the header, and of course 'the report', as noted in the text for reference). Can ours be called a 'review' instead? This is more of an issue I expect to come up with outside entities referring to our report on a report rather than a concern about internal confusion of the two (though that may occur too).
2. In several places where we request more detail on the characteristics of connectivity (e.g., "the quantification of the degree, magnitude, or consequences of connectivity" on p. 1, line 45; "variation in the strength, duration and magnitude and effect of those connections" on p. 2, lines 3-4; "though the magnitude and effects of these connections" on lines 22 and 23, p. 5; throughout section 3.1.2. response on . 8; and then of course in the detailed responses), I question 2 things about this language –

(a) should we include 'frequency'? Perhaps this is implied to be characterized somehow, but it is not explicitly called out. Is it too demanding to discuss *frequency* of connection? This too is a range or continuum of options to consider. Given some emphasis on ephemeral and intermittent streams, it seems appropriate to request this within the scope of the

Report. Given subsection 3.5.3 and the discussion of the temporal context of connectivity, it seems appropriate to include 'frequency' in this list.

(b) I am concerned that the inclusion of terms like "consequences" and "effect" begin to go beyond our focus on connectivity. My interpretation of what we have been charged with is to focus on the "nexus/connectivity" part of the 'significant nexus', but NOT the significance part. We discussed this at some length in our meetings in Washington DC in Dec. I would suggest that we either remove such terms from our Review, or clarify so as to be careful not to incite confusion.

3. on p. 10, line 1, we recommend that the definitions of 'river' be consistently used. In the spirit of trying to 'improve the usefulness of the document to decision makers' (p. 7, line 13), I continue to be concerned that the definitions of 'stream' and 'river' that include both surface water and groundwater components (as they do now in the Report), will only serve to confuse the public and decision makers (including Congress). Language used in the summary, such as the recommendation to "require additional detail ... [on] groundwater-surface water interactions" (p. 3, lines 27-28), is not the most direct way to require attention to these definitions. I suggest that we be more explicit. Perhaps a sentence that explains why this term should be used consistently or the consequences of it's current definition would be appropriate at this point in the Review? Other opportunities for this explanation are in the subsection 3.2.4 Revising and Defining the Terminology Used in the Report, subsection 3.3.1, and 3.3.2. It is difficult to discuss hyporheic exchange or other groundwater-surface water interactions if "stream" and "river" include substantial elements of both. Perhaps we carefully outline the potential pitfalls of the nuanced definitions and leave the final decision on how to proceed to the Report authors.

Dr. Judson Harvey

See specific comments in 4/23/14 redline-strikeout draft of the Panel's report.

Dr. Lucinda Johnson

See specific comments in 4/23/14 redline-strikeout draft of the Panel's report.

Dr Michael Josselyn

Overall, the Draft Report captures the discussion of the Panel; however, it needs considerable work to bring the main concepts expressed by individual panel members in the sections for which they were assigned to the Executive Summary and set of recommendations. In addition, the way in which the various sections were written by individual groups means that there is considerable variation in the style and level of detail for each of the sections. I am concerned that substantial editorial review is required to be sure that some topics are not repeated too often whereas others are left out or given minor attention as they are not fully developed. Some sections are only outlines of suggestions; others go into great detail on recommendations. Some sections repeat similar themes or topics (e.g. human alterations, terminology) and such

redundancy needs to be removed. Other sections reference each other and the conceptual model, but provide recommendations that are slightly different and may be confusing to the EPA staff charged with revising the Report. The report contains only one figure; however, I believe figures related to the conceptual flowpath model are needed to make the Report understandable to the reader.

My comments are provided below:

Section 1.0 Executive Summary

It is my conclusion from the Panel's recommendations that the Report will require more than just cosmetic revision or "strengthening", it needs to be substantial revision and subsequent review. A new conceptual model, additional analysis, and added reference materials may alter findings and conclusions of the report. Specifically, the recommendation that the Report provide further clarification on the use of the term "connectivity" and how the relative degree of connectivity is measured; that the Report provide greater analysis on how connectivity may change on a temporal and spatial scale using the existing scientific literature; and that the Report provide more quantitative as well as geographic analysis of the scientific literature; will, more than likely, alter the conclusions reached. This is an inescapable result of these recommendations, yet the Panel Executive Summary fails to make this strong recommendation that once these changes are made that the Report should be reviewed again by this Panel.

I think that the Executive Summary as currently written merely suggests additional measures that will clarify or strengthen the Report and is misleading in the character and significance of the more detailed recommendations contained in the Report. The statement that the report "could be more useful to decision-makers" (page 1, line 43) must be replaced with a stronger emphasis that, currently, the report as written does not provide useful information related to the interpretation of connectivity (and especially the degree of connectivity), except in a very general sense. The fact that all water flows downhill (either through surface or underground) is not useful when the fundamental issue is the measure of the relative importance that individual or groups of wetlands and waters play in modifying or affecting downstream water quality within the broad geographic landscape in the US. Clearly, there is a substantial body of science on this issue which the report has uncovered, it just has not been analyzed in a manner that can address that question in a regulatory or legal sense

Section 2.0 Introduction

My only comment on this brief introduction is that it should contain a statement on the number of written comments received from the public on the Draft Science Report, the number of comments received in public testimony, and how those comments were incorporated into the Panel review process.

