29 March 2010 Preliminary Review Comments of the NO_x-SO_x Welfare Panel on EPA's *Policy Assessment for Review of the Secondary NAAQS for NO_x and SO_x*

Comments received:

Ms. Lauraine Chestnut **2**
Dr. Ellis Cowling **7**
Dr. Paul J. Hanson **13**
Dr. Dale W. Johnson **19**
Dr. Myron J. Mitchell **23**
Mr. Rich Poirot **49**

Ms. Lauraine Chestnut

Chapter 3: Considerations of Adversity to Public Welfare

Charge Question 4: What are the views of the panel regarding the characterization of adversity to public welfare presented in this document? What are the views of the panel regarding the use of the ecosystem service framework as an additional metric to inform questions of adversity? What are the views of the panel regarding the usefulness of including economic valuation of some of these ecosystem services in the policy assessment document?

Chapter 3 does a nice job at the beginning in bringing in language from other agencies and other regulatory assessments to articulate why protection and preservation of natural environmental resources are important and motivate legislation and regulation in many areas. I especially like the words from the FWS about wildlife refuge systems being managed to "ensure that the biological integrity, diversity, and environmental health of the Systems are maintained for the benefit of present and future generations of Americans." (underline added)

The focus in the text is on federal protections, but it is important to recognize that the public cares about all kinds of natural areas including state and local parks as well as the federal Class I areas. This distinction is important for the management authorities, but not so much for the public. I think, therefore, that while Figures 3-4 and 3-5 have the right idea in terms of concept, the focus on NPS Class I areas is too limited. There are large areas throughout the country that are largely natural where people drive, fish, hike, sight see and enjoy the natural flora and fauna, including state and local parks, national and state forests, and all the lakes and streams therein. Even though these do not have the protection levels of the national parks and wilderness areas, and there may be multiple uses such as timber harvesting and grazing, the value of these areas stems largely from their natural characteristics and the public cares about the "integrity, diversity and environmental health" of these areas.

The basic concepts of ecosystems services are useful to explain why the health of these systems matters. To aid this process of providing information to help the Administrator assess adversity with regard to determining an appropriate level for the secondary standard, more is needed than just a conceptual framework. The framework needs to be used to characterize the change or loss in services that currently exists as a result SOx/NOx deposition. Chapter 3 does a reasonable job with this for the aquatic acidification case, but not as well for the others. It is ideal if this change or loss can be defined quantitatively, but this is not necessary. The change or loss can be described based on causal linkages that are well documented even if they cannot be quantified with specific dose response relationships.

The economic valuation estimates included in Chapter 3 are useful when they are tied to the change or loss in value of ecosystem services that can be reasonably attributed to SOx/NOx deposition. Total values of services that flow from the effected ecosystems are less useful because the convey little about what share of this value is being lost. In fact, if they are based on

current service levels then they are already missing the value of what has been lost due to harmful effects of SOx/NOx deposition.

Page 76: The discussion here unnecessarily undercuts the usefulness of economic valuation estimates. It is true that just because there is some quantifiable loss does not mean that the loss is necessarily significant enough to be adverse. However, demonstrating a substantial loss in economic valuation terms would provide strong support for a determination that there is an adverse effect, even though the numbers alone are not enough to specify the specific threshold at which a loss become substantial rather than trivial.

Pages 77-78: The comments here about the assumptions in economics that "public preference are paramount" are misleading. Economic valuation takes expressed preferences to be a valid measure of welfare when they are based on accurate information. No reasonable economist will argue that if people do not value the protection of ecosystems from the effects of pollution because they do not understand the implications of these effects that such lack of value should guide policy decisions.

Page 80: I think the Banzhaf et al. (2006) study should be given more mention than just in footnote 11. It provides strong evidence that the public cares about water quality in Adirondack lakes being sufficient to support native species, even if they do not participate in fishing. It is important to emphasize that these results are for residents of NY state. Residents in other states could also be expected to value water quality in the Adirondack area.

Page 82: The estimates of economic value of lost recreational fishing services in the Adirondack region are not very well explained. The $4 million is the annualized value of reaching an ANC level of only 20. At ANC of 50 or 100, the annualized value is $8 to $9 million. This seems like the most relevant range. The $300 million number is a present value through 2100. (REA, Appendix 8, Table 2.2-6) When the fishing losses are extrapolated to all the comparable lakes in NY state, the estimate of annual value of gaining ANC of 50 is $25 to $28 million, and of gaining ANC of 100 is $110 to $130 million, and present values are in the billions (REA, Appendix 8, Table 2.2-7). It is not enough to just say that the range is $4 million to $300 million. The numbers need a bit more explanation. It is also not clear what point is being made in lines 11-15. In contrast to these numbers, the estimates of <u>annual</u> value to all NY state households of reducing acidification in the Adirondacks region to an ANC of 50 is $300 million to $800 million based on extrapolations from the Banzhaf et al. study (REA, Appendix 8, Table 2.2-9). These estimates are worth mentioning in Chapter 3. They reflect use and nonuse values held by the public for protecting the area and the underlying study specifically described the effects of acidification in the region.

The discussion of the terrestrial effects of acidification would benefit from a descriptive statement about how the terrestrial ecosystem services are affected by SOx/NOx deposition related acidification at current levels. Can something be said about forest decline? Mortality rates of trees in sensitive species in affected areas? Geographic areas affected? Visual aesthetic effects for visitors? Habitat losses or quality degradation? The statements should not be that acidification could cause these kinds of effects, but rather, that such and such effects are documented at current conditions.

Page 83, lines 20-28: These seem like important studies. How do the descriptions of the effects on the forests that are being valued in these studies compare to current documented effects of acidification?

Page 84: I think these are estimates of loss in commercial value of timber harvested for red spruce and sugar maple trees. It appears to be relatively small compared to the total market (of these species alone or of all timber in the region?), but this is not entirely clear. These numbers need a bit more explanation and context.

Charge Question 5: To what extent is the presentation of ecosystem services in this document scientifically sound and clearly communicated?

The basic concepts of ecosystem services and how they relate to ecosystem function and to the idea of welfare effects as defined in the CAA are clearly communicated and well presented. Description and summarization of how these services are being affected by the effects of SOx/NOx deposition need to be improved. The REA and ISA provide support for descriptions of these effects on services even though specific quantification is not feasible.

Charge Question 6: What are the views of the panel on the critical uncertainties associated with articulating adversity to public welfare that need to be characterized in terms of their potential implications for the secondary standards?

It is pretty clear that current levels of acidification are causing adverse effects on aquatic resources in some locations. It seems there is plenty of support to argue that it is adverse to public welfare to have a significant share of lakes and streams that cannot support several species of fish that would have lived there but for the effects of manmade pollution.
Important uncertainties include how much of the adversity would be reduced with a standard based on ANC 50 versus ANC 100. The economic valuation estimates show additional value in going from 50 to 100, but they cannot give a specific estimate of how much is enough. Related to this is the question of what percentage of lakes and streams need to achieve these levels to eliminate an adverse effect. It is hard to argue for less than 100% other than for those that are naturally below these ANC levels. However, there are many practical constraints so a target of less than 100% may be reasonable. The evidence does not help much in determining this.

Chapter 9: Conclusions

Charge Question 25: What are the views of the panel on the preliminary staff conclusions regarding the adequacy of the current standards, the need for an integrated multi-pollutant structure for the revised standards, and the proposed form of the joint NOx SOx standards for aquatic acidification?

The case has been well established that the current standards are not adequate to protect ecosystems from harmful effects of NOx and SOx deposition. The only aspect not addressed is that current exceedences of PM and ozone standards will require further reductions in NOx and/or SOx precursors as these also contribute to formation of PM and ozone. How far meeting

these standards will go toward protecting ecosystem resources from effects of NOx and SOx deposition has not been addressed, and it may be quite difficult to do so.
The proposed form of the joint NOx and SOx standard makes sense conceptually. The execution of the specifics still seems problematic in several regards.

Charge Question 26: What are the views of the panel on the overall characterization of uncertainty as it relates to the determination of an ecologically-relevant multi-pollutant standard for NOx and SOx?

Page 220, bullet (3): The conclusions stated about limited confidence in relating natural habitat provision and biological control services to ANC levels are too cautious. A clear quantitative relationship between ANC concentrations and loss in fish species has been established. This means there is a loss in these services even if there is not a specific metric to quantify this loss.
Page 220, bullet (4): Please note that the dollar values for recreational fishing losses are in the Adirondack region (or for all of NY state, depending on the numbers presented) and are for NY residents only. Lines 24-25 seem to imply they are for the whole Northeast. Note the comment on Chapter 3 about the problem with lumping annualized and present value numbers into the same "range."

Page 221, lines 12-14. It seems appropriate to also list the recreation and aesthetic value of forest health as a type of cultural service that is harmed by the effects of acidification.
Other important uncertainties
Extrapolations from catchment or watershed specific analyses to regional areas are necessary to implement the proposed standards. Are these extrapolations sufficiently accurate or reliable for use in a standard setting and enforcement process? (Chapter 5, section 5.2.1.7)
Selecting a method to estimate the amount of N that will be taken up by the ecosystem seems like an important unresolved issue. (Chapter 5, page 160).

Is there any information to help guide the Administrator about what percent of an ecosystem would be appropriate for achieving a selected ANC? You need to make the case that 100% is not realistic or reasonable. Something more than half seems necessary, but how far is needed is unclear. It is also seem like there is a leaning toward a standard of ANC 50, but it seems like there are harmful effects up to ANC 100. What justification is there for targeting less than ANC 100 in terms of the goal of preventing adverse effects? There is a tradeoff in practice between the selected ANC target and the percentage of the area expected to meet that.

The exclusion of reduced forms of N from the standard still seems problematic. It assumes that the contribution of these to the ecosystem effects remains the same over time. (Chapter 5, page 165).

The benchmarks for terrestrial acidification effects of 0.6, 1.2, and 10 are mentioned several times. Do these relate to lower and higher levels of effect or are these a range of estimates for a "no effects" or safe level? How far will protection of aquatic resources go toward protecting terrestrial resources and how does uncertainty about the benchmark make it difficult to answer this question?

