

**Response to External Peer Review Comments of
EPA's Draft Document**

***Regional Monitoring Networks to Detect Climate
Change Effects in Stream Ecosystems***

A. INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is working with its regional offices, states, tribes, and other organizations to establish regional monitoring networks (RMNs) at which biological, thermal, and hydrologic data will be collected from freshwater Wadeable streams to quantify and monitor changes in baseline conditions, including climate change effects. RMNs have been established in the Northeast, Mid-Atlantic, and Southeast, and efforts are expanding into other regions. The need for RMNs stems from the lack of long-term, contemporaneous biological, thermal, and hydrologic data, particularly at minimally disturbed sites. Data collected at RMNs will be used to detect temporal trends; investigate relationships between biological, thermal, and hydrologic data; explore ecosystem responses and recovery from extreme weather events; test hypotheses and predictive models related to climate change; and quantify natural variability. RMN surveys build on existing bioassessment efforts, with the goal of collecting comparable data that can be pooled efficiently at a regional level.

The draft document, “Regional Monitoring Networks to Detect Climate Change Effects in Stream Ecosystems,” describes the development of the current RMNs for riffle-dominated, freshwater Wadeable streams. It contains information on selection of candidate sites, expectations for data collection, the rationale for collecting these data, and provides examples of how the RMN data will be used and analyzed.

The purpose of the requested peer review is for EPA to receive written comments from individual experts on the document and framework for the RMNs that have been developed in the Northeast, Mid-Atlantic, and Southeast regions. Versar selected three senior scientists with expertise in regional-scale monitoring of streams, including benthic macroinvertebrate sampling, bioassessment programs, and climate change impacts in aquatic ecosystems.

PEER REVIEWERS:

Lucinda B. Johnson, Ph.D.

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Duluth, MN 55811

Kent W. Thornton, Ph.D.

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Little Rock, AR 72211

Chris O. Yoder, Ph.D.

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B. CHARGE TO REVIEWERS

CHARGE QUESTIONS:

1. Are the goals of the document clearly stated?
2. Are there additional steps or sections that should be included in this document that would clarify the development and use of these Regional Monitoring Networks? If so, please describe.
3. Are the current steps needed for development and implementation of Regional Monitoring Networks described sufficient detail? If not, please suggest specific improvements.
4. Are any sections of the document difficult to understand? If so, please list the section and your suggestions for improving clarity.
5. Do you have any additional comments that would improve this document?

C. PEER REVIEWER COMMENTS

Table 1. General Impressions

Reviewer Name	Reviewer Comment	EPA Response to Comment
Lucinda B. Johnson, Ph.D.	<p>The overall goals of the proposed network is to draw from existing monitoring efforts ongoing in the States to identify a set of sites that can be used to detect potential climate change impacts as they pertain to biota (mainly benthos and possibly fish and/or periphyton), hydrology, temperature, habitat, and water quality. Two tiers of sites would be established: one set to be used as reference sites; the other set to augment the dataset, which would have some amount of background disturbance due to anthropogenic stressors. The proposal lays out the general methods for site selection, proposes a set of methods for each of the response variables, and discusses potential data sharing arrangements. Many of the decisions that contributed to the development of the network framework were derived from a manuscript in review by Bierwagen et al.; that manuscript was not provided to the reviewers, thus it is difficult to assess how some of the underlying decisions about the minimum number of sites, and other critical information (power to detect trends) were arrived at. Of most concern to me is the total lack of information or thought given to the data themselves. <i>Who will own the data for the network; how will the data be entered and QC'ed; who will be in charge of summarizing the trends; what statistical methods will be used to detect trends; who will have access to the data, and which type of data will be available to end users; in what form will the data be accessible and made available; what metadata standards will be employed; what database options are being considered, etc.</i> As for the report itself, I found the information that was provided to be reasonably complete. I found the references to be useful, and the detail given in the various appendices to be quite complete.</p>	<p>We added in a new appendix (Appendix A) that covers the relevant material from the Bierwagen et al. manuscript (it provides information on the power analyses that were performed on the Northeast data set to help inform design decision).</p> <p>We also added a new section on data management. We agree that this is a critical component of the RMNs and have been working on this issue since 2013. At this time, there is not a single existing system that can accommodate all of the types of data being collecting at RMN sites. Our strategy at this point is to get the biological, habitat, and chemistry data into the Water Quality Exchange (WQX) and develop an interim solution for the continuous data, since implementation of the national data sharing strategy for continuous data is still several years off (this is a multiagency national effort led by Dwane Young). The Quality Assurance Project Plan (QAPP) that covers the partner activities also describes the data management aspect. The QAPP will be available along with the report.</p>

Table 1. General Impressions (continued)

Reviewer Name	Reviewer Comment	EPA Response to Comment
Kent W. Thornton, Ph.D.	<p>The report was well-written and clearly describes the process for designing and implementing a regional monitoring network (RMN) to detect climate change effects in stream ecosystems in the Northeast, Mid-Atlantic, and Southeast Regions. The report and supporting appendices were informative, clearly presented, and well-reasoned. The time frame for how quickly the RMN program will be developed and implemented, however, was unclear. Adding the anticipated timeframe for the RMN would be useful for readers. The report and its conclusions were well documented, with one exception. There are numerous references to a report by Bierwagen et al., which was not available for review, but whose findings were the basis for some of the report's conclusions (Bierwagen, et al., in review. <i>Analytical foundation for a monitoring network to detect climate change-related effects in streams in the Northeastern United States</i>). Dr. Bierwagen and colleagues have an excellent research and publication record, so there is no reason to question the conclusions. However, documentation of their research findings was not available for perusal, so the conclusions must be accepted at face value. The results they presented from their research were intriguing. It would have useful to have had the Bierwagen et al. report in support of the review.</p>	<p>We added new material on implementation, timeframes, etc. into the last section of the report (now Section 7).</p> <p>We added in a new appendix (Appendix A) that covers the relevant material from the Bierwagen et al. manuscript (it provides information on the power analyses that were performed on the Northeast data set to help inform design decision).</p>

Table 1. General Impressions (continued)

Reviewer Name	Reviewer Comment	EPA Response to Comment
Chris O. Yoder, Ph.D.	<p>This is a valuable contribution to the science of climate change and biological assessment in general. Long-term ambient monitoring as envisioned by this document is a critical aspect of managing water quality and biological integrity of the Nations streams and rivers. It was made very apparent that the resources to implement such a network of sites is limited and in all likelihood this may constrain the potential of such a network. The frequent mention of these limitations was a bit distracting. I found myself thinking that if the risks of climate change are this important, then monitoring its effects and especially the benefits of early warning is certainly worth making a higher priority. The resource constraint issue also seemed to at least indirectly spill over into the document seeming to accept different levels of technical rigor for the same fundamental purpose of detecting changes due to climate change. Reason would only dictate that lesser approaches would be less able to detect such changes, so why not set an adequate technical standard for this program? Realizing these limitations, my comments are also directed at hopefully spurring additional funding and vision for detecting the effects of climate change that include both direct (i.e., thermal alterations) and indirect (e.g., hydrologic, chemical, and biological alterations) effects.</p>	<p>At this time, the RMNs are essentially a volunteer effort, with variable levels of support from EPA regional offices. However, we have revised the language addressing these limitations.</p> <p>Because it is a volunteer effort that is driven by each set of regional partners, we are trying to balance the technical standards with partner needs and abilities.</p>

Table 2. Charge Question 1

Charge Question 1: *Are the goals of the document clearly stated?*

Reviewer Name	Reviewer Comment	EPA Response to Comment
Lucinda B. Johnson, Ph.D.	<p>Although the title clearly articulates that this monitoring network is being developed to detect climate change effects in streams, the underlying data that are collected during the monitoring programs from which data will be drawn are inherently designed to detect condition in response to anthropogenic disturbances (for the most part).</p> <p>Managers might want to know what the added value is of any additional effort that will be required for implementation of this monitoring network. Can this be framed more directly in terms of the costs and benefits to the managers and the public?</p> <p>The Abstract says: Data collected at RMNs will be used to detect temporal trends; investigate relationships between biological, thermal, and hydrologic data; explore ecosystem responses and recovery from extreme weather events; test hypotheses and predictive models related to climate change; and quantify natural variability.</p>	<p>The title has been revised to “Regional Monitoring Networks (RMNs) to Detect Changing Baselines in Freshwater Wadeable Streams” to better reflect the multiple ways in which the RMN data can be used.</p> <p>In this report, added value is framed in terms of the multiple benefits derived from long-term monitoring and analyzing across broader regions, but not explicitly costs of adding sites.</p> <p>Sites with similar environmental and biological characteristics have been selected (see description of the classification component of the site selection process in Section 3) to reduce the natural variability across sites.</p>