Section 3.0 Responses to EPA's Charge Questions

Section 3.1 Overall Clarity and Technical Accuracy of the Report

Section 3.1.1

I concur with the recommendations made in this section.

Section 3.1.2

I strongly agree with the recommendation that the “degree, magnitude, or consequences of connectivity” have not been analyzed in sufficient detail and that this needs to be emphasized within the Recommendations. I suggest a re-wording of the first recommendation to state:

- *There must be more analysis of the scientific literature to provide a better quantification of the degree, magnitude, and frequency of various hydrologic, chemical, and biological connections for each of the wetland types and “waters” that are discussed in the report to better understand the consequences that they have on downstream water quality. Where there is uncertainty in the understanding of these consequences, such uncertainty needs to be discussed.*

The Report should explain the differences in the definitions used in the report from those used in the regulations it proposes to inform. At present, it presents an analysis using terminology that will be confusing to the decision makers as it is not the same as the legal definitions in the regulations it proposes to inform. Specifically, the Report bases its definition of wetland on a broader definition than contained in the Clean Water Act and also combines its analysis of unvegetated features (ponds, lakes, and basins) with vegetated features. I suggest a recommendation to state:

- *The Report must explain how the definitions in the Report for rivers, streams, and wetlands differ from those used in the Clean Water Act and its regulations and how such differences may affect the analysis contained in the Report. In addition, the Report should present an analysis of the differences in the functions associated with vegetated and non-vegetated wetlands as defined in the Report.*

As to the recommendation on dealing with spatial and temporal scales for aggregation, I believe that a stronger recommendation is needed so that the document will be more useful to the decision-makers. In particular, I suggest the following recommendation:

- *The Report should more explicitly explain how the scientific literature can be used to address the cumulative and aggregate effects of streams and wetlands on downstream waters. In particular, the Report should determine if the scientific literature can support a more quantitative approach to the scale (both spatial and temporal) at which aggregation over a watershed (e.g. HUC classifications) should be considered to have an effect on downstream water quality.*

3.1.3

I concur with these Recommendations and suggest an additional recommendation to deal with the lack of information contained in the report on certain geographic regions of the US (and the wetlands contained in those regions) to state that:

- *The Report should analyze the scientific literature evaluated for this report to determine where it may be insufficient to draw conclusions on the degree of connectivity for certain wetland systems or geographic areas by preparing a table that shows the distribution of the scientific literature for various regions of the US.*

3.1.4.

I concur with these recommendations and believe that since the decision makers need to understand that the literature is often focused on natural systems and not human altered systems that the topic related to human modifications should be expanded to include an additional statement (in italics) at the end of the topic of “human modifications” which states

- Human modifications and their impacts on connectivity... (e.g., piped streams, stormwater pipes). *Differences in the functions associated with these man-altered systems and their natural counterparts should be evaluated using the scientific literature base.*

3.1.5.

I concur with these recommendations and that they should be removed from the body of the report and used only for the purpose of examples. This can best be achieved in a “text box” type of approach.

3.2

Conceptual Framework: An Integrated, Systems Perspective of Watershed Structure and Function

3.2.1

The Report needs to not only define “connectivity” but also how the scientific literature can or cannot be used to determine the degree of connectivity and its effects on downstream water quality. To be most useful to the decision makers, the Report should consider the tools that are available to measure and quantify the degree of connectivity. I recommend a change (italics) to the recommendation:

- Connectivity should be defined and discussed at the beginning of Chapter 3 of the Report and *a discussion included on how the scientific literature was used to establish the degree to which such connectivity was determined to have an effect on downstream water quality.*

3.2.2

I previously commented on this use of the definitions used in section 3.1.2 and concur with this recommendation, but would expand it to state that the Report should also provide an analysis of how the wetland definition used in the Report could lead to differences in the degree of connectivity found. I suggest that this recommendation be expanded by stating:

- The differences between the wetland and waters definitions used in the Clean Water Act regulations and those used in the Report should be clearly explained. The Report should document, based on the scientific literature, what differences this may have on determining the degree of connectivity between wetlands and waters with downstream water quality.

3.2.3

I concur with the general concept of flowpaths and their multi-directional nature. However, I think that the term “continuous” in this context is somewhat misleading as it assumes that all connections are unbroken, steady, or persistent. This is clearly not true as many are episodic, ephemeral, or inconsistent. While it is true to the hydrologic cycle is continuous over time, the introduction of this term into the conceptual framework can present confusion, especially with later recommendations in the report dealing with uncertainty in the timing and frequency of these connections. Since the Report is trying to document “connectivity”, I suggest we avoid using the term “continuous” or “connected” in the framework and that we simply state “hydrological, chemical, and biological flowpaths”.

I am concerned that the flowpath conceptual framework not simply discuss all the possible connections but also deal with the differences between those flowpaths. For example, surface water connections are more likely to have quicker and more direct influence on downstream water quality than groundwater connections; especially those that may be related to deep aquifers. Just because a flowpath may be present does not mean that downstream water quality will either benefit or be effected by such a flowpath. This may best be addressed through the four pathways described on Page 14, lines 6-21. As used on Page 14, line 34, I disagree with the use of the term “continuous phenomenon” as this is not the same as the switching behavior described in this paragraph. This is more of an example of how flooding can result in a change from a groundwater to surface water connectivity.