The analysis for the acidification effects reveals a tradeoff between SOx and NOx to achieve the same target (ANC level), but this does not account for the fact that NOx contributes more to nutrient enrichment than does SOx. Thus, a comprehensive standard would take account of both types of effects. This may not be feasible at this time, but it is a drawback of focusing only on acidification in setting a standard that should be acknowledged.

Dr. Ellis Cowling

My individual comments on the March 2010 First External Review Draft of the Policy Assessment for the Secondary National Ambient Air Quality Standards for Oxides of Nitrogen and Oxides of Sulfur are organized below in response to each of the several Charge Questions posed in Lydia Wegman's memoranda to Kyndall Barry dated March 4, 2010 in preparation for the April 1-2, 2010 CASAC meeting. As requested by Chairman Ted Russell, my attention has been given primarily to the three Charge Questions on Chapter 2 and the several Charge Questions on Chapter 6.

Overview Comments on the Whole of this First Draft Policy Assessment Document

Before plunging directly into my assigned chapters (Chapters 2 and 6), permit me to suggest that a very constructive and useful addition to the Second Draft Policy Assessment document would be a short but very frank description of the reasons why identifying ammonia and ammonium ion (NHx) as a seventh Criteria Pollutant would not be a desirable alternative to the clever way that chemically reduced forms of nitrogen have been built into the "as given" characteristics of the various regions of our country where NHx deposition is a very significant contributing cause of both acidification and nitrogen enrichment of terrestrial and aquatic ecosystems.

This suggestion is especially relevant in view of the very thorough attention that was given to chemically reduced forms (NHx) of acidifying deposition in both:

- The ISA and the REA for the present Integrated Review of the NOx/SOx NAAQS Secondary Standards, and
- The thorough exploration of the importance of NHx as well as NOx and NOy in the soon to be completed Final Report of the Integrated Nitrogen Committee of EPA's Science Advisory Board.

Chapter 2: Known or Anticipated Ecological Effects

1. What are the views of the Panel on the appropriateness of staff's weight-of-evidence approach which assesses information from across the various ecological research areas described in the NOx SOx Secondary Standards Integrated Science Assessment (ISA), including studies of acidification and nutrient-enrichment in aquatic and terrestrial ecosystems, and laboratory research on responses of plant and animal species to acidification and nutrient enrichment? To what extent is the presentation of evidence drawn from the ecological effects studies assessed in the ISA technically sound, appropriately focused and balanced, and clearly communicated?

The summary of "known" effects of atmospheric-deposition induced acidification and nitrogen enrichments effects presented in Chapter 2 is outstanding well done and faithful to the findings of causality and other atmospheric-ecosystem linkage relationships that are presented in the ISA and the REA reviewed earlier by the CASAC Integrated NOx/SOx Secondary NAAQS Review Panel. By contrast, "anticipated" effects are given very short shrift in Chapter 2.

I was especially delighted to see for the first time in my career -- the extraordinarily useful overview figures shown in Figures 2.8 and 2.9 on pages 42 and 43. There is no general reference as to the source of either of these two figures. Thus, I presume that they were assembled by one or more EPA staff or consultants whom I recommend develop and publish these two figures in one or more of the peer-reviewed journals of both ecology and atmospheric science. In doing so, however, it would be essential to include each of the original articles that are cited in Figure 2.8 but 17 of which are not included in the reference list on pages 52-61 at the end of Chapter 2.

My principal suggestions for improvement of this otherwise excellently well written Chapter 2 are the following:

a) Add to the list of references on pages 51-61 all those references that are included in the body of Figure 2.8 on page 42 but are not included in the references listed at the end of the chapter.
b) Add literature citations to the various (1-20) geographical areas where effects of acidification have been observed in Figure 2-9.
c) Revise the caption for Figure 2.8 so it is more fully descriptive of the information contained in this figure.
d) Revise the wording of various paragraphs within Chapter 2 to include the phrase "total reactive nitrogen," "total reactive N," or at least "total N" in place of just "N" as used in many places in Chapter 2 so there is no question about whether the term "N" in this chapter includes both chemically reduced as well as chemically oxidized forms of total reactive N.

This very same point is explained very thoroughly in Chapter 8 and also very well on lines 21 through 25 on page 37. But the just "N" terminology is adopted in most parts of Chapter 2. Examples of places where this suggested revision would increase the clarity of communication throughout Chapter 2 include: lines 4 and 19 on page 35, line 17 on page 37, lines 8 and 23 on page 38, lines 13 and 20 on page 39, among many others.

I also recommend that this recommended revision of wording -- including the phrase "total reactive nitrogen," "total reactive N," or at least "total N" in place of just "N" -- be examined not only in my two assigned chapters (2 and 6) but also in all the other chapters of this First Draft Policy Assessment document -- Chapters 3, 4, 5, 7, 8, and 9.

2. To what extent are the interpretation and presentation of the results of the exposure and risk assessment technically sound, appropriately balanced, and clearly communicated?

As indicated in the first paragraph of my comments to Charge Question 1, above: "The summary of "known" effects of atmospheric-deposition induced acidification and nitrogen enrichments effects presented in Chapter 2 is outstanding well done and faithful to the findings of causality and other atmospheric-ecosystem linkage relationships that are presented in the ISA and the REA.

What are the views of the Panel on the critical uncertainties associated with the risk and exposure analysis and the evidence from ecological effects studies that need to be characterized in terms of their potential implications for the secondary standards?

Critical uncertainties are hardly touched on at all in Chapter 2 but seem to have been dealt with more thoroughly (and I think appropriately) in Chapters 4 and 6. Thus I refer this question also to the attention of the other CASAC Review Panel members Chairman Russell has identified in his message transmitted in Kyndall Barry's E-mail message dated March 15, 2010.

Chapter 6: Options for Elements of a Standard to Protect Against Effects from Aquatic Acidification

15. To what extent does the Panel agree that the proposal to develop an Atmospheric Acidification Potential Index (AAPI) linked to key determinants of aquatic ANC is a reasonable approach to developing an ecologically relevant standard? Does the Panel generally agree that the secondary standard options identified by staff (including indicator, averaging time, form, and level) are generally consistent with the available scientific and technical information and are appropriate for consideration by the Administrator?

I believe that the structured plan outlined in Chapters 5 and 6 for an Atmospheric Acidification Potential Index (AAPI) linked to key determinants of aquatic ANC is a reasonable approach to developing an ecologically-relevant two-pollutant standard. A very complicated series of adjustments in thought processes by air quality managers will obviously have to be borne in mind. This will take a good deal of educational as well as technical thought.

But the logic and rationale behind the various parts of the AAPI as outlined in chapters 5 and 6 appear to be reasonably well thought out. Thus, I have so far discovered no serious omission from the various location-specific and ecosystem-specific factors as well as the mathematical calculations and modeling estimates that will have to be brought together when these kinds of integrated ecologically-relevant standards are implemented for two Criteria Pollutants at the same time.

Also, the attention given in Chapter 6 to each part of the definition of a NAAQS standard (indicator, level, statistical form, and averaging time) seem appropriate to me.

16. What are the views of the Panel on the degree of uncertainty associated with each element of the suggested standard, e.g. the ecological indicator; the concentration to deposition ratios, reduced nitrogen, the natural background ANC, and the ambient indicator and averaging time for NOx and SOx, and its relationship to the degree of protection that could be expected from the standard? What are the views of the Panel on how to fairly characterize the uncertainty associated with the degree of protection that such a standard would provide from aquatic acidification?

I am impressed with the extent to which the language used in Chapter 6 has embraced the concept of location-specific and ecosystem-specific Critical Loads which have been used widely in Europe and to a more limited extent in Canada. But finally, the USEPA seems to be coming

around to the idea that protection of ecosystems from adverse effects requires an approach that is very different from its traditional notions of national standards that are applied rather uniformly across our country for protection against adverse effects on human health.

Once again in Chapter 6, the issue of how to cope with the uncertainties associated with the degree of protection that any integrated NOx/SOx secondary standard would provide has not been dealt with very explicitly – except with regard to spatial variability. I hope that others in our panel, such as Rich Poirot, will have more to suggest than I have so far been able to suggest.

17. What are the views of the Panel on aggregating the terms (Q, N_{eco} and BC_{0*}) used in estimating natural background ANC, denoted by the function g(·),into 5 bins based on the geologic classification scheme?

Use of a series of "5 (or more?) bins" for aggregating the terms (Q, N_{eco} and BC_{0*}) used in estimating natural background ANC, denoted by the function g(·), seems reasonable to me, but I confess to having no direct experience from which to offer a well-informed professional judgment in response to this question.

18. What are the views of the Panel on the use of regional air quality modeling (e.g., CMAQ) results to establish the concentration-to-deposition ratio (V_{NOy}, V_{SOx}) and reduced nitrogen deposition (NHx) in the AAPI calculation? What are the views of the Panel on the critical uncertainties associated with the use of CMAQ to generate these parameters, and the potential implications of these uncertainties for the secondary standards?

Although I am not a very mathematical-modeling-savvy kind of scientist, I have come to have great respect for the usefulness of both the CMAQ and the MAGIC models, and thus offer a largely-second-hand assurance of professional confidence in the usefulness of these two specific models for atmospheric processes in the case of CMAQ and acidification effects on aquatic ecosystem in the case of MAGIC.

19. What are the views of the Panel regarding presentation of the standards as a set of tradeoff curves for NOx and SOx associated with specific levels of AAPI, and specific values of the g, V_{NOx}, V_{SOx}, and NHx terms?

Using a series of tradeoff curves for comparative evaluation of alternative NOx and SOx secondary standards associated with specific levels of AAPI, and specific values of the g, V_{NOx}, V_{SOx}, and NHx terms seems intuitively promising to me. But, once again, I must confess to having no direct professional experience from which to offer a well-informed professional judgment in response to this question.

20. What are the views of the Panel on using a single year or a three year average of recent year CMAQ modeling results to estimate the AAPI terms?

I agree with the suggestion in this draft Policy Assessment document that both one-year and three-year-long modeling results should be done for several different acidification sensitive and

potential nitrogen-enrichment sensitive geographical areas and compared in the next draft of this CASAC Policy Assessment NAAQS Secondary NOx/SOx Review Panel process.