Table 2. Charge Question 1 (continued)

Charge Question 1: *Are the goals of the document clearly stated?*

Reviewer Name	Reviewer Comment	EPA Response to Comment
	<p>Some of these goals are aspirations only, given the density of sites, and the temporal sampling frame from which the data will be drawn. The only way to achieve this entire set of objectives would be to implement a tiered sampling framework, with some sites sampled with greater intensity to detect temporal trends in response to extreme events, in particular. Furthermore, quantifying natural variability requires that there be adequate sampling and quantification across the natural gradients that control the underlying variation in biological, physical and chemical responses to be measured.</p>	<p>Regarding the frequency of sampling, in the context of routine biomonitoring, we feel that annual (and in some cases, bi-annual) macroinvertebrate sampling along with year-round thermal and hydrologic data will provide valuable information on natural variability (and will fill data gaps—there are not many high quality sites where this type of information is available).</p> <p>We agree that there is a need to track other potential sources of variability. We added in language to acknowledge that other sources of variability (land use, acid deposition, etc.) will need to be tracked in order to attribute variation to “natural” vs. other factors.</p> <p>Regarding extreme events, we added in some language to acknowledge that whether or not the RMN data can fully capture biological responses to extreme weather events will depend on the timing of the event in relation to the RMN sampling period, and that additional biological sampling may be warranted.</p>

Table 2. Charge Question 1 (continued)

Charge Question 1: *Are the goals of the document clearly stated?*

Reviewer Name	Reviewer Comment	EPA Response to Comment
Kent W. Thornton, Ph.D.	There are no explicit goals stated in the report. There is a need statement, “The need for RMNs stems from the lack of long-term, contemporaneous biological, thermal, and hydrologic data, particularly at minimally disturbed sites” (Ex. Summary, 2 nd paragraph). There are priorities (i.e., “...collect uninterrupted, long-term biological, thermal, and hydrologic data at primary RMN sites, as well as utilize and build on data already being collected...”), and uses stated (e.g., detect temporal trends, investigate and resolve relationships among biological, thermal, and hydrologic data, test hypotheses, etc.), but there are no goals stated for the RMN program. The purposes for the RMN program are clear from the information included in the report, but there are no clearly stated goals. Explicitly stating the program goals would be useful.	We revised the report to more explicitly state our goals.
Chris O. Yoder, Ph.D.	Yes, the goals are clearly stated in the abstract and the executive summary.	No response needed.

Table 3. Charge Question 2

Charge Question 2: *Are there additional steps or sections that should be included in this document that would clarify the development and use of these Regional Monitoring Networks? If so, please describe.*

Reviewer Name	Reviewer Comment	EPA Response to Comment
Lucinda B. Johnson, Ph.D.	<p>I am still confused as to who the owner of the overall database will be; where the data will be housed and served, who will be responsible for maintaining the integrity, metadata, etc. How will the data be accessed and distributed? Who will have access to the various types of data (i.e., raw data, derived metrics, trends, maps, reports, etc.)? There are no guidelines for development and storage of metadata.</p> <p>The report needs to more clearly address the question of data handling, archiving, storage, distribution, etc. For example, I am horrified at the thought that these data will be stored in an Excel worksheet, and I suspect any professional data manager would be similarly horrified. (I noted that one of the public comments also mentioned reservations about this practice.) Storing data in an Excel file seems like an accident waiting to happen (not to mention the thought of a nefarious group in a black helicopter waiting to co-opt government data for unscrupulous ends). At minimum data should be stored in some type of database (not spreadsheet), which can be linked via the station IDs. A monitoring network needs a data plan, and a data coordinator, along with an SOP for data practices. If each region is going to be responsible for handling their own data (page K-3), there must be a clear set of guidelines for how this will be done for the network sites.</p>	<p>We added a new section on data management. We agree that this is a critical component of the RMNs and have been working on this issue from the early stages (2013). The data and metadata will be available to participating organizations and outside users. At this point, our strategy is to get the biological, habitat and chemistry data into the Water Quality Exchange (WQX) and develop an interim solution for the continuous data, since implementation of the national data sharing strategy for continuous data is still several years off (this is a multiagency national effort led by Dwane Young). Until the interim data management and sharing system is in place, the individual organizations will be the custodians and owners of the RMN data. Data management is also discussed in the QAPP for this work.</p>

Table 3. Charge Question 2 (continued)

Charge Question 2: *Are there additional steps or sections that should be included in this document that would clarify the development and use of these Regional Monitoring Networks? If so, please describe.*

Reviewer Name	Reviewer Comment	EPA Response to Comment
Kent W. Thornton, Ph.D.	<p>The report is thorough in its presentation of numerous metrics/indicators that might be consider, nearly to the point of being mind-numbing. Not all of these metrics/indicators are equally likely to respond to climate change. Geographic differences among regions are also likely to moderate the response of different metrics/indicators. For example, snowmelt and associated hydrologic metrics are important in the Northeast, but not in the Southeast. Therefore, different hydrologic metrics/indicators would be expected to have a higher likelihood in the Northeast in exhibiting a response to changes in the timing or amount of runoff because of changes in snow accumulation and/or melt. It would be useful to have a conceptual model for each region that describes how stream ecosystems are expected to respond to climate change and which indicators, given the current state of knowledge, are considered most likely or probable to change. There is considerable uncertainty associated with stream ecosystem response to climate change because of the inherent variability in streams. Having a conceptual framework that envisions the pathways for change and potential, possible, and probable stream indicators of response to climate change has heuristic value. A similar approach was used to conceptualize pathways and indicators that might be contributing to eagle mortality in southeastern water bodies in the late 1990s (see Figure 1 below). Eagles suddenly started dying in the mid-1990s on an Arkansas reservoir, and by, 1998, had spread throughout the Southeast. A conceptual model was developed that identified potential, possible, and probable pathways and factors contributing to this mortality. In 2014, a neurotoxin produced by blue-green bacteria</p>	<p>The development of conceptual models to illustrate pathways for change is a good idea. However this is beyond the scope of this document.</p>

Table 3. Charge Question 2 (continued)

Charge Question 2: *Are there additional steps or sections that should be included in this document that would clarify the development and use of these Regional Monitoring Networks? If so, please describe.*

Reviewer Name	Reviewer Comment	EPA Response to Comment
	<p>was confirmed as the factor contributing to coot mortality and subsequent eagle mortality as the eagles fed on the infected coots. This pathway, and neurotoxin, was identified in the heuristic conceptual model as the probable pathway and toxin, but it took almost 20 years to confirm. A similar time frame is expected for trends in stream responses to climate change to be confirmed. Having a conceptual model, updated by region as additional information is collected and analyzed, could be useful in describing which indicators have or are expected to respond, how biological, thermal, and hydrologic indicators are interrelated, which hypotheses appear to be most probable, and communicating these results.</p> <p>An additional section on information management should be added. There is a discussion of the use of Excel spreadsheets, but little information on how data will be collated across states within a region and among regions and subsequently analyzed. The types of analyses to be conducted on the data are discussed, but not how the data will be organized, compiled, quality-assured, analyzed, and the results provided to the respective participants. Will each state analyzed their own information? How will information exchange among states within a region be organized so that regional trends might be identified? Similarly, how will these analyses be conducted among regions? Some discussion of this should be added to the report.</p> <p>As noted above, information on the anticipated time frame for development and implementation of the RMN should be added.</p>	<p>We added a new section on data management. We agree that this is a critical component of the RMNs.</p> <p>We added new material on implementation, timeframes, etc. into the last section of the report.</p>

Table 3. Charge Question 2 (continued)

Charge Question 2: *Are there additional steps or sections that should be included in this document that would clarify the development and use of these Regional Monitoring Networks? If so, please describe.*

Reviewer Name	Reviewer Comment	EPA Response to Comment
Chris O. Yoder, Ph.D.	I do not believe so at this time. However, this should be periodically revisited as the RMN gains experience.	We agree and plan to revisit protocols, indicator lists, analytical techniques, etc. with the regional working groups on a regular basis. We will mention this in the report.