As to the discussion on ASTM and RASA, I would appreciate more information on these systems before concurring on their inclusion in the report. I am not sure that I believe that the Panel should favor one specific standard over another without further background and technical information on their validity to the issues involved in this report.

I suggest an additional recommendation to this section:

- In presenting this conceptual framework, the Report should also discuss the temporal and spatial significance of the various pathways to downstream water quality.

3.2.4

I concur with the discussion why uni- and bi-directional terminology should be changed, but again recommend that the use of the term “continuous flowpath” (Page 16, line 42) be changed to flowpath. I do not believe it would be useful to further confuse the public and the decision

makers with something that may actually be discontinuous during shorter space and time intervals for which regulatory decisions are being made. While scientifically correct over millennia, it may not be understood within the context of the regulatory environment nor may it have an effect on downstream water quality that can actually be measured within the timeframe contemplated by the conceptual model.

It is important, I believe, that the SAB members recognize that “isolated” is a term that is used by the regulatory practitioners and that while it may not be relevant to the conceptual model, the fact that it is used as a means to distinguish those wetlands that may have a very limited impact on downstream water quality. Furthermore, many “isolated wetlands” are considered not be connected by surface water to downstream waters under the regulatory scheme, although they may be connected (at least some of them) by groundwater.

I suggest that the discussion and recommendation given within this section related to “geographically isolated wetlands” be dealt with under terminology and that the recommendation should simply recognize that the term “isolated” has many meanings and that it generally has been used to refer to those wetlands which lack surface water connections.

3.2.5

Some of the considerations raised in this section of the draft SAB report are more fundamental and should be moved to the Section 3.1 of the Report. Issues such as functions, human altered systems, regionalization, and map scale are issues that must be addressed by the Report as a whole and not just in conceptual model. I recommend that they be moved towards the initial section of the Report.

I believe that the two most important consideration in this section should deal with the function framework and the spatial and temporal scales. These should be specifically addressed within the conceptual model framework as they directly relate to how connectivity is measured and what types of connections have an effect on downstream waters.

One additional issue that might be discussed within this section of the SAB Report is the regulatory role that the EPA plays in terms of regulating surface waters vs groundwater. This may become more relevant once the SAB reviews the Draft Rule proposed by the EPA and the Corps. At present, the regulatory context of the Clean Water Act is related to surface water and the role of wetlands and other waters on the surface water quality of the nation’s waters. While it is clear that groundwater is an important element of wetland hydrology from a scientific basis, I believe that the Draft Report will need to have some discussion of the regulatory environment under the Clean Water Act and the constraints that it imposes on groundwater regulation.

3.2.6

I concur with this recommendation

3.3 Review of the Literature on Ephemeral, Intermittent, and Perennial Streams

Comments from individual members of the Science Advisory Board (SAB) Panel for the Review of the EPA Water Body Connectivity Report to assist meeting deliberations. These comments do not represent consensus SAB advice or EPA policy. DO NOT CITE OR QUOTE

I do think that this section should provide some further recommendations related to geographic differences in stream dynamics; especially in the western United States. At present, the Report does not discuss streamflow dynamics nor distinguish between those streams that flow intermittently from those which may flow only every 5 to 10 years in the arid west. I believe that a section should be added to the review with a recommendation that the report should evaluate the degree of connectivity associated with streams that may only flow on decadal events or for a few days or hours.

3.3.1

I concur with this recommendation.

3.3.2

I suggest that for each of these recommendations that the following phrase be added after each: *“and the effect of these processes on downstream water quality, if known”*.

3.3.3

No comments.

3.3.4

I concur with these recommendations.

3.3.5

I concur with this recommendation.

3.3.6

Another outcome of human alteration is the reduction in connectivity between headwaters and downstream waters. In some cases, these human alterations have been permitted and approved by government agencies such as dams, groundwater withdrawal, or irrigation diversions. They have been implemented to serve human needs and as such have become the new “natural circumstances”. To the extent that the scientific literature provides information on such systems, this level of disconnection should be discussed as it may be relevant to the decision makers.

Some relevant literature may include:

Booth, D.B. 1990. Stream-channel incision following drainage-basin urbanization. *Journal of the American Water Resources Association* 26: 407–417.

Bull, W.B., and K.M. Scott. 1974. Impact of mining gravel from urban stream beds in the Southwestern United States. *Geology* 2: 171–174.

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Chin, A., and K.J. Gregory. 2001. Urbanization and adjustment of ephemeral stream channels. *Annals of the Association of American Geographers* 91: 595–608.

Doyle, M.W., J.M. Harbor, C.F. Rich, and A. Spacie. 2000. Examining the effects of urbanization on streams using indicators of geomorphic stability. *Physical Geography* 21: 155–181.

Graf, W.L. 2006. Downstream hydrologic and geomorphic effects of large dams on American rivers. *Geomorphology* 79: 336–360.