21. What are the views of the panel on the ambient monitoring requirements? Is for the proposed three ambient air measurements – NOy, SO_2 and particulate sulfate – sufficient to judge compliance with and AAPI?

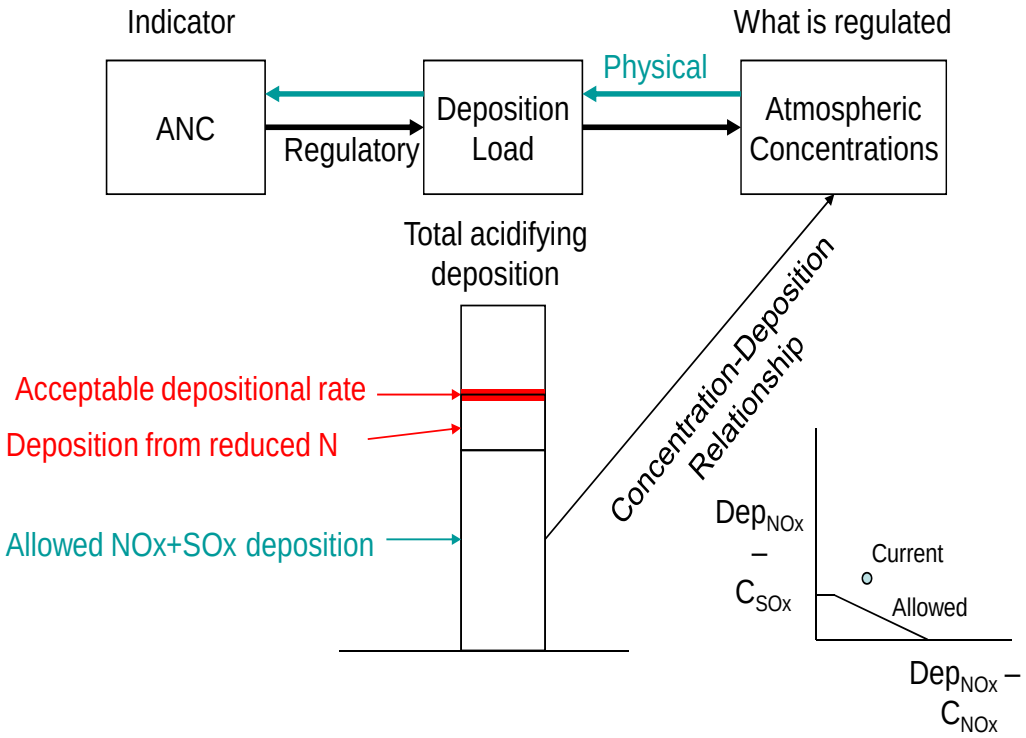
No, I believe these three ambient air measurements – NOy, SO_2 and particulate sulfate – would not be sufficient to judge compliance with an AAPI unless NHx is also included in the evaluation. It is the amount of total reactive nitrogen (NOy + NHx), and not just the chemically oxidized forms of nitrogen and sulfur that cause adverse effects on both terrestrial and aquatic ecosystems.

22. What are the views of the Panel on using existing NOy and PM2.5 sulfate measurement techniques as the basis for defining a Federal Reference Method to judge compliance with and standard?

I believe that consideration should be given to using the existing measurements of NOy and PM2.5 sulfate measurement techniques for defining a possible Federal Reference Method to judge compliance with a possible NOx/SOx Integrated Secondary Standard. But I also know that we will need a substantially increased number of remote, rural, suburban, and urban sites and must examine critically the frequency with which these techniques would be used and the results compiled in useful ways.

Below please find a simplified diagram developed by Ted Russell for a presentation he made to the Integrated Nitrogen Committee of the EPA Science Advisory Board in October 2009.

Integrating Across Species Contribution to Acidification: A Proposed EPA Approach…



Dr. Paul J. Hanson

General Comment:

The Policy Assessment for NOx and SOx welfare effects represents a good beginning. I agree with EPA staff that a useful NAAQS for NOy and SOx welfare effects requires a unique indicator, averaging time; form and level separate from the primary standards for NOx and SOx. I also agree that the data for terrestrial effects are not as well established as those for aquatic impacts. The proposed focus on the development of a standard focusing on aquatic considerations is an appropriate path forward.

The following comments are provided for EPA staff's consideration in the preparation of a second draft Policy Assessment (PA). I'm commenting on what I didn't like or what I would like EPA to change. In general, I found the document to be an appropriate discussion of the policy needs for the NAAQS process for secondary effects of NOx and SOx.

Front Matter – Key Terms

The term or concept of "Adverse Effects" needs an overarching definition. I realize that Chapter 3 is set aside to discuss this issue, but a brief introduction to someone that might not read the entire report is advised.

In the definition of "Acid Neutralizing Capacity" I wondered if the word "water" shouldn't be replaced by precipitation. Pure water is not what falls from the sky.

Is base saturation really a measure of soil acidification (a process), or just an indication of the state of acidity of a given soil?

Add a definition of "Reduced N" to the list of key terms.

Should the definition of Eutrophication highlight its special significance to aquatic systems?

The definition of Semi-arid regions still contains a lower level of precipitation than the definition of arid regions. I've pointed this out previously and it hasn't been addressed. Someone needs to explain to me why the desert isn't as dry as the semi-desert.

Page xiii line 28: Super and subscripts need attention.

Chapter 1:

Page 5 lines 6 to 11: Something isn't quite right in this section. The wording implies a heavy emphasis on direct effects of gaseous forms of NOx and SOx, but I was left with the impression that the intention might have been something else.

Page 12 lines 2 and 3: The inclusion of global warming in this list seems unnecessary and perhaps a bit of a stretch. Connections between NOx and SOx and climate change do not show up elsewhere in the PA document.

Page 13 line 26: Isn't the concept of "excessive degradation" a policy rather than a science question. Levels of change that represent excessive degradation are a judgment not a fact.

Page 14 line 9: The term "ecosystem sensitivities" might be replaced by 'location-specific characteristics' to better inform the new reader of the intent.

Page 17 lines 12 and 13: I don't think the PA does a very good job of addressing this question.

Page 20: On this page and in some other locations within the document the concept of reduced N (meaning chemically-reduced forms of N) may be confused with discussions of reduced deposition of N forms (see lines 23 and 24). I know what the authors intended, but I did stumble over the presentation.

Page 21 line 18: Does the Agency or the Administrator alone actively consider the appropriate levels?

Chapter 2:

Page 23 line 8: Deposition of acidic compounds does lead to exposures, but not necessarily effects. The relationship between deposition (the exposure) and the effects depends on the characteristics of the ecosystem.

Page 23 line 11: The wording might be changed to "magnitude <u>and rate</u>".

Page 23 line 26: The phrase "small spatial scales" is not defined. Do the authors mean meters, kilometers, watersheds, counties, states or something else?

A common critique that I have within the PA document is that sentences are often written to suggest that acidification or nutrient enrichment effects have the potential to effect all ecosystems, vegetation or aquatic systems the same. The authors should be careful to reemphasize that many effects being discussed are applicable only to the most sensitive components of ecosystems. They may still warrant special protection, but they do not represent a response that is universal for all organisms.

Page 24 lines 21 and 22: Later on in the document confounding effects are mentioned, but this statement makes it appear that the results of acidification are absolute. In many cases I think it is likely that the evidence is based on inference drawn from strong correlations rather than a controlled study designed to isolate the specific effects of NOx and SOx additions to natural systems.

Page 25 line 17: Should the C: N ratio really be in this list. It is not emphasized in the document.

Top of page 26: The statements in this section do not suggest lots of confidence in the certainty of the relationship between acidification and observed phenomenon. The text describes a

correlation, a response that “may be contributing” and a “likely” response. If appropriate, please change this text to indicate what we do know versus what continues to be hypothesized pending better data.

Page 26 line10: Not all terrestrial ecosystems are sensitive. The wording needs to be changed.

Throughout the document I believe it is important to characterize all pre-acidification results derived from MAGIC or CMAQ as simulations. Don’t pretend that we know what pre-acidification levels really are.

Page 32 line 6: I would change the wording here to “above simulated pre-acidification (1860) conditions”.

Page 38 line 4: The wording “terrestrial ecosystems” should be “sensitive terrestrial ecosystems”.

Page 38 lines 25 and 26: This is not true for all species, organisms, or ecosystems. Make sure that the reader is reminded that this document is taking the approach of protecting sensitive organisms and ecosystems.

Page 39 line 20: Add a reference for this statement.

Page 39 line 22 and line 24: The phrases “may result” and “may lead to” do not make a believer out of me. I would hope that we would be making suggestions for NAAQS based on data that can be fully supported by the published literature.

Page 40 lines 6 to 8: This statement is too strong. I don’t believe that “almost all” ecosystems will be altered by the addition of anthropogenic nitrogen. I actually expect the opposite. In most ecosystems (judged by % area of the US) we will be unable to detect the influence anthropogenic N additions. This is another case where the focus on sensitive ecosystems needs emphasis.

Page 40 line 13: I would add plant growth rate to the list of factors.

Page 43 line 11: “Hardwood forests” probably needs to be changed to sugar maple species. I doubt seriously that the vast majority of upland oak hardwood forests located throughout the eastern United States are very sensitive.

Figure 2-8 is pretty, but it application to the analysis isn’t obvious.

Within Figure 2-9: Are the conclusions cited under #13 the result of natural deposition or those derived from the manipulation studies conducted on the Fernow Experimental Forest?

Section 2.3.3: I was surprised that this section did not conclude with the strong statement from the ISA report that few direct effects from gaseous NOx or SOx are anticipated throughout most of the US.

Page 52 line 7: What does “significant numbers” imply?

Chapter 3:

General comment: The PA document doesn’t address natural rates of change versus change induced by anthropogenic N and S inputs. Change happens anyway. How are natural rates of change viewed in the context of other changes driven by N and S inputs or various other confounding factors?

Page 68 lines 23 to 29: I found this section of text to be very important. The realization that the establishment of critical load demands a judgment call of what is or is not an important adverse effect makes subsequent discussion of the use of critical loads in the characterization of risk to be a bit of a circular argument. This is an interesting conundrum. Does the EPA staff have a solution?