Table 4. Charge Question 3

Charge Question 3: *Are the current steps needed for development and implementation of Regional Monitoring Networks described sufficient detail? If not, please suggest specific improvements.*

Reviewer Name	Reviewer Comment	EPA Response to Comment
Lucinda B. Johnson, Ph.D.	I might have missed this detail, but it is unclear how the 30 sites within and across regions will be selected. If climate change is the disturbance of interest, then as noted in some comments below, precipitation dominated versus groundwater dominated streams will have very different magnitude and types of responses to climate-related variables (and other anthropogenic disturbances), and that factor must be considered as a primary variable in site selection. What specific environmental conditions (aside from stream gradient and riffle habitat structure) and biological community characteristics form the basis for site selection?	<p>We made edits to further clarify the site selection process.</p> <p>In the updated version of the report, we are placing more emphasis on the multipurpose nature of this network, and how it can be used to support Clean Water Act programs in addition to helping to detect long-term changes attributable to climate change.</p> <p>We decided to remove climate change vulnerability from the site selection list because it was more of a secondary consideration.</p> <p>Regarding hydrologic source (e.g., groundwater vs. precipitation-dominated), that is definitely on our radar, particularly as we expand into the Midwest, where groundwater influence can be really strong (e.g., southern MN, driftless area in WI, parts of MI) or really weak (e.g., southern IL). However groundwater influence can be highly variable, even within a local reach (e.g., see Snyder et al., 2015), and we do not have good, consistent data sets at regional or national scales that capture this. For the initial screening, the best we have been able to do is to use the baseflow index (Wolock, 2003). Once data collection begins, we can examine air-water temperature relationships at each site to assess thermal sensitivity (and level of groundwater influence—see Snyder et al., 2015).</p>

Table 4. Charge Question 3 (continued)

Charge Question 3: *Are the current steps needed for development and implementation of Regional Monitoring Networks described sufficient detail? If not, please suggest specific improvements.*

Reviewer Name	Reviewer Comment	EPA Response to Comment
Kent W. Thornton, Ph.D.	The general steps for developing and implementing the RMNs is included in Section 6, Next Steps. It was not clear where the various states or regions are in the process of developing and implementing their monitoring networks, nor how long it is expected before the primary sites are operational and collecting data. Similar questions relate to the status of the regional coordinators and taxonomic resolution. Data infrastructure was addressed above. Text should be added to help the reader assess where the program currently is, by state and region, in development and implementation, and project when full implementation is expected.	We added new material on implementation, timeframes, etc. into the last section of the report. We provided general regional updates. At this point, there is too much variability in levels of effort (e.g., from year to year and site to site) to be able to succinctly summarize this information at the state-level.
Chris O. Yoder, Ph.D.	It seems that they are, perhaps in too much detail in some cases. The detail in the specific methodologies could be reduced especially knowing that the states already (or at least they should) have this aspect covered. This almost borders on being a distraction from the meat of the document which is the conceptual and technical basis for the RMN itself.	A QAPP was developed for the RMNs after this review was conducted. We now reference the QAPP and shortened some sections of the report.

Table 5. Charge Question 4

Charge Question 4: *Are any sections of the document difficult to understand? If so, please list the section and your suggestions for improving clarity.*

Reviewer Name	Reviewer Comment	EPA Response to Comment
Lucinda B. Johnson, Ph.D.	<p>I admit I am still confused about the site selection process. Given the reliance on the Bierwagen paper as the basis for many of the decisions, and the fact that the manuscript was not provided as an appendix, or described in sufficient detail, I feel incapable of assessing several components of the plan-- mainly the decision to select 30 sites. That number seems insufficient to me for detecting subtle trends in climate signals, unless the site selection is so tight as to eliminate other potential sources of variation.</p> <p>The authors clearly stated that environmental conditions leading to vulnerability to climate change were analyzed in the site selection process. Yet I did not see reference to consideration of the dominant sources of stream flow, wet to groundwater versus surface water. Streams with large groundwater contributions will be more resilient to climate change impacts than those dominated by precipitation and surface sources. This must be a component of the site selection process, if the goal is to understand the influence of climate change on hydrology, biology, and water chemistry in these streams.</p> <p>How will the data and analyses between reference and secondary sites be distinguished in the database and subsequently analyzed? How were the secondary sites selected?</p>	<p>We made edits to further clarify the site selection process for both primary and secondary RMN sites.</p> <p>We added in a new appendix (Appendix A) that covers the relevant material from the Bierwagen et al. manuscript (it provides information on the power analyses that were performed on the Northeast data set to help inform design decision). This appendix explains why we feel a 30-site sample size (limited to the targeted stream class—colder temperature, small to medium size, faster water streams) will meet our objectives.</p> <p>We decided to remove climate change vulnerability from the site selection list. Regarding hydrologic source, as mentioned in our response to charge question 3, we agree this is important but there are data limitations (we could not find adequate local-scale groundwater data sets at regional or national scales for our screening process).</p> <p>We are in the process of working through the details on how data and metadata from the various sites will be stored and shared (see [new] Data Management section).</p>

Table 5. Charge Question 4 (continued)

Charge Question 4: *Are any sections of the document difficult to understand? If so, please list the section and your suggestions for improving clarity.*

Reviewer Name	Reviewer Comment	EPA Response to Comment
Kent W. Thornton, Ph.D.	I did not find any sections that were difficult to understand.	Thank you (no response needed).
Chris O. Yoder, Ph.D.	I did not think any sections were particularly vague or otherwise difficult to comprehend.	Thank you (no response needed).

Table 6. Charge Question 5

Charge Question 5: *Do you have any additional comments that would improve this document?*

Reviewer Name	Reviewer Comment	EPA Response to Comment
Lucinda B. Johnson, Ph.D.	I would like to see further discussion about how this network will be linked to or will take advantage of existing networks, e.g., USGS NQWA; NEON; NARS, etc. Can this program somehow be linked to the National Climate Assessment to provide some robust information to inform that report?	We added some text that mentions our attempts to tie into these existing networks. In short, during the site selection process, we tried to co-locate as many sites as possible with USGS gages and sites that were part of the LTER or NEON networks. Unfortunately few of these sites met our criteria and/or were seen as good candidates by our RMN partners.
Kent W. Thornton, Ph.D.	See Specific Observations below.	No response needed.
Chris O. Yoder, Ph.D.	1. Minimally disturbed sites—“they had better be.” In making these comments I followed the definitions of Stoddard et al. (2005) for the terms minimally and least disturbed and best attainable . While the document began to establish the need for the RMN sites to be minimally disturbed, it seemed to drift away from this standard seemingly employing a rationalization that minimally disturbed may be difficult to find in certain regions. While I certainly agree with that sentiment, the fact remains that separating climate effects from all other effects is of paramount importance. It could well be that some regions of the U.S. simply do not have minimally disturbed sites and therefore may not serve as RMN sites. This is an inherently critical concept that the RMN must deal with.	1) Yes, this is a challenging issue. For these reasons, we decided on the Stoddard et al. terminology. As we expand to new regions like the Midwest, some areas lack minimally disturbed sites (and instead have least disturbed sites). This will introduce limitations in how those data can be used, particularly when trying to assess climate change effects.