Gregory, K.J. 2006. The human role in changing river channels. *Geomorphology* 79: 172–191

Faulkner, S. 2004. Urbanization impacts on the structure and function of forested wetlands. *Urban Ecosystems* 7:89-106.

Horner, R., S. Cooke, L. Reinelt, K. Ludwa, N. Chin and M. Valentine. 2001. Effects of watershed development on water quality and soils. In: *Wetlands and Urbanization: Implications for the Future*, A. Azous and R.Horner (eds.) New York: Lewis Publishers.

Paul, M. and J. Meyer. 2001. Streams in the urban landscape. *Annual Review of Ecology and Systematics* 32: 333-365.

Schumm, S.A., M.D. Harvey, and C.C. Watson. 1984. *Incised Channels: Morphology, Dynamics, and Control*. Littleton, CO: Water Resources Publications.

Williams, G.P., and M.G. Wolman. 1984. Downstream effects of dams on alluvial rivers. Professional Paper 1286. Reston, VA: U.S. Geological Survey.

Wohl, E. 2005. *Disconnected Rivers: Linking Rivers to Landscapes*. New Haven, CT: Yale University Press.

Much of this literature finds that as urbanization increases, the fragmentation and surface and ground water connectivity to downstream waters decreases or is severed. Because the Report will need to inform decision makers on both natural as well as human altered wetlands, the comparison needs to be drawn in the Report.

In addition, as documented by the US Fish and Wildlife Service in their status and trends reports, human alterations have created many features such as stock ponds, settling basins, wastewater ponds, rice and berry farming areas, fish ponds, and settling basins that are all considered to be “wetlands” under the Cowardin definition. These features would not be considered in the same context as natural wetlands in terms of their function and connectivity and the Report should recognize the distinction. To the extent that scientific information is available on these features, the Report should document it.

3.3.7

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I think that it is important for the SAB Report to document the limitations of the SPARROW model and to recommend that, based on the availability of scientific information beyond that already reported, that this section be expanded. The references cited are primarily related to nitrogen dynamics. It may be necessary for the Panel members to provide additional documentation of references to the EPA beyond that supplied.

3.3.8

I disagree with this recommendation as it is not germane to the issue of wetland connectivity, but rather a function of non-wetland riparian forests input. Upland forests also contribute leaf litter, woody debris, and other organic inputs. However, the Report's focus is not on ecosystem function, but on connectivity of wetlands and streams to downstream waters and therefore the inclusion of non-wetland inputs would considerably expand the EPA's efforts and would not be relevant to the purpose of the Report.

3.3.9

I disagree with this recommendation for similar reasons as stated above.

3.3.10

I believe that this was covered in a previous section of the Draft SAB report.

3.4 Review of the Findings and Conclusions Concerning Ephemeral, Intermittent, and Perennial Streams

3.4.1

I strongly support the recommendation that the Report be as quantitative as possible in providing documentation on connectivity as long as scientific reports that do not support such connectivity are also included. The problem with science (as reported recently in Science) is that rarely do scientists report negative results. Therefore, the science is generally skewed towards showing connectivity in their findings. This issue should be discussed in the report under methodology. As to the recommendations, I concur with the exemption of the following:

Page 32, line 4: This recommendation should include a statement that "The Report should analyze the scientific literature and discuss the differences in connectivity within the floodplain under various flood regimes, from 1 to 100 year floods. There may be significant differences in the degree of connectivity that should be evaluated".

Page 32, line 10: This recommendation should be clarified because aquifer replenishment is a broad category and may not be relevant to downstream water quality. I suggest that it should only be discussed in terms of aquifers that address downstream water quality, not deep basins.

3.5 Review of the Literature on Waters and Wetlands of Riparian/Floodplain Settings

I suggest that the SAB Report consider requesting that the EPA better clarify the definition of the floodplain and how the literature was evaluated in terms of either a flooding frequency and duration or a discussion of a geomorphic feature bordering a stream or river. Decision makers are more likely to use flooding frequency and duration rather than a geomorphic feature and without further clarification in the Report, it could result in confusing once a rule is implemented.

3.5.1

I agree that the Report as drafted confuses riparian habitats and wetland/waters in the analysis of the literature. Upland forests also contribute woody debris and organic matter to streams, just as riparian areas do. It is important to parse out the distinction within the scientific literature between those that focus on wetlands within floodplain areas and those that focus on riparian forests.

Page 33, line 46: I suggest that this recommendation be clarified to state “The Report should further discuss how the scientific literature evaluates the relationship between flooding frequency and duration on connectivity between wetland features and their adjoining streams”.

3.5.2

I concur with the recommendations.

3.5.3

Page 36, Line 14-20: While I agree with this statement that the report should discuss degrees of connectivity, it needs to be clearly related to downstream water quality and not just water quantity or changes in hydroperiods. I disagree that the Report should go into details on flood management. I recommend deleting this paragraph.

I do concur with the recommendations, especially those that relate to a better understanding of how the scientific literature can be used to establish differences in connectivity on temporal and spatial scales and that the basis for the floodplain classification be discussed in the Report.

3.5.4

I concur with the recommendation.

3.5.5

This section is well written and points out the over reliance on a single paper for much of the findings. I concur with the recommendations.

3.5.6

I concur with this recommendation assuming that the approach used will be consistent with the other case studies.