Page 72 lines 10 and 11: What is the policy relevant background level of ecosystem change or biodiversity alterations against which anthropogenic N and S induced effects might be judged?

Page 83 line 2: Provide the reference for this statistic.

Page 84 lines 7 to 23: I don’t believe this paragraph is a strong argument for broad national controls. The available data are representative of only a few key species. Furthermore, if the net annual effect is only $690,000 thousand dollars of production per year one might ask why we are concerned – certainly not for financial reasons. Conducting expensive research to understand responses, or setting standards to combat a problem that only sums to a $690K per year phenomenon are not good justifications. The arguments based on endangered species are stronger.

Page 88 lines 9 to 15: These statements do not seem to consider that N and S deposition effects are fractional. For example, they are probably not likely to remove the entire ecosystem service for recreation. How does EPA judge the impact on aesthetic use if only a portion of an ecosystem is impacted by N and S inputs?

Chapter 4:

Page 103 lines 3 and 4: I think this sentence should emphasize sensitive ecosystems not all ecosystems.

Page 131 line 28: Add the word ‘sensitive’ to qualify terrestrial and aquatic in this statement.

Page 131 line 31: Should carbon really be in this list? Convince me.

Page 132 lines 1 to 5: These items seem to come out-of-the-blue. Are they needed?

Page 134 line21: Who defines the benchmark levels?

Page 135 line 18: The phrase "large portions" needs to be quantified. The authors should provide the area of the US involved to convince me that this is a big deal.

Page 136 line 16: There is not a significant risk to all terrestrial ecosystems. Only the sensitive systems are being highlighted in the case study analyses.

Page 136 line 28: Provide a quantitative statement for the land cover that defines "many" in this sentence.

Page 137 line 19 and 20: What criteria were used to define the critical load that forms the basis for this conclusion? Change the word "believes" to something else if you can. I'm not interested in what EPA staff believes. I want to know what they can justify from the science. Please conduct a search for the word believe and make appropriate substitutes throughout the document.

Page 138 lines 30 and 31: This may be true for some ecosystems, but other forests sequester all of the annual N inputs into aboveground wood production.

Page 139 line 8: Please be specific about the tree species to which this conclusion applies. It is not true for all species.

Section 4.5.2 seems to be missing a strong conclusion statement.

Section 4.5.4 seems a bit at odds with the statements in Section 4.5.2.

Page 141 line 5: "Large areas" is too vague. Please provide a quantitative statement about the amount of land area impacted.

Chapter 5:

Page 145 line14: You might add wind to the list of factors.

Section 5.3.1: This section reads as if the relationships are universal to all tree species. I don't believe that EPA would be able to support that concept. Make this discussion reflect the sensitive species that it targets.

Section 5.4.1: In an attempt to make the equations simple and easy to follow the authors have not appropriately reflected what is really being attempted. Equations 1 through 4 should include components for gaseous, particle and occult deposition that depend on concentrations and deposition velocities plus an independent component of wet deposition that is a function of rainfall. The processes are not the same. Please make the equations reflect the true processes being calculated within the model (e.g., page 172 lines 8 to 11.

Chapter 6:

No comment at this time.

Chapter 7:

This section is underdeveloped. There is not much to comment on.

Chapter 9:

Throughout this section make sure that the focus on sensitive aquatic and terrestrial ecosystems comes through loud and clear. Don't lead the reader to conclude that all ecosystems are uniformly at risk from N and S inputs.

In the research needs list a better precipitation model or emphasis on direct measures of wet deposition inputs should be further emphasized.

Dr. Dale W. Johnson

Comments on the Executive Summary:

P. ES-3, paragraph 5: I do not agree that geology is the principal factor governing sensitivity to N: decades of biogeochemical research have shown that plant uptake is a major factor (often THE major factor) deciding whether atmospherically-deposited N passes through the terrestrial ecosystem to the aquatic one.

p. ES-4, paragraph 3: Again, as the authors are so often loathe to admit, I would assert that N deposition to N-limited commercial forests could be beneficial. After many such comments, however, I do not, expect to see this fact reflected in any executive summary and this is unfortunate because I can assure you that my colleagues, at least, will take note of that and possibly dismiss this entire endeavor.

p. ES-5, last paragraph: The statement about the Sierra Nevada is an over generalization – the eastern and more remote portions of that range do not receive N deposition levels above 5.

p. ES-7, last paragraph: The statement that reduced forms of nitrogen are converted to nitrate is incorrect as a blanket statement: ammonium can be taken up by plants or microbes before being nitrified and, in N-limited ecosystems (that is, in 90% of all terrestrial ecosystems), this is the rule not the exception. Also, in the same paragraph, I simply do not understand the wording of the last sentence.

p. ES-8, paragraph 1: The treatment of NH4 is very cursory and no doubt will invoke much criticism.

p. ES-8, last paragraph: You should mention that this applies to aquatic ecosystems – there is no measure of ANC in terrestrial ecosystems as such.

p. ES-9, paragraph 2: give units. Also, what kind of term converts deposition to fluxes? I thought deposition WAS a flux?

p. ES-11, paragraph 1: Give units. Is something missing in the equation as per "(˙)"?

Comments on the overall document:

I reviewed the entire document, with special attention to those portions where I have some expertise. Specific suggestions and comments are given below.

p. 23, line 9: replace "in some instances" with "unless buffered by high base soils"

p. 23, lines 15-28: Good summary, but you should also mention the effects of NH4+

p. 24, line 16: replace “leads to the acidification of” with “leads to varying degrees of acifification” . It is all a question of amount: small background levels of SOx, NOx and NHx will not lead to any significant acidification nor will this take place in limestone bedrock systems. As a generic statement, this does not stand.

p. 24, line 24: what is a surplus of base cations?

p. 34, line 12: Replace “Tree species” with “Some tree species”. Some tree species tolerate Al very well and in fact seem to thrive in acidic environments.

p. 35, line 4: Replace “exceeds” with “exceed”

p. 37, lines 8-12: Having worked with many models of acidification over the years, I definitely do not share your high confidence in this one. I am not sure what change is needed, but I want to go on the record as a skeptic.

p. 39, line 24: insert “deemed desirable in commercial forests but may also” in front of “may”. Bias toward negative is showing through here again and I believe it is important to express both sides of the nitrogen issue.

p. 70, Table 3-1: Where are forest products? Fiber, timber, furniture wood?

p. 72, lines 1-15: Important ecosystem services from forests should certainly include timber, furniture wood, pulp stock from commercial forests.

p. 82, lines 27-28: A very true statement – but where is this shown in Table 3-1?

p. 84, line 11: What about loblolly pine? It is far more commercially important than sugar maple or red spruce.

p. 84, lines 21-23: This is a gross overstatement: these estimates are based on two species and do not include the far more commercially important southern pines!

p. 84, lines 25-29: Why on earth have you decided to overlook any beneficial effects in your economic assessment? I cannot imagine this being defensible and certainly do not agree with it in any way.

p. 88, line 30: change “depositio” to “deposition”

p. 89, lines 1-2: If you select two case studies based on the presumed negative effects of atmospheric deposition, how can this possibly be any kind of regional assessment?

p. 102, line 11: Add “or NH4+” after “SOx

p. 136, line 20: BC:Al in soils, presumably?

p. 136, line 26: first mention I see of timber – again, loblolly pine is king of that.

p. 137, lines 1-8: This could use some references cited.

p. 138, lines 10-15: This section is biased. Nitrogen limitation is common, not only in limited situations and N inputs will probably cause long-term benefits in most managed systems. I recognize from past experience that the authors are very loathe to admit this, so I will continue to point it out. Your statements fly in the face of many decades of forest nutrition research.

p.138, lines 30-31 and on to page 139: As I have noted in the past, the statement that most atmospherically deposited N is retained by soils is disputed. The sentences after this try to minimize N benefits to commercial forests, as the authors have done in the past. We have agreed to disagree on this matter, it seems.

p. 153, lines 7-18: This is where I have real trouble with the model used: no ecosystem or soil is ever in steady-state; Were this the case, no soils would ever acidify in the absence of atmospheric acid inputs, and they certainly have done so as evidence by many studies in pristine areas such as Alaska.

p. 155, lines 18-20: This seems like an overly confident statement – what is there to back it up? For example, here in the Sierra Nevada, we have chronically hydrophobic soils which can profoundly affect surface hydrology in ways very different from eastern soils which are not hydrophobic. This is a gross over generalization.

p. 158, line 21 through p. 159 line 17: Please provide units for $DL_{ANClim}(N+S)$ – it would seem from the other units given that the units for this would be meq m^{-2} after some conversion?

p. 177, line 26 through p. 178, line 11: Same comment

<u>Comments on Chapter 7 Charge Questions:</u>

23. What are the views of the panel on the approach taken to compare the protection provided by a potential aquatic acidification standard to the protection needed for terrestrial acidification?

While I do not share the authors' faith in the validity of the models used, I see no other viable approach for answering this question. Thus, I can offer no criticism for the approach taken.

24. What are the views of the panel on a future comparison of the protection provided by a potential aquatic acidification standard to nutrient enrichment benchmarks? What are the views of the panel regarding using a nutrient enrichment benchmark to be a limiting factor on the nitrogen in the aquatic acidification standard, instead of having a separate standard?

Acidification and nutrient enrichment could be very much discoupled, especially if the major cause of acidification is S and not N. Also, there will be little aquatic effect of N deposition until

the terrestrial ecosystem is N-saturated unless deposited N circumvents the terrestrial ecosystem (for example, but surface runoff). So on the face it it, it does not seem like a wise idea conceptually to try to use a standard for one ecosystem and apply it to the other. On the other hand, it could be argued that, in the absence of significant surface runoff, a linked standard is called for rather than a separate one in that aquatic ecosystems will not receive much effect of N deposition until the terrestrial system is nitrogen saturated. When it comes to S, retention in the terrestrial ecosystem will be dominated by soil chemical processes (since S limitations in terrestrial ecosystems are exceedingly rare) and negative aquatic effects will not occur until and unless 1) sulfate is mobile in sufficient amounts in soils to become a major anion in solution, and 2) soils are either naturally acidic or become acidified by atmospheric deposition. In cases where sulfate is complete mobile and soils are already acidic (for example, Spodosols in the northeast), negative aquatic effects can be expected to occur immediately (and disappear immediately as S deposition declines). These are complicated questions that will probably need to be resolved with simulations of many different scenarios and linked standards would, on the face of it, seem to be necessary.