Table 6. Charge Question 5 (continued)

Charge Question 5: *Do you have any additional comments that would improve this document?*

Reviewer Name	Reviewer Comment	EPA Response to Comment
	2. RMN primary sites are termed “reference” sites, the quotes are assumed to be purposeful and to distinguish from the concept of regional reference sites that are employed by states in support of biocriteria development. Given that a common understanding of reference sites has already been established, the use of the same term for a somewhat different meaning and purpose is potentially confusing. Can we come up with another term? Sentinel sites might be a better term—we just need to avoid another confusing use of the same term for different purposes.	2) We are no longer using the term “reference” sites for the reasons mentioned by the reviewer.
	3. I suggest vetting any bioassessment protocol via the critical technical elements (CE; U.S. EPA 2013) prior to acceptance into the RMN as it addresses issues such as methods, reference sites/condition, data management, and stressor/response. There is an attempt to cite the process on p. 7 (lines 26–32 and Table 2 on p. 8), but this is not consistent with the CE process. I suggest that the document be modified to be consistent (or call it something else) the latter not being a preferred solution. Making the document consistent with the CE process would better incorporate the use of single vs. two assemblages. Attaining the maximum score for six of the 13 critical elements is based on having at least two assemblages with full technical development.	3) We appreciate the suggestion to use the critical elements process to vet the protocols. This is something we will strive for in the future. We removed the text on p.7 (on tying into the CE process).
	4. Some “secondary” sites are likely serving (or would otherwise qualify) as least impacted reference sites—this is where it can get complicated and it will need to include an understanding of attainability for the present and through time, if anything to prevent the unwanted influence of relativism in setting attainable goals, i.e., the shifting baseline.	4) Yes, we agree—this will require some careful thought.

Table 6. Charge Question 5 (continued)

Charge Question 5: *Do you have any additional comments that would improve this document?*

Reviewer Name	Reviewer Comment	EPA Response to Comment
	5. Any measure used to assess biological data needs to be indexed or “mapped” to the BCG. This would be accomplished in a CE review. I am concerned that it will be difficult to standardize bioassessment outcomes between states with varying levels of rigor – this is a critical need for the project.	5) Yes, this is a good idea and is something we will strive for.
	6. Concerns with the limited resources statement – need to be careful having it both ways – need to admit the limitations of the RMN (does the document do this?). I don’t like the frequent reference to this limitation that seems to be followed by a rationalization for why the design will need to deviate from some of the desired parameters. If this is really all that important of a project then adequate funding should not be an issue.	6) The report has been revised accordingly.
	7. The reference to academia and volunteer groups is troubling – despite claims to the contrary, very few volunteer groups, if any generate the level of data needed for this project, so why even mention it as a possibility? Academic sources can also be unreliable for similar reasons. Any source of data should be first vetted by a CE review.	7) Under the right circumstances (volunteers undergo formal training, have very specific tasks, are audited, etc.), involvement of outside organizations could help make the RMNs more robust if data quality objectives are met.
	8. Macroinvertebrate taxonomy is a critical issue – simply stated more refined taxonomy yields better resolution. My concern is that the genus level “standard” that we have been using in the CE process simply will not be adequate, thus, we are considering changing it to give more credit to lowest resolution programs.	8) We agree that species-level IDs give us a better chance of detecting subtle trends over shorter time periods. We encourage RMN partners to do the identifications to the lowest level.

Table 6. Charge Question 5 (continued)

Charge Question 5: *Do you have any additional comments that would improve this document?*

Reviewer Name	Reviewer Comment	EPA Response to Comment
	9. In the northeast U.S., RMN there appear to be no sites in northern Maine, only in central and downeast Maine. I suggest that sites be added from the Allagash and Aroostook basins in particular as these have not been invaded by introduced fish species and they represent minimally disturbed conditions perhaps better than some of the current RMN sites. This will be especially critical if fish are used as a second assemblage as the majority of New England with the exception of these basins have been influenced by introduced species, most of which would “benefit” from increasing temperature and most of which would not be as adversely affected by the secondary effects of altered stream flows, increased effects of nutrient enrichment, etc.	9) We agree, but would need other organizations to support such sites. We also encourage every state to sample fish if possible.
	10. It seems critical to include fish whenever possible because of their sensitivity to thermal alterations and the wealth of knowledge about thermal effects on this assemblage group. This would also ensure that Level 4 is attained by most of the participants.	10) We agree and encourage everyone to sample fish if possible.

Table 6. Charge Question 5 (continued)

Charge Question 5: *Do you have any additional comments that would improve this document?*

Reviewer Name	Reviewer Comment	EPA Response to Comment
	<p>11. There is insufficient discussion about the “size” in watershed area of streams to be included in the RMNs. The focus on “riffle-dominated, freshwater wadeable streams” seems too broad with regard to stream “size” particularly when the regional sample size is limited. More consideration about how stream size (e.g., as a surrogate base flow) is likely to be influenced by climate change is needed. Add to this the influence of stream size on the ability of a stream to buffer or moderate the early influences of climate change seems to argue for a focus on small watersheds (i.e., <10–20 sq. mi.) as the target size for the RMN. Also, the influence of stream size on variables such as species/taxa richness needs to be considered. In addition as one moves into the most populated states the likelihood of finding “minimally” impacted streams diminishes with increasing watershed size. It would appear that most of the RMN sites are <100 km² (~38 sq. mi.). The expected differences in species/taxa richness in streams between 1–35 sq. mi. can be quite different. This is another reason to perhaps focus on a smaller and narrower range of stream sizes to reduce the confounding influence of watershed size.</p>	<p>11) Good point. We did consider stream size and added in new text to mention this. In short, we targeted streams with drainage areas of 10–100 km² (but there were exceptions). We agree—stream size takes on added importance with the fish data. Based on our experiences with other projects, stream size tends to be less of an issue with the macroinvertebrates.</p>

Table 6. Charge Question 5 (continued)

Charge Question 5: *Do you have any additional comments that would improve this document?*

Reviewer Name	Reviewer Comment	EPA Response to Comment
	12. The habitat assessment component is critical to this project thus it will be important to review the recommended methodologies to ensure that sufficient and critical habitat features are measured that will show change as the flow regime changes over time. For example with some analyses on low flow influences in Midwest streams we extracted some factors out of the Qualitative Habitat Evaluation Index (QHEI; Rankin 1989,1995; Ohio EPA 2006) that uses the habitat features that were most related to flow (distribution of deep, fast areas, etc.,) called a “Hydro-QHEI” (Rankin et al. 2011). This provides a habitat indicator that was sensitive to altered flows. We would caution against simply recommending an “off-the-shelf” methodology like the RBP without more vetting of its capabilities.	12)We agree—the habitat component is very important and will warrant further discussion. During the first few years of data collection, we made macroinvertebrate, thermal and hydrologic data our top priorities. Now we need to flesh out the habitat and chemistry components.
	13. I would recommend the consideration of adding “Sentinel Rivers” to the network since these are where changes may be evident first and also for their higher public profile. Such rivers will need to exemplify a minimally disturbed condition, hence they will likely not be available in all regions. Examples of such rivers in the northeast U.S. would include the Allagash and Aroostook Rivers. The Allagash is in a nationally protected corridor and both it and the Aroostook have not been influenced by invasive and introduced fish species that are commonplace in New England at points south. This would also include multiple sites to ensure the detection of effects and also enhance the understanding of longitudinal responses.	13)This sounds like a great idea.