3.5.7

I concur with the recommendations. Such alterations can become part of the normal condition upon which regulatory agencies must make decisions on jurisdiction. Such alterations can sever connectivity in many ways and should be explained in more detail such that the proposed rulemaking can consider them, especially in urbanized situations.

3.6 Review of the Findings and Conclusions Concerning Waters and Wetlands in Riparian/Floodplain Settings

3.6.1

I concur with the statements that there is a significant problem with the current evaluation of the role of wetlands in floodplains based on the combination of literature from both general floodplain studies and those that are more specifically related to wetlands within floodplains. In most cases, upland habitats (forested, grassland, scrub-shrub) are much more prevalent in the floodplain than wetlands and some functions attributed to wetlands may also be performed to a significant degree by uplands (e.g. shading, organic matter input, sediment trapping). It is important that the Report discuss how this decision on the review of the scientific literature could affect the findings reached in the Report. As to the recommendations, I suggest that the first recommendation be revised slightly:

- There is strong scientific support for the conclusion that riparian and floodplains and wetlands are highly connected to receiving waters through multiple pathways.

The reason for these deletions is that the literature was not separated in a way to make the distinction that wetlands within floodplains have similar connectivity.

I concur with the other recommendations.

3.6.2

The discussion on terminology is particularly important within this section and has been discussed previously. Given the precision that is applied in the regulatory setting for which this report will support, it is very important that definitions as used in the Report do not conflict with or present uncertainty as to what is being discussed. I also reiterate my suggestion that the report be consistent with other regulatory definitions of floodplain in relation to specific recurrent year flood events. This would also be consistent with the discussion on temporal component in this section of the Panel recommendations.

I concur with the recommendations at the end of this section.

3.6.3

I concur with this recommendation.

3.7 Review of Literature on Non-Floodplain Waters and Wetlands

3.7.1

The recommendations should not be limited to simply additional references, but should also address the analysis of those data. The paragraph within the introduction to 3.7 outlines a number of issues which were not analyzed using the data that were collected. Some of these include the types and strengths of connections that may occur between non-floodplain wetlands, the temporal and spatial scales, and the landscape position.

I suggest an additional recommendation:

- *The literature review should analyze the scientific literature to specifically address the relative degree of connectivity for various non-floodplain wetlands and describe the relative strengths of those connections for those wetlands. Geographic differences, especially as it relates to precipitation, should be analyzed.*

3.7.2

I concur with this recommendation.

3.7.3

I believe that this is a key diagram for consideration, not only of non-floodplain wetlands, but also floodplain wetlands. It might be considered for inclusion (or referenced in that section as well). The figure is consistent with the EPA recommendation that not all non-floodplain wetlands have definitive connections that have impacts on downstream water quality and may need to be evaluated on a case-by-case basis.

I concur with the recommendations with the addition of a statement at the end of the third recommendation to state:

- The EPA Report should identify endpoints for each connectivity gradient, and quantify each connection to the degree possible *based on the scientific literature and provide specific statements on where the literature is lacking or incomplete.*

3.7.4

While it is true that the Report should recognize that all systems are interconnected over long periods of time, I suggest a combination of the two recommendations to state:

- The Report should emphasize that while that all aquatic habitats are connected to downstream water (in various magnitudes) over sufficiently long time scales, such connections may not be

relevant if they do not have important effects on downstream water quality. As a result, the Report should assess connectivity in terms of those downstream effects with an emphasis on frequency, magnitude, and duration of connections.

3.7.5

This topic is also discussed previously in the SAB Draft and should be combined with that section. It is clear that a better definition of watershed and the scale (or various scales) should be evaluated in terms of how aggregation should occur. This can best be addressed, I believe, using a practical measure such as the HUC classification system so that decision makers will have a better understanding of the practical meaning of watersheds and how regulatory staff are to make decisions on aggregation. I believe that this is one of the most significant weakness of the Report in that it provides little guidance from the scientific literature on how aggregation should be done and at what scale. This is perhaps most important as it relates to non-flood plain wetlands. I suggest an additional recommendation to state:

- The Report should analyze the scientific literature to determine if there is an appropriate scaling that should be used for determining how non-floodplain wetlands may be aggregated when considering their effects on downstream waters. A discussion on the how the scaling may vary geographically and based on factors affecting connectivity should be included.

3.7.6

I suggest an addition to this recommendation to state:

- Section 5.4 and other sections of the Report should be revised to discuss the legacy effects of human disturbances and their effect on the type, strength, and magnitude of connectivity *and to describe to the degree possible how connectivity may have been reduced or eliminated by such human disturbances.*

3.8 Review of the Findings and Conclusions Concerning Non-Floodplain Waters and Wetlands

I concur that the issue is not the amount of scientific literature reviewed, but the manner in which it was analyzed. This has been discussed previously in the Panel's recommendations that the EPA should be more quantitative in its analysis rather than just listing the reports that it reviewed and the types of connections that were observed. The degree of connectivity and its temporal and spatial variability should be emphasized and characterized where possible.