Dr. Myron J. Mitchell

Chapter 2: Known or Anticipated Ecological Effects

1. What are the views of the Panel on the appropriateness of staff's weight-of-evidence approach which assesses information from across the various ecological research areas described in the NOx SOx Secondary Standards Integrated Science Assessment (ISA), including studies of acidification and nutrient-enrichment in aquatic and terrestrial ecosystems, and laboratory research on responses of plant and animal species to acidification and nutrient enrichment? To what extent is the presentation of evidence drawn from the ecological effects studies assessed in the ISA technically sound, appropriately focused and balanced, and clearly communicated?

The current document provides a good review based upon the ISA. There needs to be clarification, however, with respect to some of the details including how the document provides results with respect to specific years. The document needs to be made more explicit with respect to the actual year(s) of the analyses. Some of the discussion is repetitive and some additional editing should be used to decrease the redundancy. Specific suggested changes are provided in my detailed comments.

2. To what extent are the interpretation and presentation of the results of the exposure and risk assessment technically sound, appropriately balanced, and clearly communicated?

The presentation and summarization of results related to exposure and risk assessment are generally good.

3. What are the views of the Panel on the critical uncertainties associated with the risk and exposure analysis and the evidence from ecological effects studies that need to be characterized in terms of their potential implications for the secondary standards?

More attention needs to be placed on the issues related to the uncertainties of the deposition estimates provided and used by various models. This is especially important with respect to estimates of dry deposition and deposition via clouds and fog. The descriptions of other issues of uncertainty are sound and include considerations of the degree of uncertainty related to different ecosystems and their respective components.

Chapter 3: Considerations of Adversity to Public Welfare

4. What are the views of the panel regarding the characterizations of adversity to public welfare presented in this document? What are the views of the panel regarding the use of the ecosystem services framework as an additional metric to inform questions of adversity? What are the views of the panel regarding the usefulness of including economic valuation of some of these ecosystem services in the policy assessment document?

The inclusion of public welfare seems to be appropriate for this document. Clearly understanding the role of ecosystem services is central to setting these standards. Hence, a description of the importance of these services needs to be a focal point of the document. The use of economic valuation also needs to be included so that the public will be aware of the issues as they relate to economic issues and other ways to evaluate how the standards affect the public welfare. Clearly a major challenge in developing the secondary standards will be to provide to the public information on ecosystem services and how maintaining these services is critical for the welfare of both individuals as well as the Nation.

5. To what extent is the presentation of ecosystem services in this document scientifically sound and clearly communicated?

The overall description is adequate, but further editing will be needed to sharpen the focus and to be sure to avoid confusion among the various issues relating to public welfare and setting secondary standards for SO_x and NO_x. In some places it is not clear on the relative concerns associated with procedures to make evaluations on ecosystem services versus having the necessary information for making these evaluations. There is also an issue related to whether there should be an attempt to make an evaluation with respect to any positive aspects related to nitrogen deposition. If there is an exclusion of the determinations of the positive benefits, this might be construed as a major bias by EPA in this evaluation.

6. What are the views of the Panel on the critical uncertainties associated with articulating adversity to public welfare that need to be characterized in terms of their potential implications for the secondary standards?

Some further elaboration of how the types of uncertainties may affect the setting of secondary standards and how these uncertainties vary with type of effect on public *welfare is needed.*

Chapter 4: Addressing the Adequacy of the Current Standards

7. What are the views of the Panel on staff's assessment of the adequacy of the form of the existing NOx and SOx secondary standards? To what extent does the Panel agree with staff's assessment of the protection provided by existing standards, given the current levels, forms, averaging times, and indicators?

The document provides a good review of existing secondary standards and shows that they are not adequate for ecosystem protection.

8. What are the views of the Panel on the time frame of ecological response related to current deposition? The adequacy evaluation relies on recent NOx, SOx, deposition, and on long-term steady state ANC. Does the panel agree that long-term steady state ANC is the most appropriate representation of ANC for evaluating the adequacy of the current standards?

The use of long-term ANC has merits with respect to setting standards, but may not adequately capture some of the temporal changes that will likely occur in conjunction with changes in

surface water chemistry. Clarification is needed on the specific time to be used as targets for recovery and the actual rates of these recoveries.

9. To what extent are the characterizations of ambient air quality and deposition appropriately characterized, relevant to the review of the secondary NOx and SOx NAAQS, and clearly communicated?

A more balanced approach is needed in which it is more clearly delineated what information the current networks currently provide and what information is lacking. For example the network distribution may be completely adequate for estimating wet only sulfate deposition, but the estimates for NH_x, including both wet and dry, are lacking. Maybe the inclusion of a figure or table that provides a description of the both spatial and temporal coverage of the major chemical species atmospheric concentrations would be useful. Some of the discussion implies that the CMAQ model will be used to overcome some of the problems with respect to spatial coverage of atmospheric pollutants and deposition of sulfur and nitrogen compounds. Within the document the limitations of CMAQ need to be provided with respect to how well the model outputs have been validated both with respect to temporal and spatial patterns.

Chapter 5: Conceptual Design of an Ecologically Relevant Multi-pollutant Standard

10. What are the views of the Panel on staff's proposed conceptual framework for the structure of a multipollutant, ecologically relevant standard for NOx and SOx? To what extent does the Panel agree that this suggested structure adequately represents the scientific linkages between ecological responses, water chemistry, atmospheric deposition, and ambient NOx and SOx?

Some of the discussion with respect to ecological responses and various watershed attributes were confusing in the different treatments of nitrogen and sulfur. A treatment that shows more clearly the biogeochemical similarities and differences would strengthen the overall approach.

11. What are the views of the Panel on the relevance of the conceptual design for developing standards to protect against aquatic acidification effects?

The overall conceptual design is adequate.

a) What are the views of the Panel on staff's proposed options for the ecosystem acidification model to represent the ecological response function?

There are some concerns related to the application of this model with respect to accurately capturing the critical biogeochemical processes. There will be important tradeoffs between keeping the model relatively simple and capturing important spatial and temporal patterns affecting acidification.

b) What are the views of the Panel on the relative merits of the two techniques for calculating N_{eco}, the parameter representing the amount of deposited nitrogen that is available for acidification due to uptake, denitrification and immobilization?

The use of N_{eco} formulation that needs estimations of N retention, immobilization and denitrification may be very problematic since the parameter estimates (especially immobilization and denitrification) are very difficult to obtain. It would be better to focus on the actual N losses via leaching. This latter value is easier to obtain. An issue that needs consideration is the time units used in these calculations. It will probably be important to include some seasonal effects since there are marked changes in nitrate losses during different periods of the year.

c) What are the views of the Panel on staff's proposed options for developing acid sensitivity classes to categorize the national landscape? Is it appropriate to base this classification on bedrock geology? Should multiple criteria be used to inform the sensitivity categories?

It is not appropriate to only use bedrock geology for assessing the potential for acidification and/or recovery from acidification. The surficial geology including the parent material and hydrological flow paths can be extremely important and catchments with the same parent material can show very different responses to acidification. Yes, multiple criteria are needed to provide sufficient information for sensitivity categories.

d) What are the views of the Panel on staff's proposed options for how to aggregate acidification modeling from the catchment-scale to represent acid-sensitivity categories at the national-scale?

The aggregation needs to be done in a meaningful manner that takes into account the controlling factors of acidification of surface waters. There is an over dependence on the use of bedrock geology that does not consider the importance of other critical factors, especially superficial geology, in affecting sensitivity to acidification.

e) What are the views of the Panel on staff's suggested method to account for reduced nitrogen in the deposition metric?

The assumption that the proportion of reduced N is constant over time, may cause a number of problems both for forecasting and also for any attempt to examine model performance using hindcasting.

12. What are the views of the Panel on the relevance of the conceptual design for developing standards to protect against terrestrial acidification effects? Terrestrial nutrient enrichment effects? Aquatic nutrient enrichment effects? Does the panel have suggestions on additional data or methods that might enable EPA to expand the current aquatic acidification approach to cover additional effects?

Developing a single standard for either aquatic or terrestrial ecosystems is highly problematic due to the major differences in acidification and nutrient response among and within the regions. The standard needs to vary to account for differences in the biogeochemical responses among different responses. There are importance differences in the landscape features across the nation and the historical inputs of S and N that influence ecosystem responses.

13. What are the views of the Panel on the critical uncertainties associated with the conceptual design of an ecologically relevant multi-pollutant standard that need to be characterized in terms of their potential implications for the secondary standards?

The development of some careful analyses related to the precision and accuracy of the CMAQ simulations needs to be included. It would be helpful to also show any other regional approaches that have estimated N and S deposition and how these compare with CMAQ simulations.

14. To what extent do the figures and examples aid in clarifying the text? Should more or less information of this type be included in the second draft?

The figures and examples need to be modified to capture the major processes that control ecosystem response to acidification and nutrients.

Chapter 6: Options for Elements of a Standard to Protect Against Effects from Aquatic Acidification

15. To what extent does the Panel agree that the proposal to develop an Atmospheric Acidification Potential Index (AAPI) linked to key determinants of aquatic ANC is a reasonable approach to developing an ecologically relevant standard? Does the Panel generally agree that the secondary standard options identified by staff (including indicator, averaging time, form, and level) are generally consistent with the available scientific and technical information and are appropriate for consideration by the Administrator?

Although the current approach allows for the development of unified national standards, it does not account for the high level of biogeochemical variation in the processing of nitrogen and sulfur in catchments. Especially for those catchments which have major differences in seasonal drainage rates (including snowmelt) time scales are needed that will reflect episodic conditions. There is a large body of evidence of the importance of the spatial and temporal variation in reflecting acidification and nutrient enrichment processes among ecosystems.