Table 6. Charge Question 5 (continued)

Charge Question 5: *Do you have any additional comments that would improve this document?*

Reviewer Name	Reviewer Comment	EPA Response to Comment
	<p>References</p> <p>Ohio Environmental Protection Agency. 2006. Methods for assessing habitat in flowing waters: using the qualitative habitat evaluation index (QHEI). Division of Surface Water, Ecological Assessment Section, Columbus, OH. 23 pp. http://www.epa.ohio.gov/dsw/document_index/psdindx.aspx.</p> <p>Rankin, E.T., R. Mueller, and C.O. Yoder. 2011. Ecological Low Flow Protection Process for Ohio Streams and Rivers of the Lake Erie Basin. Report submitted to The Nature Conservancy, Columbus, OH. 49 pp. + appendices. http://www.midwestbiodiversityinst.org/publications?type=L.</p> <p>Rankin, E.T. 1995. Habitat indices in water resource quality assessments, in W.S. Davis and T.P. Simon (Eds.), Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making, Lewis Publishers, Boca Raton, FL, 181–208.</p> <p>Rankin, E. T. 1989. The qualitative habitat evaluation index (QHEI), rationale, methods, and application, Ohio EPA, Division of Water Quality Planning and Assessment, Ecological Assessment Section, Columbus, Ohio.</p>	

Table 7. Specific Observations on the Document

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
Lucinda B. Johnson, Ph.D.			Due to the heavy reliance on this manuscript, Bierwagen et al. should be included as an appendix in this report.	We added in a new appendix (Appendix A) that covers the relevant material from the Bierwagen et al. manuscript
	10	Table 3	The Level 3 effort suggests that all methods are compatible, yet the text above that, page 7, lines 33–35 suggests that it is OK for aspects of the method to vary, e.g., mesh sizes, frame type, etc. This important contradiction can lead to incompatible data. It is possible for the Regional Groups to agree on methods that differ, as long as there is a stringent and reliable method for cross-walking the data sets. Even so, I strongly encourage the methods for macroinvertebrate collection to be compatible with the sampling regime, picking methods, taxonomic resolution, etc.	We agree; this was poorly explained and confusing. We reworked this section to address these issues.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	11	2	I strongly encourage the collection of macroinvertebrates from multiple (standardized) habitat types, for the reasons stated in this paragraph. As temperatures warm, groundwater temperatures also will be warming, thereby reducing the amount of coldwater habitat. Further issues associated with altered flow regimes may alter or affect riffle habitat differentially. I strongly recommend incorporating additional habitats into the monitoring program, where feasible, through addition of edge and pool habitats. Edge habitat, for the reasons stated (likely to be impacted first), and pool habitat because they are likely to persist under dry conditions. Samples from different habitats must be kept separate, as indicated.	<p>We agree. The ideal scenario is that programs can collect from multiple habitats and keep the bugs from those habitats separate (like in the Southeast). However, based on feedback we received from the Southeast, this level of effort is very resource intensive and will be difficult to sustain over the long-term.</p> <p>Other regions have not been able to do this. The consensus in each region has generally been to go with the “majority rules” (e.g., in the Northeast, most programs take kick samples from riffle habitats, so this is what they agreed to, since it fits in best with their existing efforts [and bioassessment indices]; in the Upper Midwest, the consensus was to sample multiple habitats [more or less following MPCA’s protocols] but they will not be able to keep bugs from each habitat separate).</p>
	12	Table 4	I would recommend that taxonomy be verified through inter-laboratory exchanges of blind samples. This would minimize the expense of paying an independent contractor, but would provide some independent verification of taxonomy.	Good idea. Unfortunately only a few of our partners do their taxonomy in-house these days.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	15	Lines 24–25	I am a strong proponent of the use of traits. But some things to consider are: 1) which trait database is the most complete for the region where the collections occur? How will the data for unassigned traits be handled when calculating relative frequencies (i.e., traits are not known for many taxa resulting in many unknowns; this affects relative frequency estimates for some traits).	Good points. We revised the text to reflect this input. We are planning to use the Freshwater Biological Traits Database (see citation below). U.S. EPA. Freshwater Biological Traits Database (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-11/038F, 2012.
	16	Lines 13–15	If the data are to be housed in a common database, it is essential they be compatible. No data should be compiled in the common database that does not meet strict standards of comparability. That said, you also don't want to lose data that someday might be found to be compatible through a method.	Yes, good point. Data will need to be formatted a certain way (see new Data Management section). We are working through this issue with the partners and through the QAPP.
	16	4	Since fish can be identified almost immediately, they can be very cost-effective for the amount of information gathered. In addition, the physiological requirements of fish are well known, for the most part, making it possible to use species traits as potential indicators of condition, including warming and changes in flow regime. As noted, the public have an understanding and appreciation for fish that transcends that of insects and other invertebrates.	We agree and encourage everyone to sample fish if possible.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	17	Lines 17–29	Note that there was a recent special issue of Freshwater Science on GW-SW interactions, with some interesting and pertinent papers that tested different methods and protocols for measuring and monitoring temperature. C.f., Gonzalez-Pinzon, et al. 2015; Ebersole et al., in Volume 34(1). 2015. While the focus is on detecting groundwater-surface water interactions (i.e., gw seeps into streams) these important features are going to provide a buffer to the impacts of warming air temperatures on streams. A stream that contains significant groundwater inflow will be much less vulnerable to changing climate, and as a result the warming trends will be more subtle and difficult to detect. It is critical that there be some understanding of the extent of influence of GW vs. SW in the set of streams selected for intensive monitoring.	We agree. Hydrologic source (e.g., groundwater vs. precipitation-dominated) is very important to consider. We have not found consistent, high quality data sets that are available at regional or national scales that capture localized groundwater influence. Initial screenings use the baseflow index (Wolock, 2003). Once data collection begins, air-water temperature relationships can be examined at each site to assess thermal sensitivity (and level of groundwater influence—see Snyder et al., 2015).
	20	1	It is unlikely that year-round temperature measurements will be possible in the NE, where extensive ice cover is common. Ice scour is a threat to the instruments.	Year-round temperature is successfully being collected in the Northeast as well as in other parts of the U.S. that experience ice (e.g., see Dan Isaak’s efforts in Idaho and the Pacific Northwest). However, this may become an issue (e.g., maybe if the stream freezes all the way through vs. only on the surface; maybe certain sensors are more sensitive to this than others) but so far none of our partners have experienced this.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
			Check on what metrics will be derived from the 30-minute temperature data...	We appreciate your suggestions and added in your suggested references. There are countless possibilities. We discuss our rationale for choosing these metrics in Section 4.
	20		Re: hydrologic gage data. The vast majority of gages are located on the main stems of rivers, which can be difficult to sample using wadeable stream protocols.	Correct, only a limited number of USGS gage sites are wadeable and meet our site selection criteria.
	21		Same comment for pressure transducers as for temperature monitoring in NE streams. Ice cover is a significant impediment.	Correct, sometimes we cannot use some of the hydrologic data due to ice cover. It depends on the site, the type of winter we have and the type of sensor that is deployed.
	24	Lines 17–18	Critical to resurvey elevation transducer if stream is impacted by ice.	Yes, elevation surveys are a critical component of collecting high quality hydrologic data.
	25		Reliable use of the qualitative habitat metrics requires experienced personnel with substantial training to ensure consistency. A web-based training program may be able to cover the majority of these components.	The habitat component will warrant further discussion. We will consider this idea, although our RMN partners are now leaning towards collecting a standardized set of quantitative habitat measurements vs. doing the qualitative assessment. We will resolve this when we work through the region-specific protocols in the QAPP addendums.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	25–26		In association with invertebrate sampling it does not seem to me to increase the workload to add the limited list of quantitative habitat variables to the sampling effort, and the benefits are two-fold. In addition to adding a set of measures that are linked to hydrologic disruptions due to ag and urban land uses, ratios of bankfull depth to baseflow depth through time may potentially be linked to a climatic signal of hydrologic regime change. It is important that measures such as these be accompanied by field notes and photos to identify possible covariates (debris flows / dams; boulders; channel adjustments since the last time of sampling. Note this requires special handling for ancillary data associated with the primary database.	We agree—quantitative habitat measurements would be great to have. During the first few years of data collection, we made macroinvertebrate, thermal and hydrologic data our top priorities. We agree that the photos and field notes will be very important, and will require special handling.
	27		Encourage some documentation of the type and extent of vegetation on point bars as a measure of flow stability; also, must include cardinal direction in addition to GPS location.	Good suggestions. We added this in.
	29		As more states acquire LiDAR imagery, we should encourage the use of high resolution (~3 m) DEMs to delineate geomorphic features within the reach and valley segments. These may serve as good predictors of the effects of changing precipitation and storm intensity patterns, also may serve to help predict erosion and sedimentation rates.	Good suggestion. We added in text to encourage this.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	32		Suggest including a metric reflecting voltinism (as a measure of life span; Richards et al. 1997), which is sensitive to flow modification due to channelization (urbanization and agricultural LU), and may ultimately be related to climate as warming water temperatures allow for multiple cohorts in a year.	We will consider this. Our only hesitation is that voltinism can be complex, and it is unclear how accurate some of the trait assignments are (e.g., at times it could be very difficult to separate two cohorts; they may only be recognizable during short emergence periods, and it's difficult to know exactly when the emergence period will occur). Also, voltinism is not necessarily static, although it's treated as such when metrics are calculated (e.g., with certain taxa, the number of cohorts in a given year can vary depending on environmental conditions).