3.8.1

The statement that "over sufficiently long time scales, all aquatic habitats are connected" is meant to reflect that the hydrologic cycle (via surface and ground water) and various chemical and biological processes may occur over decadal and longer time scales. This is a reminder that all ecosystems are connected; but the question that is germane to the conclusions reached in the Report is which connections and on what time scale is most important in effecting downstream water quality. This is particularly true for non-floodplain wetlands as they are often spatially

disconnected and the frequency at which they may be hydrologically connected could be decades or, in some cases where groundwater flows slowly, significantly longer. Therefore, an analysis of the literature which can assist decision makers in which types of connections may be more important than others will be of great benefit.

I concur with the recommendations.

3.8.2

This section of the report should be edited to be more consistent with the other chapters. I do not believe that the Panel should be responsible for re-writing conclusions for the Report and therefore suggest that the recommendations in Key Finding C and F be deleted and replaced with discussion for the basis of the suggested change. For example, under Key Finding C, the Panel could recommend that additional discussion and literature be added to strengthen the analysis of movement of animals between non-floodplain wetlands and other waters and how this affects downstream water quality. In Key Finding F, the Panel could recommend further analysis of the literature as it relates to spatial context in terms of slope, distance, and soil condition. I concur with the recommendation related to Key Finding B.

I believe that the recommendations in this Section should be restated to reflect the discussion in the introduction to this portion of the SAB report.

See specific comments in 4/23/14 redline-strikeout draft of the Panel's report.

Dr. Latif Kalin

The draft report is written very well. I applaud the team who synthesized the different pieces from each individual working group. The different sections of the report flow seamlessly and there are no inconsistencies between the sections, which is possible when independent groups work on each section. Below are few additional comments and suggestions.

1. In multiple parts of the report SAB recommends that the interpretation of connectivity be revised from a dichotomous, categorical distinction (connected versus not connected) to a gradient approach that recognizes variation in the strength, duration and magnitude, and consequences of those connections. SAB also talks about the lack of emphasis on cumulative or aggregate of impacts. However, it fails short on advising how these can be done (i.e. identifying the strength, duration and magnitude of connectivity; assessing the cumulative impacts, etc.). Models are effective tools for such purposes. Flood forecasting is mentioned in place, but that's not adequate (consider groundwater-surface water interaction). Adding some information on models and how they can be used for such purposes would be useful. For instance, the recent paper of Golden et al. (2014) reviews some select models suitable for studying the hydrologic connectivity between geographically isolated wetlands and surface water systems.

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2. Section 3.3.6: I suggest adding land use change in the headwater watersheds, especially increased imperviousness, under the need for discussion of human alterations. The downstream impacts of increased imperviousness in watersheds on the stream hydrology, water quality, flora and fauna are well studied and there are tons of papers in the literature (e.g. Nagy et al. 2011). There are case studies showing a perennial stream becoming ephemeral and vice versa after urbanization in the watershed, or increase in imperviousness on recharge area drying out springs.
3. Section 3.3.10 (Selection of Case Studies): I am not recommending a new case study but the Baltimore and the Central Arizona LTERs would have been perfect examples for human dominated systems. At least they should be mentioned in the report.
4. Page 31, Case Studies and Context: The 2nd paragraph states “*The SAB also recommends that the EPA develop an alternative case study framework that uses hydrology as a unifying theme. For example, stream flow is a function of runoff, which is in turn a function of weather and underlying geology, all of which vary regionally.*” I am not sure I understand what is recommended here.
5. Section 3.5.7. I suggest adding the following paper Barksdale et al. 2014, which studied the effects of watershed land conversion and associated run-off on the hydrology and carbon cycling of headwater wetlands in coastal Alabama, USA.

References:

- Barksdale, F., C. Anderson, L. Kalin (2013), "The Influence of Watershed Runoff on the Hydrology, Forest Floor Litter and Soil Carbon of Headwater Wetlands", *Ecohydrology*, 7(2):803-804
- Golden, H.E., C. Lane, D.M. Amatya, K.W. Bandilla, H.R. Kiperwas, C.D. Knightes, H. Ssegane, 2014, “Hydrologic connectivity between geographically isolated wetlands and surface water systems: A review of select modeling methods”, *Environmental Modelling & Software*, 53:190-206.
- Nagy, C., B.G. Lockaby, L. Kalin, and C. Anderson (2011), “Effects of Urbanization on Stream Hydrology and Water Quality: The Florida gulf Coast”, *Hydrological Processes*. 26:2019-2030.

Dr. Kenneth Kolm

See specific comments in 4/23/14 redline-strikeout draft of the Panel’s report.

Dr. Judith Meyer

See specific comments in 4/23/14 redline-strikeout draft of the Panel's report.

Dr. Mark Murphy

General comments. I am generally very pleased with the document assembled and acknowledge all of the hard work of the Chair and Charge Question (CQ) authors in getting the document to this point. The overall document seems to include almost all of the ideas discussed in the deliberations and subsequent discussion of which I was a part. Despite this, I think we still have significant work to do to get to a final draft. I hope EPA allows us the time to completely represent the consensus opinion of the group and I am very unclear if we can get this done in time to inform the Public Comment period of the EPA Rule. In any case, here are my suggestions.