16. What are the views of the Panel on the degree of uncertainty associated with each element of the suggested standard, e.g. the ecological indicator; the concentration to deposition ratios, reduced nitrogen, the natural background ANC, and the ambient indicator and averaging time for NOx and sox, and its relationship to the degree of protection that could be expected from the standard? What are the views of the Panel on how to fairly characterize the uncertainty associated with the degree of protection that such a standard would provide from aquatic acidification?

More attention is needed on other factors that will affect the biogeochemical processing of N and S within watersheds. Also, the strong reliance in using the CMAQ model would be greatly improved by more specific comparisons related to actual comparisons between CMAQ estimates and measured values. Consistency is needed between the temporal and spatial resolution of the

depositional predictions and the actual measurements within terrestrial and aquatic ecosystems regarding nutrient enrichment and acidification.

17. What are the views of the Panel on aggregating the terms (Q, N_{eco} and BC0 *) used in estimating natural background ANC, denoted by the function g(A), into 5 bins based on the geologic classification scheme?

I don't believe the use of the geologic classification scheme is adequate to capture the spatial and temporal patterns needed for setting these standards. This can be shown by looking at the modeled outputs in the Adirondacks that do not appear to show what is known about the spatial patterns of surface water acidification in this region. At a minimum more attention is needed with respect to surficial geology and soil properties both with respect to physical aspects (e.g., soil depth) and chemistry (e.g., base cation concentrations).

18. What are the views of the Panel on the use of regional air quality modeling (e.g., CMAQ) results to establish the concentration-to-deposition ratio (VNOy, VSOx) and reduced nitrogen deposition (NHx) in the AAPI calculation? What are the views of the Panel on the critical uncertainties associated with the use of CMAQ to generate these parameters, and the potential implications of these uncertainties for the secondary standards?

As indicated in previous comments there are a number of issues related to the use of the CMAQ results.

19. What are the views of the Panel regarding presentation of the standards as a set of tradeoff curves for NOx and SOx associated with specific levels of AAPI, and specific values of the g, VNOx, VSOx, and NHx terms?

To make valid assessments of the effects of N and S deposition on ecosystem processes the various components that provide the deposition and the actual chemical species (especially for nitrogen compounds) need to be delineated separately.

20. What are the views of the Panel on using a single year or a three year average of recent year CMAQ modeling results to estimate the AAPI terms?

The use of such a short time frame for developing terms should be reconsidered especially in the context of ecosystem level responses that occur over much longer periods (e.g., decades and longer). Is there an issue with respect to the limitations of results from the CMAQ model in determining what information is available with respect to atmospheric deposition?

21. What are the views of the panel on the ambient monitoring requirements? Is for the proposed three ambient air measurements – NOy, SO2 and particulate sulfate – sufficient to judge compliance with and AAPI?

It is not completely clear whether this approach (especially aggregating information on watershed responses) will result in the development of useful results for predicting the spatial

and temporal patterns of acidification and most importantly how these systems will respond to changes in loads of atmospheric deposition.

22. What are the views of the Panel on using existing NOy and PM2.5 sulfate measurement techniques as the basis for defining a Federal Reference Method to judge compliance with and standard?

There are important issues with respect to whether NOy captures the major N chemical species. For PM2.5 the amount of S is relatively high in this atmospheric fraction, but its overall contribution to S loading is relatively small; hence this is not the major issue. For S the major problem is associated with making accurate and precise estimates of S in dry deposition and also for some sites deposition from fog and/or clouds.

Chapter 7: Co-protection

23. What are the views of the panel on the approach taken to compare the protection provided by a potential aquatic acidification standard to the protection needed for terrestrial acidification?

The results presented that show differences in protection between aquatic and terrestrial systems are interesting and shows both the linkages, but also some of the problems. There are issues beyond acidification with respect to terrestrial ecosystems recognizing that soil acidification is a natural process especially in forested ecosystems and hence the major concern is related to nutrient imbalances some of which is captured by the use of the Bc: Al ratio, but for this to be meaningful this ratio needs to address the spatial variability of soil chemistry.

24. What are the views of the panel on a future comparison of the protection provided by a potential aquatic acidification standard to nutrient enrichment benchmarks? What are the views of the panel regarding using a nutrient enrichment benchmark to be a limiting factor on the nitrogen in the aquatic acidification standard, instead of having a separate standard?

The section on nutrient enrichment benchmarks is not yet developed fully in the document and hence comments would be premature.

Chapter 9: Conclusions

25. What are the views of the Panel on the preliminary staff conclusions regarding the adequacy of the current standards, the need for an integrated multi-pollutant structure for revised standards, and the proposed form of the joint NOx SOx standards for aquatic acidification?

The review of current standards and the need for an integrated multi-pollutant structure for revised standards is satisfactory.

26. What are the views of the Panel on the overall characterization of uncertainty as it relates to the determination of an ecologically-relevant multi-pollutant standard for NOx and SOx?

The section on uncertainty is yet to be developed and it is premature to make any comments. However, the need for this analysis is critical and should be a major focus of the document.

Detailed Comments

Page	Line	Comment
x	4	LTER should be defined as "Long Term Ecological Research"–delete monitoring.
x	29-30	Delete "reduced".
xii	30-31	The definition for dry deposition implies that dry deposition only occurs when there is not wet deposition–this is confusing. Delete "in the absence of precipitation (e.g., rain, snow) or occult deposition (e.g., fog)".
xii	37-40	The definition of ecosystem is too broad. The earth is not an ecosystem. Delete "Ecosystems cover a hierarchy of spatial scales and can comprise the entire globe, biomes at the continental scale, or small, well-circumscribed systems such as a small pond".
xii	7	The definition of eutrophication is not correct. Other elements (e.g., P) can result in eutrophication. Substitute "nutrients" for "nitrogen".
xiv	4	Change to "other forms of precipitation".
2	6	Replace "elements" with "components".
5	7	Why are "commercially managed forests and agricultural lands" excluded? Does this mean that those portions of the Adirondacks that are used for commercial forestry are not to be considered?
7	1	Replace "components" for elements. I would suggest the term "element" should be avoided in this document to avoid any confusion with chemical elements.
8	22	"m3" needs to have the 3 superscripted.
9	6	Change to "that SO_x air concentrations have".
9	19-20	This statement is not true and should be changed to "since dry deposition was believed to account for a substantial portion of the total acid deposition problem".
13	4	Delete "past".

15	28-29	It is not evident that emphasis has been added. Do the quotations indicate emphasis?
17	3-5	I agree that this review should not include those managed systems that are subject to N fertilization, but there are large areas of forest land that are managed (e.g., timber harvest) and not fertilized. These forests maybe highly susceptible to the effects of acidic deposition due to the combined deleterious effects of cation nutrient depletion due to biomass removal and leaching from the forest soil.
18	11	Modify this statement to be more comprehensive: “acidification, nutrient depletion and the mobilization of toxic metals in sensitive aquatic and terrestrial ecosystems”.
19	1	This beginning sentence shows how the term “element” or in this case “elements” can lead to confusion as indicated in my previous comments.
19	23	Change to “deposition decreased”.
19	24	Change to “deposition is decreased”. There may be confusion in terms when discussing nitrogen in the use of the term “reduced” since it also has a chemical meaning.
22	26	Replace “significance” with “importance”. Reserve the use of the term “significance” here and elsewhere for indicating statistical significance.
23	5	Delete “and thermodynamic processes”. This is not needed since thermodynamics is a function of the chemical reactions.
23	7	Not sure what is meant by “ecosystem exposure”.
23	13-14	Change to “and reduced chemical species”.
23	23	Replace “host” with “variety”.
23	26	Change to “but others, like geology, vary over larger spatial scales”.
24	9	Change to “episodes with deleterious consequences to sensitive biota”.
24	17	Change to “biogeochemical components”.
24	20	Change to “water bodies; moreover, deposition”. Also change “effects” to “affects”.
25	2	Change to “in inorganic Al concentration. These changes contribute to declines”.

25	4	Change to “animal species in various ecosystems. These fish may also serve as a source of food and recreation”.
25	15	Replace “communities” with “taxa”.
25	17	Change to “multiple studies are: ”.
25	19	Change to “20%, exchange chemistry”.
25	20	Change to “Under these conditions”.
25	23	Change to “The Ca^{2+} and Al concentrations in soil water”.
26	3	Delete “episodic”.
26	3	Do not capitalize “sugar”.
26	4	Change to “cations from soil with low levels of available Ca”.
26	5	Change to “forests due to grassland soils being generally rich in base cations”.
26	9-10	This is not a very useful sentence. A more specific delineation of sensitive ecosystems is needed beyond freshwater and terrestrial. Either delete or revise.
26	16	Change to “flowpaths”.
26	16	Delete “at relatively high elevation”.
26	18	I would suggest that the term “magnitude” is not a very useful term. How about “range”? Also, line 21.
27	2	Delete “since the 1980s”.
27	7	I would be careful here with respect to how to phrase this description since within the western U.S. there are acidic waters associated with various factors including acid mine drainage. Maybe something like: There the acidification of surface waters by acidic deposition is uncommon in the western U.S.
27	22	Replace “classes” with “taxa”.
27	22	Change to “whereas other taxa are reduced to only acidophilic species”.
27	23-24	Change to “changes in taxa composition is associated with the high energy cost”.
28	1	Delete “In the literature,”.

28 7 Delete “from the EPA-administered”.

28 Figure 2-1 Replace “forms” with “taxa”.

29 1-4 In this section be more explicit of the actual date(s) related to these results.

29 6 Change to “there would be no improvement in water quality”.

29 7-8 Change to “same from 2020 to 2050".

30 Figure 2-3 Figure caption. Change from “and current (2006) conditions” to “and 2006 conditions”.

31 5 Provide the actual year versus indicating “current”. Also (line 7) give the actual year instead of indicating “today”. Such changes should be made for the entire document.

32 12 Change to “emission levels from 2010 to 2050".

32 15 Change to “are predicted to increase by 5%”.

32 17 Change to “blacknose dace”.

33 Figure 2-6 This figure needs a scale indicator of size. Such scales are needed in all figures showing spatial location.

34 11 Change to “Tree health has been linked to the availability of base cations”.

34 12 Change to “Tree species show a range of sensitivities to”.