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	33		With only one sample per year, stability may be a problematic variable, which may be sensitive to a large number of factors, climate being only one. Thus, voltinism may be a slightly better indicator of stability.	We feel that stability is important and easy to track. We expect that the number of individuals, particularly for certain taxa, will be quite variable from year to year. As mentioned above, we have some hesitations about voltinism and are unsure about what type of sampling regimen you have in mind to capture this (e.g., how many site visits do you have in mind? would this be tracked for specific taxa? would this require special training?). Also we have concerns about misinterpretation (e.g., what if univoltine populations appear bivoltine because part of the cohort emerges in the fall and the rest emerge in the spring due to a halt in emergence caused by low temperatures; or maybe multivoltine species have overlapping generations)? We would need information for both larvae and adults.
	36		Suggest adding metrics that cover 7-day averages, e.g., maximum 7-day maximum temperature. See Eaton et al. 1995; Wehrly et al. 2007 for a justification. See also, Butryn et al. 2013. Hydrobiologia 703:47–57.	We appreciate your suggestions and added in your suggested references.
			Another common phenomenon associated with climate change is a change in the distribution of	The hydrologic data should capture this signal (with the understanding that flows

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
			seasonal precipitation. What metrics are intended to capture this signal, and what biological, chemical, and physical responses are anticipated as a result? It is likely there will be a geographic pattern to this phenomenon that may require the study area to be partitioned into similar response regions.	<p>are mediated by other factors, such as groundwater influence). Table 7 contains hypotheses on the relationships we expect to see between hydrologic and biological metrics (based on literature). Flow has a more direct effect on benthic macroinvertebrates, fish, and periphyton than rain, so we made flow a higher priority than precipitation, since our main focus is on how climate change will affect bioassessment programs.</p> <p>Also, there have been more efforts to develop hydrologic classification schemes than precipitation classification schemes.</p> <p>All this being said, we are encouraging people to collect precipitation data, if resources permit, or to obtain it from the nearest weather stations.</p>

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	43	Lines 4–5	Where possible, the data should be consistent across all Tier 1 sites; to lack consistency is to lack comparability and decrease the value of the integrated data set. Table 6 shows the effects of different methods on taxonomic composition. But no solution to this issue is proposed.	Yes, we are doing our best to take steps to minimize differences. Methods comparability studies can quantify how much of a difference the methods make. We added in new text to better explain and acknowledge the issues that arise when there are methods differences. We find it encouraging that results from the Northeast pilot study, which we describe in the new appendix and which are based on an aggregated data set (10 different methods) where no efforts were made to standardize protocols, suggest that trends in certain biological metrics will be detectable in 10–20 years, depending on metric and strength of the trend. If steps are taken to reduce variability and improve trend detection power (annual sampling, classification, etc.) our trend detection power will improve.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	44	Line 5	<p>I lack confidence that the data collected will be able to assess how organisms respond and recover from extreme weather events. The qualitative habitat data are not sufficiently resolved to assess effects of a major weather-related flow event versus flow regime shifts due to land use disturbances. The biological data are not collected with sufficient frequency to determine the signal from the noise, I suspect. For example, samples taken a short time after a major flow event are likely to show impacts, but those taken a year later may not. Depending on the extent of background disturbance, many streams can recover relatively quickly to a major disturbance.</p> <p>Similarly, some hypotheses related to climate change may be quite difficult to test, which others may be possible. E.g., presence of thermal refugia are likely to increase resilience to warming air and water temperatures; but habitat alteration due to changing riparian vegetation may be more difficult to decipher.</p>	<p>We reworked the Data Usage section to better address these issues. Regarding extreme events, we feel the RMN sampling will improve our chances of capturing these types of events (e.g., at a minimum, it will help establish preevent baseline conditions, and the continuous thermal and hydrologic data will capture the magnitude, frequency and duration of the events). We added in new language to acknowledge that whether or not the RMN data can fully capture biological responses to extreme weather events will depend on the timing of the event in relation to the RMN sampling period, and that additional biological sampling may be warranted.</p> <p>Also, in the reworked Data Usage section, we discuss some specific studies and hypotheses on climate change that we feel can be reasonably tested at RMN sites.</p>

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	44		Quantifying natural variability also may be difficult to assess without more frequent sampling, OR without a long period of record. Further, this would require that natural factors (i.e., non-anthropogenic disturbances) that account for underlying variation must be quantified, and those factors were not among the spatial variables recommended in Table 11 or elsewhere. To suggest this is possible is to potentially oversell the benefits of this monitoring program.	<p>Regarding the frequency of sampling, in the context of routine biomonitoring, we feel that annual (and in some cases, bi-annual) macroinvertebrate sampling along with year-round thermal and hydrologic data will provide valuable information on natural variability (and will fill data gaps—there are not many high quality sites where this type of information is available).</p> <p>Good point about the need to track other potential sources of variability. We added in language to acknowledge that other sources of variability (land use, habitat, acid deposition, etc.) will need to be tracked in order to attribute variation to “natural” vs. other factors.</p>
	45		A common approach for detecting changes in trends is to examine variance through time. Since increasing variability in the climate signal is one of the dominant characteristics of climate change, we should also see a change in the variability of the biological, chemical and hydrologic variables as well.	Yes we will attempt to track this. Few sites have long, uninterrupted historic records so it will take a while before we accumulate enough data to take a look at this. In some cases, it may be possible to “hind-cast” and come up with some historic estimates to extend the periods of record.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
			Another common phenomenon associated with climate change is a change in the distribution of seasonal precipitation. What metrics are intended to capture this signal, and what biological, chemical, and physical responses are anticipated as a result? It is likely there will be a geographic pattern to this phenomenon that may require the study area to be partitioned into similar response regions.	(This is a repeat from earlier.) The hydrologic data should capture this signal (with the understanding that flows are mediated by other factors, such as groundwater influence). Table 7 contains hypotheses on the relationships we expect to see between hydrologic and biological metrics (based on literature).
			The intent of the Data Usage Section is not clearly defined. In some respects it is repetitive; furthermore, some issues are left hanging. E.g., if methods are not consistent across the different entities, how (and who) will determine if the data whose methods do vary, are sufficiently aligned as to be incorporated in the same database? What types of analyses are possible with data that are not closely cross-walked and cross-calibrated? Who “owns” this database and is the caretaker?	We rewrote the Data Usage section to better address these issues. It now describes how the data will be used to support CWA programs and help detect climate change effects over 1–5, 5–10, and 10+ year time periods. We also added a new section on data management that discusses “ownership” of the data.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	47	Lines 3–5	<p>As stated above, somewhere, the Bierwagen paper that is in review is cited numerous times; but the text is not provided, and the methods are not described, so it is not possible to assess whether the results are valid for the purpose of the recommendations upon which this program is designed. 30 sites is a relatively small number for detecting trends. The variance must be relatively low in order to detect a change with that small number to any level of confidence that I am comfortable with (I have not done the power analysis, though.) Given the large year to year and site to site variation in macroinvertebrate metrics I would like to have seen more information about the Bierwagen analysis to be confident of this recommendation. For example, “After accounting for differences in sampling methodology, results suggest that well-designed networks of 25 to 30 sites monitored consistently can detect underlying changes of 1–2% per year in a variety of biological metrics within 10–20 years if such trends are present.”</p> <p>BUT the recommendation is for 30 sites within or across regions, and as stated more than once, the methods are not expected to be completely aligned. Therefore, the boundary conditions in the Bierwagen paper are not what is proposed for the network- unless I am missing something.</p>	<p>We added in a new appendix (Appendix A) that covers the relevant material from the Bierwagen et al. manuscript (it provides information on the power analyses that were performed on the Northeast data set to help inform design decision, including the 30-site/analysis unit sample size, and the 10–20 year trend detection timeframe, depending on the biological metric and the rate of change). This is based on an aggregated data set in which no attempts were made to minimize variability (e.g., use comparable methods).</p> <p>Also we changed the text to say 30 sites within each RMN region (vs. within or across).</p>