I found the summary of the SAB Report contained in the letter to the EPA Administrator and the section on the overall accuracy of the SAB Report cogent, clear and of one voice. With a few tweaks, I would not change much; however, the rest of the SAB Report wanders from this a bit, quite a bit in some places. I think several broad changes would greatly improve the clarity. The major themes of our critique, stated in these two initial sections, should be more directly keyed to the specifics of the charge question. They are in danger of getting lost in the details.

1. First, I would like to see a consistent format in all sections of the SAB Report. Each charge question needs to start with a **brief** summary of the four or five main points, which themselves should use consistent language reflected in the executive summary. The EPA Report requires both big changes and detailed changes. The summaries need to emphasize the big changes.
2. Several of the CQ groups asked the EPA authors for a conceptual model that was consistent with the current ecological literature. CQ group 5a&b developed a diagram and accompanying text that provided an example model. Currently this material is buried in the response to CQ 5(b), page 48. The Chair and CQ authors for questions 2, 5a and 5b should work to integrate this model, or a similar one, into the initial parts of the SAB report and use it to inform the 'flow-path model,' discussed in response to CQ 2. The model should back up the comment in the Letter to the Administrator,

“ . . . the SAB recommends that the interpretation of connectivity be revised from a dichotomous, categorical distinction (connected versus not connected) to a gradient approach that recognizes variation in the strength, duration and magnitude, and consequences of those connections.”

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3. There is highly variable level of detail and voice in the text. I think that, in an attempt to include every opinion, there has been too little cutting and pasting. It maybe that following the formatting suggestion described in comment 1 will help. Consistency in nomenclature is also still a problem. The terms bidirectional and unidirectional imply that everything flows in response to gravity (flow); however, in several places the SAB has promoted the multi-dimensional exchange of energy and mass within the riverine ecosystem elaborated by Ward. The document needs to settle on terms that are not useful in the EPA report, suggest alternatives and then consistently use them.

4. There are places in the SAB report that, because of the multiple authors, repetition is extensive. These sections need to be edited.

See specific comments in 4/23/14 redline-strikeout draft of the Panel's report.

Dr. Duncan Patten

General comments on EPA Connectivity Review Document – Patten

I had a feeling after some of our comments that we should quote Chief Seattle that "This We Know. All Things Are Connected". We seem to head that direction with our comments and recommendations.

Repetitive: At first I was bothered by the text covering our recommendations and then following with bulleted recommendations. This is a form of "emphasizing one's points" so probably is good to use.

We often have similar recommendations in different sections which seems repetitive but actually is not. The reader may think it is, however.

Letter to Administrator: this is well written and organized. It will change slightly after our discussion of our report.

Some issues or points that need discussion.

We talk of all water bodies are connected given "sufficiently long time".... that is true but are we really discussing geological time here? What do we mean? Is this a way of making sure we can say all water bodies are connected regardless of distance, time, etc.?

I am concerned that we have created biological connections that will cause our report to be "laughed at" or even rejected by those who only want to see hydrological connectivity. We discuss avian connectivity, although technically correct, raises the issue of all water bodies that birds fly between are connected, regardless of how far apart. If birds can transport seeds or plant propagules between wetlands and/or bodies of water, so can wind...does wind count as a form of connectivity?

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Should we put our emphasis on hydrological connectivity and chemicals and biota that are directly tied to hydrology and not the landscape?

Often when there are discussions of surface connections (e.g., flood pulse), there is a lack of similar discussion of subsurface connections (e.g., alluvial aquifer, hyporheic zone).

On page 34 we state "Making this distinction will clarify the scope of the report and reinforce the goal of the report as a scientific, and not a policy, document." Is this a point that needs emphasis elsewhere?

See specific comments in 4/23/14 redline-strikeout draft of the Panel's report.

Dr. Mark Rains

See specific comments in 4/23/14 redline-strikeout draft of the Panel's report.

Dr. Jack Stanford

I have read the SAB Connectivity Panel report and I have no review comments. The report is accurate with respect to points raised by the panel in the review process.

Dr. Mazeika Sullivan

I have provided preliminary overview comments and suggested discussion points for the SAB Connectivity Panel Draft Report. I have also included some minor editorial suggestions. I look forward to further discussion at the upcoming SAB Panel teleconferences.

Overall, I found the Draft Report to accurately reflect the Panel's conclusions and recommendations relative to the connectivity of streams and wetlands to downstream waters. The level of detail is appropriate to provide the EPA with specific and constructive suggestions for improving the current draft (September 2013) of the "*Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Information*" (hereafter, Connectivity Review). I offer the following perspectives and comments:

General comments

1. The Panel has urged the authors of the Connectivity Review to consider gradients of connectivity (vs. as a binary property). In addition to continuous scales of frequency, magnitude, and duration, I would be interested in hearing the Panel's thoughts on more explicitly incorporating a gradient of the predictability of connectivity and its downstream effects into our recommendations. Some mechanisms of connectivity are highly predictable (e.g., migration of anadromous fish and waterfowl, spring flood pulses, seasonal peaks of

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aquatic insect emergence, etc.) whereas others are less so (flood events from storms, short-term movement of organisms, nutrient spiraling dynamics). This scale of predictability could be folded into the current gradient framework (e.g., unnumbered page one, first bullet) and/or subtly worked in to the Panel's Report in a few key locations. For example, a "predictability" axis might also be useful for Fig 1, page 48. Likewise, predictability would align nicely with recommendations related to the temporal component (e.g., flood forecasting, flood frequency-inundation science") regarding findings of waters and wetlands in riparian/floodplain settings (3.6.2).