34 13 Clarify if these ratios are “molar” or “mass” based.

35 15 Change to “studied tree species”.

35 19 Delete “in 2002".

37 1 Change to “data sets”.

37 4 Change to “Ca^{2+}”.

37 18-19 Change to “Nitrogen deposition is a major source of anthropogenic nitrogen”. For many terrestrial and freshwater systems other sources of nitrogen including fertilizer and waste treatment are greater than deposition.

37	18-21	The statement associated with estuaries is confusing. This needs to be reworded to indicate that for estuaries that other sources of N input greatly exceed N deposition.
37	29	Change to “biogeochemical”.
38	27	Change to “The most sensitive terrestrial taxa to N deposition”.
39	27	Change to “sensitive terrestrial ecosystems to N deposition”.
42	Figure 2-8	Delete in caption “with the inclusion of the diatom changes in the Rocky Mountain Lakes”.
45	22	Change to “0.7 kg N/ha/yr”.
46	7-8	As stated in a previous comment that the wording here with respect to the effect of N loads on estuaries is confusing.
46	20	Change to “eutrophication; however,”.
50	28	Change to “such as water availability, humidity”.
63	2	Is this statement on limiting welfare effects of ozone to vegetation correct? Ozone can have major impacts on human health and deterioration of materials?
65	4-11	This text is very difficult to follow and needs to be rewritten.
66	4	Change to “20 mg/L” and “$CaCO_3$". (See also line 7 and throughout this section where similar changes are needed) Note that the proper symbol for liters is “L”.
70	7-8	Change to something like “Especially important is the acknowledgment that it is difficult to measure and/or monetize the goods and services supplied by ecosystems”.
74	Figure 3-4 legend. Do not capitalize nitrogen and sulfur. Also the source of these data needs to be provided. Units need to be given.	
75	Figure 3-5 legend. Do not capitalize nitrogen and sulfur. Also the source of these data needs to be provided. Units need to be given.	
75-76		Change the ending and beginning sentence of each of these pages to something like: “The difficulty in the monetization for ecosystems services has been previously emphasized hence necessitating using a subset of services in economic valuation.
76	14	Delete “colloquially”.

76	14	Change to “However, the amount an individual is willing to pay”.
77	21	Do not capitalize “bald eagle”.
78	2	Including the term “costly” confuses issues related to evaluation of public welfare and monetary evaluation of ecosystem services. A major challenge in this document and for moving secondary standards forward will be to provide to the public information on the importance of ecosystem services and how the secondary standards help to protect these services.
79	4	Replace “certain” with “specific”.
79	10-11	Is it really true that food is generally the most important provisioning service provided by inland service waters? Isn’t the availability of potable water by far the most important service?
80	9-10	This statement is confusing with respect to whether surface waters are affecting versus being affected by hydrological regimes and climates.
80	28	Change to “resulting from the decrease of anthropogenic”. Isn’t it impossible to actually eliminate the anthropogenic emissions of NO_x and SO_x?
81	2	See previous statement with respect to issue of emissions being eliminated.
81	14-16	Change to: These model runs assumed a 2010 implementation of “zero-out” emissions with a projected lag time to improvement of 10 years and thus results were calculated for the year 2020.
82	6-7	Change to “indicate that impaired lakes would decrease from 22 to 31% using background conditions”.
82	11-15	This sentence is very confusing and needs to be reworded.
82	16-17	Change to “This analysis provides results on only a subset of the impacts of acidification on public services and suggests that the overall impact on these services is likely to be substantial”.
82	22	Clarify whether the issue is that there is no known procedure to make these determinations or whether we do not have the necessary information.
82	29	Do not start new paragraph.
82	30	Change to “producing timber and maple syrup that”.
83	6	Give the names of these two listed species.

83	16	Replace “roughly” with “approximately” here and throughout document.
84	3	Replace “regulate that quantity and flows” with “help regulate the quantities and temporal discharge patterns”.
84	3-4	Delete the sentence starting with “Finally” and replace with “Forests also play an important role in carbon sequestration at both regional and global scales”.
84	25-20	This paragraph might be interpreted that EPA is not making a full evaluation and is biasing the analyses with consideration of only deleterious effects. Better justification is needed on why the beneficial effects are not to be considered in the evaluation. Is there a problem with availability of data or is there some other important issue that prevents this analysis?
85	2-3	Change to “Estuaries in the eastern United States are important for fish and shellfish food production”.
85	20	Change to “Mistiaen et al. (2003)”.
86	13	Change to “$2 billion”.
86	13	Change to “Almost seven million people”.
86	17	Indent starting new paragraph.
87	1	Change “air” to “atmospheric”.
87	3-10	Clarify if these amounts are based upon an apportionment of the relative role of atmospheric deposition to total nitrogen inputs to the Chesapeake Bay.
88	21-22	Provide the names of these species.
88	30	Correct to “deposition”.
89	19-20	As indicated previously, clarify if the issue is the lack of methods to make the assessment or the absence of data needed for making evaluations of the impacts on services.
100		Here and elsewhere in the document there is specific reference to “staff”. This suggests that there is a subcomponent of EPA that supports the narrative within this document. I would avoid the use of this designation to avoid any confusion.
100	13	Change to “Chapter”.

101	15-17	Change to “Acidification occurs over extended periods and the ability of both terrestrial and aquatic ecosystems to recover is dependent upon not only the decrease in acidic deposition, but the ability of these ecosystems to generate cations that are needed for nutrients and base cation supply”.
101	24	Change to “This type of structure does not take into account the spatial and temporal variability of deposition and ecosystem processes with respect to the effects of NO_x and SO_x on public welfare”.
102	2	Change to “including geological and soil characteristics related to the sensitivity to acidification as well as atmospheric and landscape characteristics that govern rates of deposition”.
104	10	Change to “of secondary standards”.
104	11	Change to “impact both nitrogen and sulfur acting”.
104	22	Change to “relevant chemical species”.
104	24	Change to “total nitrogen and total sulfur deposition”.
105	26-27	This general phrase has been used elsewhere in the document and does not adequately describe the issues. There are three major factors that all need to be considered: 1) Atmospheric concentrations 2) Deposition velocities of various chemical species and 3) the processing within ecosystems. It is not clear what are “atmospheric factors” and what are “ecological factors”. Is the type of vegetation (that affects deposition velocities) an atmospheric or ecological factor? Is surface wetness an atmospheric factor”. Are hydrological pathways ecological factors?
106	23-25	This statement is too pessimistic and suggests that the monitoring networks are completely inadequate. It would be better to state that certain components (including NH_x) are not adequately measured within the current networks. Figures 4-1, 4-2 and 4-3 suggest that the network coverage is quite extensive.
107	2-3	In Figure 4-1 legend give the actual chemical N species for which concentrations are monitored.
108-111		This section provides a narrative on what chemical species the various networks monitor, but it is not easy to use this information to evaluate the adequacy of the monitoring. Some summary figures or possibly a table showing what actual chemical species are monitored and the number of sites doing this monitoring would be more helpful in evaluating the adequacy of at least the spatial coverage of the networks for specific chemical species.
108	2-3	In Figure 4-2 legend give the actual chemical S species for which concentrations are monitored.

111	16-17	This statement suggests the CMAQ model will satisfy the needs with respect to providing data on atmospheric concentration and deposition of S and N chemical species. The limitations of the CMAQ need to be acknowledged.
111	29	Do not capitalize “organic”.
111-114		The discussion on the rationale with respect to the use of CMAQ is useful, but little quantitative results are provided with respect to clearly indicating what CMAQ does well and where are the problems.
114	18-22	The focus of CMAQ on relatively short time (e.g., hourly values) may result is a mismatch to the needs for a secondary standard that would more likely result in values needed for longer periods (e.g., yearly values).
115-123		These various figures show the modeled results from CMAQ for various atmospheric chemical species and show the spatial detail available from the CMAQ output. There is discussion on how these modeled values show the spatial distribution of these chemical species for the single year of simulation (2005). However, this is not very helpful in ascertaining the accuracy and precision of the CMAQ simulations.
116	6-7	The assertion that the modeled and observed values are similar needs to be backed up with quantitative evaluations.
116	16-17	In discussing these conditions provide the actual year of comparison. Also, the wording may be confusing with respect to the current secondary standards and the approach being developed within the current document that is trying to develop secondary standards showing broader ecological effects.
125		Showing the results from CASTNET in Figures 4-12 and 4-13 is helpful, but it would be more instructive is there were direct comparisons between the EPA and CASTNET results.
126-127		For Figure legends, correct capitalization of units.
132	4-5	I don’t believe that there is sufficient evidence between S deposition and Hg methylation. There is known relationship between sulfate reduction and Hg methylation, but there is no direct linkage with S deposition.
132	23	It would be helpful to add a third category: nutrient depletion. This category is related to acidification, but focuses on the importance of the loss of nutrient cations from ecosystems.

134	5	The MAGIC model certainly provides information, but there other sources of information that also indicate the importance of aquatic acidification in the Adirondacks and Shenandoah National Park.
134	24	Change to “concern); however”.
135	4	change to “ results based upon the EMAP”.
135	9	Here and elsewhere instead of using the term “recent”, give the actual year or period of coverage.
135	12-13	Change to “As for the Adirondacks, these results suggest that a substantial proportion of streams”.
135	28	Change “kilometers” to “lengths”.
136	2	Change to “two to three times greater than the number of lakes classified as”.
137	2	Change to “The REA did not evaluate all possible sensitive regions, but focused on specific case studies”.
137	2	Change to “For example, in the sugar maple case”.
137	14	Change to “For red spruce, 5% of all plots”.
137	15-16	Change to “In those states where red spruce is an important tree species (Maine”.
138	10	The statement “In certain limited situations” is not true. For many if not most terrestrial ecosystems N additions results in increased plant growth. This includes both natural and managed ecosystems.
138	14	I have commented previously on the importance of considering both “managed” and “unmanaged” systems especially with respect to forests.
138	20	Note that this statement is correct and conflicts with line 10.
138	23	Be careful in providing these numbers for nitrogen uptake by crops. Are these actual uptake values for N or the amount of N applied as fertilizer?
138	26	This statement is not true. There is a substantial body of information on the effects of atmospheric deposition of N to forests and other ecosystems.
139	21	Change to “capacity of each county’s”.
140	12	Change “were” to “was”.