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	47	Lines 16–17	It makes perfect sense that the different metrics behave differently and are more reliable in the different thermal regimes. That is why cold water fish IBS are different from warm-water fish IBS. But this does not help me understand whether the 30 sites proposed within and among regions would be selected to capture potential trends without first stratifying the sites to similar regions. If the emphasis is on high gradient, cold water streams across the entire region, it makes sense that a common set of metrics will apply for that region; it may be necessary, though, to further stratify those sites among precipitation-dominated versus groundwater dominated flow regimes because their susceptibility to climate-related phenomena will differ greatly.	<p>Yes, we agree—this is very intuitive. Once the data management system is in place, it will be easy to calculate a wide range of metrics and we can evaluate differences in metrics across regions (e.g., which are most responsive to climate-related changes; like you say, with some metrics it is likely that differences will emerge due to hydrologic source).</p> <p>We made edits to further clarify the site selection process and classification considerations. We decided to remove climate change vulnerability from the site selection list for the reasons mentioned above (see our response to charge question 3).</p>
	48	Lines 30–32	I am biased towards the use of the component metrics, which can be chosen to have hypothesized or validated mechanistic relationships with the climate or disturbance related phenomena that determine the responses. With few exceptions that I know of, IBIs and other condition scores are not created in advance to detect climate signals.	Yes, we agree. We expect the metrics to be more responsive. We need to track the biocondition scores as well because managers will want to know if these are changing over time (and if so, whether these changes are related changing thermal and hydrologic conditions).
			[See comments embedded in draft report (ATTACHMENT A).]	We reviewed these comments. Most were addressed in this document.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
Kent W. Thornton, Ph.D.	xii	1 st full para, 4 th line from bottom	This is the first place the text states that either 30 sites within or among regions might be the overall goal. I strongly recommend at least 30 sites within each region . Thirty (30) sites across regions is inadequate for trend detection among sites within a region. Comment is relevant throughout the report when it refers to the overall goal of sampling at least 30 sites. I recommend this should be 30 sites within regions, not among regions.	Yes, we agree. We changed the text to say 30 sites within each RMN region (vs. within or across).
	1	Lines 24–29	Are these uses listed in priority order from first to last (i.e., temporal trend detection is highest priority, quantifying natural variability in lowest priority)? While a priority might be considered unnecessary, compromises will likely need to be made as the network is developed and implemented. Understanding which uses have higher priority can help ensure that, at a minimum, the highest priority uses are incorporate in the network within and across regions. While trend detection appears to be the ultimate goal, change detection can be equally powerful in confirming responses to climate change. Was there a reason change detection was not considered as a valid use of the data?	<p>No, the uses are not listed in order of priority. We feel the data can be used for all of the uses described in the updated Data Usage section.</p> <p>Regarding change detection, from a broader context, change detection is also part of trend detection, where nonlinear responses are found and modeled. However, change detection is often confounded by uncertainty and measurement error often associated with observational data. While it is often desirable to find change points (thresholds) for management purposes, it is often unrealistic to detect ecological meaningful thresholds even though a statistical threshold can be detected. Therefore, we plan to keep nonlinear response as part of</p>

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
				future trend detection analyses, with the understanding that statistical uncertainty in the observational data should also be considered in order to make any trend analysis meaningful.
	3	Line 14	First reference to Bierwagen et al. that supports 30 sites as a representative number. See General Impressions for importance of this document in supporting conclusions on network design and implementation.	We added in a new appendix (Appendix A) that covers the relevant material from the Bierwagen et al. manuscript (it provides information on the power analyses that were performed on the Northeast data set to help inform design decision, including the 30-site/analysis unit sample size).
	4	Lines 31–36	The three exposure scenarios: 1) increasing temperatures; 2) increasing frequency and magnitude of extreme precipitation events; and 3) increasing frequency of summer low flow might be expected to co-occur in each of the watersheds. The text reads that sites with moderate or most vulnerable ratings for at least one scenario were preferred. Am I correct in assuming the idea was to select those watersheds which were most vulnerable to all three scenarios?	We decided to remove climate change vulnerability from the site selection list. Initially, we had explored this possibility but the exposure and sensitivity factors across the 3 scenarios are too different, so few if any watersheds were rated most vulnerable to all 3.
	3–6	Site Selection	4 comments: 1) While I understand the rationale in selecting minimally disturbed watersheds, an argument might also be made for having a few sites in highly disturbed watersheds, with significant impermeable	1) Good thought. We have considered this as well and agree that it would be very valuable to have some sites like this in the network.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
			<p>area. Increased frequency, intensity, and duration of precipitation events might show up more quickly in flashy, impermeable watersheds than in forested watersheds, with small drainage areas. The biological community is more likely to be impaired in these disturbed watersheds, but these communities also might be much closer to a threshold or tipping point for transformation to a different biological community with this additional climate stress. I recognize resources are limited. Just a thought.</p> <p>2) Was any consideration given to selecting primary sites that are in the same watershed, but upstream from existing secondary sites or tributaries to the secondary sites? An upstream-downstream comparison might be informative in detecting changes. In addition, it might be possible to index flow from a gauged secondary site if discharge measurements were not available or only recently established at the primary upstream sites. Appendix E on secondary sites had no information on drainage area or % forested area as did Appendix C on primary sites.</p> <p>3) I didn't see any consideration of NSF Long-Term Ecological Reserve sites. Were these sites considered as candidates, and if not, why not? Many of these sites have long-term records of hydrologic, thermal,</p>	<p>2) Another good idea. We have considered this as well and agree that it would be very valuable to have some sites like this in the network.</p> <p>Regarding Appendix E, we added in the land use information that we have for the secondary sites.</p> <p>3) Yes, we did consider Long-Term Ecological Reserve sites. Unfortunately none made our top candidate list in these regions for</p>

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
			<p>and biological indicators that might be useful in assessing the response of stream systems to climate change.</p> <p>4) While I recognize the importance of streams, particularly in the southeast where there are few natural lakes, other than oxbows, was there any consideration of small lakes as indicator sites (e.g., Schindler, DW and JP Smol 2006: <i>Cumulative effects of climate change and other human activities on freshwaters of arctic and subarctic North America</i>. Ambio 35: 160–168)? Given the inherent variability in stream ecosystems compared to the integrating response of lakes, small lakes in undisturbed watersheds might be preferred. In addition, information on indicators such as time of ice out or ice formation can be determined remotely. However, as noted earlier, small natural lakes are not ubiquitous throughout the U.S., while streams are. Just a question.</p>	<p>various reasons (e.g., did not meet our criteria; limited [if any] macroinvertebrate and biomonitoring data; added layer of complexity with getting permissions, not interfering with ongoing or potential future research projects, etc.).</p> <p>4) Good suggestion. We are very interested in other water body types, such as lakes. We started with streams because that's where we have the most data.</p>

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	6	Line 13	Limited funding is clearly stated. It would help assess the feasibility of the proposed effort if there was an indication of funding. I recognize this is difficult because of congressional budgeting (or lack thereof), but the feasibility of implementing Level 3 practices at all the sites with \$100K for the entire program is significantly lower than if the anticipated funding is \$1 million per fiscal year.	Yes, we agree it would be helpful if we could put a price tag on the RMNs. However there are so many variables and unknowns at this point it is really difficult to put an accurate price tag on it.
	6 7	Lines 37–39; Line 1	Agree with the Bierwagen et al. estimate of 10–20 years to detect change, versus detecting trends in biological indicators. This, in part, was the reason for asking if the uses of the data were listed in priority order (See above), with the first being temporal trend detection. Changes in stream metrics would likely be detected earlier than trends and could be as powerful in confirming responses to climate change.	See our earlier response (p. 34) on detecting change vs. trends (from a broader context, change detection is also part of trend detection; we plan to keep nonlinear response as part of future trend detection analyses, with the understanding that statistical uncertainty in the observational data should also be considered in order to make any trend analysis meaningful)
	7	Lines 22–32	While the Level 3 practices are the target, what is likely is a mix of levels from 1 through 4. How will information be aggregated across sites when there are different collection practices implemented? Perhaps this would be more appropriately discussed as part of Sections 4 and 5 – Summarizing RMN Data and Data Usage, but it does need to be addressed somewhere in the report because mixed practices among sites will occur.	Good point. We added text into the updated Data Usage section to address this. At this point, it is unclear what levels of rigor each organization will be able to attain (which will vary from year to year, depending on available resources).