2. The recommendation that over sufficiently long time scales, all aquatic habitats are connected to downstream waters appears repeatedly throughout the Draft Report. While certainly accurate and appropriate, I wonder if we want to revisit (or add to) this language in order to constrain or qualify the statement somewhat. This may not be necessary, but could help the utility of this document to inform regulation.
3. Consistency in the terminology of the Panel's Report is important. For example, the terms "downstream", "downgradient", and "receiving" are all used throughout the document.

See specific comments in 4/23/14 redline-strikeout draft of the Panel's report.

Dr. Jennifer Tank

See specific comments in 4/23/14 redline-strikeout draft of the Panel's report.

The following general comments are provided.

Introductory Letter:

General Comment: I found the letter to EPA summarizing the SAB Review on the physical, chemical, and biological connections of streams and wetlands to downstream waters to be accurate and clearly written.

Executive Summary:

General Comment: I found the Executive Summary outlining the SAB Review conclusions on the physical, chemical, and biological connections of streams and wetlands to downstream waters to be accurate and clearly written. Stylistically, I appreciated the abbreviated bullets used on the previous letter to EPA, and these bullets could be used effectively for the Executive Summary as well.

Potential Addition to Executive Summary: Some mention of the general utility (or not) of the case studies could be addressed, as this is mentioned repeatedly in response to almost all Charge Questions. A clear consensus should be mentioned here in Executive Summary.

Charge Question 1. Overall impressions on the clarity and technical accuracy of the EPA Report.

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General Comment: I found that this section accurately summarized the SAB Review as to whether the findings and conclusions in the Report were supported by the available science. This section is also clearly written.

Charge Question 2. Comments on the clarity, technical accuracy, and usefulness of the conceptual framework describing the hydrologic elements of a watershed and the physical, chemical, and biological connections linking these elements.

General Comments: The section reviewing the conceptual framework was clear, accurate, and reflects the SAB Review of this section of the Report, emphasizing the need for a revision of the conceptual framework. A new framework would provide the necessary foundation for describing how water and materials move in a watershed. I also agree that early coverage of all definitions is essential. The text of this section is significant, and by the end of the section, gives the impression of a complete overhaul of the conceptual framework for the Report.

Charge Question 3(a). Comments on EPA's review and characterization of the literature on the directional (downstream) connectivity of ephemeral, intermittent, and perennial streams.

General Comments: The section reviewing connectivity of ephemeral, intermittent, and perennial streams is clear, accurate, and reflects the SAB Review of this chapter of the Report. The organization of this section, with its overview paragraph for each sub-section, followed by a list of additional references to be considered, completed with bulleted list of specific recommendations, was very effective.

Charge Question 3(b). Comments on whether EPA's findings and conclusions concerning the directional (downstream) connectivity and effects of ephemeral, intermittent, and perennial streams are supported by the available science.

General Comments: In general, the section reviewing the Report's findings and conclusions on the connectivity of ephemeral, intermittent, and perennial streams is clear, accurate, and reflects the SAB Review of this section.

Charge Question 4(a). Comments on EPA's review and characterization of the literature on the (directional) downstream connectivity and effects of riparian/floodplain wetlands.

General Comments: In general, the text of the section reviewing the characterization of the literature on the connectivity of riparian/floodplain wetlands was generally clear and accurate, and reflects the SAB Review of this section.

Charge Question 4(b). Comments on whether EPA's findings and conclusions concerning the connectivity of floodplain/riparian wetlands are supported by the available science.

General Comments: In general, the section reviewing the findings and conclusions on the connectivity of riparian/floodplain wetlands was generally clear, accurate, and reflects the SAB Review of this section.

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Charge Question 5(a). Comments on EPA’s review and characterization of the literature on the connectivity and effects of non-floodplain (formerly termed “unidirectional”) wetlands and certain open waters.

General Comments: In general, the section reviewing the characterization of the literature on the connectivity of non-floodplain wetlands was clear, accurate, and reflects the SAB Review of this section particularly with the suggestion that the terminology be reconsidered and that landscape position and scale be employed in the evaluation regarding the degree of connectivity

Charge Question 5(b). Comments on whether EPA’s findings and conclusions concerning directional (downstream) connectivity and effects of non-floodplain (unidirectional) wetlands are supported by the available science.

General Comments: In general, the section reviewing the findings and conclusions on the connectivity of non-floodplain wetlands was clear, accurate, and reflects the SAB Review of this section, with an emphasis that the SAB disagrees with the overall conclusions of the Report suggesting a lack of connectivity. Rather, the text accurately characterizes the consensus of the SAB supporting “a move away from a dichotomous, categorical distinction (connected vs. not connected) towards a gradient approach that recognizes variation in the strength, duration and magnitude and effect of those connections”.

Additional Comment: It is notable that this is the only section of the SAB Review that explicitly offers alternative text or text replacement. I am very supportive of the suggested changes, but am wondering how it will be perceived, given that no other sections offered up such specific text edits.