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	10	Table 3	Level 3 practice expertise. Most states collect macroinvertebrate species as part of the ambient monitoring programs. I would suggest that the Level 4 criteria also be applied to Level 3 – trained biologist experienced in collecting aquatic macroinvertebrates	Good suggestion—we made this update.
	11 12	Lines 19–25 Table 4	Great idea of recommending multiple habitats, which include edge habitats. One could very easily see shifts in community composition in the edge habitats earlier than in riffle habitats, because species are already near their preference edge and additional climate stress could push them beyond their tolerance limits.	We agree. This is best case scenario.
	14	Lines 10–21	Different index periods in the Northeast compared to the Mid-Atlantic and Southeast regions could make comparisons more difficult. Again, having a conceptual model that highlights snowmelt and ice cover in the spring can help explain these differences among regions as well as potentially identifying indicators/metrics that might be comparable among regions.	Yes, we agree that the different index periods across regions are a challenge. We plan to evaluate this further after the biological data are available. We like the conceptual model idea.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	15	Lines 40–41	Excellent comment on potential biases in biological metrics because of large differences in methodologies (e.g., the sampling area in SE streams is 2 m ² , while the sampling area in other regions is 1 m ²). How these differences will be handled should be addressed in both Sections 4 and 5 – Summarizing RMN Data and Data Usage.	Good suggestion. We added text into these sections to address this issue.
	16	Line 14	I would recommend that “could” be changed to “should”. Members should consider conducting a methods comparison study.	Good suggestion. We agree that a methods comparison study is very important in regions where partners are using different methods.
	20	Lines 31–37	As noted in this section, flow is the master variable. Every effort should be made to at least measure stage. While I recognize that specific manufactures cannot be recommended, we have successfully used Hobo and Solinst pressure transducers, which are ~\$500–700 per unit. Placing a temperature recorder near the pressure transducer permits temperature corrections of the data.	Yes, we agree that the hydrologic data is extremely important.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	26	Lines 15–27	I agree that quantitative habitat data might not have to be collected annually, particularly if the RBP qualitative procedures are used. However, channel forming flows, regardless of their 1–2 to 5 year return periods, can occur multiple times within a 5 year period. This is a statistical probability, not a fixed return frequency. It is not uncommon to have two 100 year flood events occur in back to back years. I suggest the RBP qualitative habitat measurements co-occur with annual macroinvertebrate collection. I agree fully with your statement that further discussion among RMN work group members and outside experts is warranted.	We agree—the habitat component will warrant further discussion. We will revisit that when we work through the region-specific habitat protocols in the QAPP addendums.
	27	Section 3.6	Good section on Photodocumentation. Having repeat pictures from a site can be incredibly informative in evaluating year to year differences at a site.	No response needed.
	30	Lines 19–26	Biological indices (MMIs) can be used to reflect changes from reference conditions, but their sensitivity to subtle changes is not as robust as some of the individual metrics. The individual metrics comprising the index can provide greater resolution and insight for subtle changes. I would calculate the metrics, but they may not be as useful as some other metrics or indicators.	Yes, we agree. We expect the metrics to be more responsive. We need to track the overall biocondition scores as well because managers will want to know if those are changing over time (and if so, whether these changes are related changing thermal and hydrologic conditions).

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	31	Table 7	There are numerous indicators suggested for consideration in this table. While this is an exploratory effort, can guidance be provided on which of these indicators, by region, might be most likely to exhibit a response to climate change? Figure 4 on page 34 illustrates changes in the spatial distribution of specific taxa representing a possible response to climate change. Can similar guidance be provided for which indicators might be first candidates for consideration? Again, a conceptual model could be used to indicate which indicators are the most likely candidates to track over time, by region.	At this point, we feel the hypotheses in (the former) Table 7 on the likely responses of biological metrics to changing temperature and flow conditions will be fairly consistent across regions. We will explore this further and assess differences across regions once we get more data. We do like the idea of the conceptual models and will pursue this further if resources permit.
	34	Line 7	Remove “are” from (see formulas are provided in Appendix M).	Good catch. We made this correction.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	35	Section 4.2	During the 1960–70’s there were a number of studies of temperature effects on fish communities. References to Coutant’s reviews on the biological effects of temperature changes are shown below the comment table. While the RMN emphasis is aquatic macroinvertebrates, not fish, the earlier literature might give you insight into which temperature statistics were important for changes in fish community composition, as well as which fish species were particularly vulnerable to temperature changes including species temperature thresholds. While many of these studies were related to fish species found in large rivers, the information may be relevant for smaller watersheds.	Good thought. Others have suggested this as well. We did look into this and gave careful thought to our choice of summary statistics, as described in Section 4.2. We are also considering information from more recent work with continuous temperature sensors in smaller stream systems (e.g., by Yin Phan-Tsang at MSU—StreamThermal version 1.0 package in R).
	39–41	Table 9	Similar comment on which hydrologic indicators are probable as was raised for thermal indicators on page 31 above. However, the larger issue is how any hydrologic statistics will be computed for the vast majority of these streams when there is no existing flow data? Appendix C indicates that 8 sites out of 23, 2 sites out of 27, and 4 sites out of 37 sites in the Northeast, Mid-Atlantic, and Southeast, respectively, have discharge measurements. Unless flow can be indexed from downstream sites or nearby, similar gaged watersheds, it will be 15 to 20 years before a minimum set of hydrologic data will be available.	Correct—it will take a many years to characterize hydrologic regimes at sites that lack historic data, which can be a bit daunting. But we need to start somewhere, and we feel that it’s very important that data collection start now. We gave careful thought to our choice of hydrologic summary statistics, as described in Section 4.3.

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
	49	Lines 5–11	It would be useful to include the figure of BIBI scores correlated with summer flow percentiles to illustrate the types of trends that might be anticipated.	These data are from MBSS and unfortunately we are unable to generate a figure like that (we are limited to what is available in the Becker et al. [2010] report).
	53	Lines 6–12	This is the type of information that might be included in a conceptual model to illustrate which indicators are more likely to exhibit responses to climate change. This example indicates that stressors such as urbanization swamp climate change indicators, but it might be interesting to look at urbanized or impervious systems to see if their hydrologic/biotic indicators are responsive to climate change precisely because of their flashy nature.	Good suggestion. If we do the conceptual models, we will explore this.
	55	Line 24	Transposition – 2090 => 2009	Thank you. We rechecked the dates and made sure this is correct.
	58	Section 6 Next Steps	It would be helpful to provide a time frame for the Most Immediate Priorities. Will this occur over the next year, 1–3 years, 5 years? How soon will these regional coordinator positions be filled? It appears this position is fairly critical in each region is progress is to be made in developing and implementing the RMN. What is the expected time frame not only for the regional coordinators, but also for each of the states to fully implement the RMN?	<p>We rewrote the last section (now Section 7—Implementation/Next Steps) to better cover these topics. We now have regional coordinators in place.</p> <p>We added new material on implementation, timeframes, etc. into the last section of the report (now Section 7).</p>

Table 7. Specific Observations on the Document (continued)

Reviewer Name	Page	Paragraph	Reviewer Comment	EPA Response to Comment
			[See Thornton's Individual Comments for early references by C. C. Coutant and Figure on Conceptual Model of Eagle Problem, pages 53–54.]	We reviewed these.
Chris O. Yoder, Ph.D.			[See responses to Question 5 above.]	We reviewed these.