140	26-31	This paragraph suggests that the standard needs to focus on these systems which are most sensitive to increases in N deposition.
141	4	Delete “scientifically”.
141	5	Change “country” to “U.S.
141	13	Change to “received”.
141	21	Delete “, the authors estimated that”.
141	28	Shouldn’t this be “systems where N is limiting”?
142	13-16	Is this really a link with S deposition or is this a function of sulfate concentration which can be affected by other factors in addition to S deposition?
142	29	Change to “Assessment document”.
147	9	Change “big” to “major”.
148	9	The term “landscape features” is rather vague. Does this include physical, chemical and biotic attributes? Isn’t there an important issue related to the history of deposition for given areas with the most sensitive areas to N deposition in the west which have been subject to relatively low atmospheric N inputs?
148	11	How is the country being subdivided? Are these states, biomes, ecosystem types, or something else?
149	19	Delete “scientific evidence”.
149	20-22	Change to “aquatic acidification should be measurable and causally linked to the deposition of N and S. The indicator should have ecological effects that adversely affect public welfare”.
150	6	Change to “impairment, including the number of fish species”.
150	15	Change “acid anions” to “mobile anions”.
150	16	Change to “when these anions are mobilized in”.
150	22	Change to “deposition. These acidification models simulate a variety”.
150	26	Change to “ANC= 50 :eq/L”.
151	22	Change to “These data were”. Change “current” to “recent”.

152	3	Delete “time”.
152	15	Change to “with different levels”.
152	24	Change to “due to variation in biogeochemical processes among watersheds”.
152	25	Change to “that quantifiable relationships exist”.
152	26-27	Change to “These relationships are shown by long-term”
152	28-29	Change to “Models are important tools in evaluating how”.
153	3	Change to “There are various factors that modify”.
153	4	Change to “of these factors are described”. Delete “that parameterize ecosystems to simulate the process”.
153	6	Change to “input data for 17 to 20 environmental”.
153	9	Change to “specific responses of aquatic ecosystems”.
153	12-13	Change to “The weathering of soil minerals is a major source of base cations to ecosystems”. (Note this it may not be the main source in all cases.)
153	15	Change to “Landscape factors that affect the acid sensitive of forest ecosystems”.
153	19-20	Delete from “Numerous ..... example,”.
153	22	Change to “Water discharge values for the catchment”.
153	27	Replace “quality” with “chemistry”.
154	8	Replace “correlated” with “linked”.
154	8-9	Delete the sentence “Consideration....models”.
154	10-11	Change to “The calibration of the models stream water chemistry, soil characteristics and atmospheric deposition estimates”.
154	15	Change to “will vary among catchments”.
154	16-17	Delete the sentence “However.... simulations”.
154	20	Replace “quality” with “chemistry”.
154	24	Give the units for the ANC values.

155	8	Delete “mountain”.
155	14-16	Change to: “With these data the atmospheric deposition loads that will cause streams to exceed the critical limit of ANC can be calculated”.
155	18	Delete the sentence “The relationship....nationally”.
155	19	Change to “similar hydrology and mineral weathering rates should show similar”. Need to be careful in these statements since the amount of base minerals generated is a function not only the weathering rates of soil minerals, but also the hydrological relationships including flow paths.
155	21	Is there an implicit assumption of what maximum area constitutes a “catchment”?
155	24-26	This statement is confusing in that critical load is highly dependent on the characteristics of a catchment. How can aggregation be used to develop a national standard? Isn’t it more likely that different standards will be needed for different catchments or that standards will be set to protect a certain subset of catchments?
156	3-7	It is not clear if developing a single standard is the goal of this process. See my previous comment.
156	14-15	Change to “Models are important tool for evaluating how multiple”.
156	17	Change to “Mineral weathering is a major source of base cations and is therefore considered an important factor in determining critical loads”.
156	19	Replace “correlated” with “linked”. Here and elsewhere the use of the term correlated is somewhat weak since this infers there is a statistical correlation and not necessarily a causal relationship. Using factors that have casual relationships is a stronger approach than using statistical correlations.
156	21	Delete sentence “Modeling every...requirements”.
156-157		These summary statements should clarify that having a single secondary standard may not be warranted to take into account the substantial variation in the sensitivity among regions with respect to surface water acidification.
157	4	Replace “to” with “for”.
157	7	Change to “to protect different areas”.
157	13	Delete the phrase “scientific literature”. Here and elsewhere in the document it is implicit that the overall procedure will be scientific and this phrase is not needed.

157	20-23	This dichotomy is not valid since S can certainly be retained in ecosystems especially those with high potential for sulfate adsorption. Both the leaching of nitrate and sulfate as well as the retention of N and S need to be part of the overall evaluation.
157	26	This is confusing since there is generally little ammonium lost in runoff in systems sensitive to acidification. Maybe this should be restated with respect to N solute leaching and hence the inclusion of DON would also be warranted.
157	16	The legend for Figure 5-3 needs more information including the meaning of the various abbreviations.
159	1-23	The use of these models and the different treatment of S and N is confusing. It would be clearer if the models more accurately captured the biogeochemistry of each of these elements. One issue that could be important in some of the areas is that there is a net loss of sulfate from soil that is greater than atmospheric inputs and this will delay the recovery of these systems from acidification.
160	8-10	The use of N_{eco} formulation that needs estimations of N retention, immobilization and denitrification may be very problematic since the parameter estimates (especially immobilization and denitrification) are very difficult to obtain. It would be better to focus on the actual N losses via leaching. This value is easier to obtain. An issue that needs consideration is the time units used in these calculations. It will probably be important to include some seasonal effects since there are marked changes in nitrate losses during different periods of the year.
160	12	As indicated previously the assumption that all S deposition is leached is not valid.
161	9	The goal of "obtaining a representative deposition value" is very problematic due to the high variation in acid base chemistry response among catchments is very high (e.g., even adjacent catchments may have very different responses).
161	12-23	There may be merit in the identification of specific population of surface waters that have substantial representation among all water bodies of a region, but are most susceptible to acidification.
162	3-10	The use of bedrock geology for the classification of acid sensitive catchments is problematic. The surficial geology needs to be used in this classification. In the early days of "acid rain" research the use of bedrock geology was used in classifying watersheds, but as the understanding of acidification processes increases it became apparent that surficial geology including soil depth is very important in evaluating spatial variability of sensitivity to acidification. For example using Figure 5-4 it is indicated that the central Adirondacks would be most sensitive to acidification, but we know that the highest proportion of acidic

		surface waters in the Adirondacks are found in the southwest portion of this region.
163	6-15	Here and elsewhere in the document the use of elevation as a parameter is suggested in the analyses. Elevation is not the casual factor associated with sensitivity to acidification, but it is related to factors that are correlated with elevation including precipitation amount, soil depth, changes in vegetation, etc. It would be better to use the actual causal factor in these determinations or at least indicate that elevation is linked to these causal factors.
164	25-27	The statement that "reduced forms of nitrogen deposition" are quickly converted to nitrate is not correct. Some reduced forms of N can be assimilated by both the vegetation and the soil microflora without being converted to nitrate. If nitrification rates are low N deposited in reduced forms may also not be converted to nitrate. It should be emphasized that the total amount of N deposited is the factor that determines the N atmospheric loading. This is why total N deposition needs to be considered in making these evaluations.
165	2-3	Isn't the most important assumptions associated with any temporal changes in N deposition versus the relative importance of oxidized versus reduced forms of N deposition.
165	7-29	Within this "summary" a number of statements related to the use of bedrock geology, deposition calculations, etc. for which concerns have been provided in comments above.
166		Table 5-2 (this is actually a figure versus a table). The descriptors should be changed to more clearly reflect the factors that influence acidification.
167	21	"This leads to the question, are aquatic or terrestrial ecosystem more sensitive?"– aquatic and terrestrial ecosystem responses to acidification differ with the effect of limiting nutrients (e.g., calcium) more important for terrestrial versus aquatic ecosystems. This actually is implicit in the use of different indicators (e.g., Bc:Al for terrestrial and ANC for aquatic systems, respectively).
168	11	It is really feasible "one indicator that can be applied across the nation". This may not be possible with different conditions among regions (e.g., west having lower historical rates of atmospheric N inputs).
169	2	Change to "first draft PA; however, a"
169	1-19	Concerns related to these summary statements are provided in my previous comments.
169	22-24	Clarification is needed on how cloud/fog deposition fits into these two mechanisms.

169	25	Change to “and chemical species-specific”.
169	10	See above comment associated with incorporation of fog/cloud deposition into this formulation.
171	1-2	The rationale for using $V_{S/N}$ is not evident due the great variation in deposition velocities among various atmospheric chemical species.
171	2	Change to “aggregated deposition”.
171	4	Change to “the chemical species specific”.
171	8	Clarify what is meant by “annual average”–isn’t the relative value the total annual deposition?
171	13-15	It is not clear what is being suggested by this statement.
171	25-27	The development of uncertainties in the CMAQ predictions will be extremely important in understanding the accuracy and precision of these estimates.
171-172		The procedure for calculating VS/N seems very convoluted and it is not evident how this is better than calculating separately annual deposition of N and S.
178	3-4	Correct units.
179	2-3	As stated previously, the calculation of a depositional load for a specific ANC that does not account for variation in catchment responses to acidification will not result in accurate predictions of how these systems are responding. At least some classification of catchment types is needed. Such classifications have been used extensively in some of the regions such as the Adirondacks (e.g., thick till, thin till, seepage lakes, etc.)
180-188		Before developing further details on these calculations, agreement is needed with respect to the overall approach. Many of these calculations are based on the need to develop a single standard. Are there other approaches that should be considered?
190	15-16	I agree that the previous methods for defining indicator, averaging time, form and level are not appropriate with respect to ecosystem level effects associated with N and S deposition.
190		The statement that: “Moreover, the inherently complex and variable linkages between ambient concentrations of NOx and SOx, their deposited forms of nitrogen and sulfur, and the ecological responses that are associated with public welfare effects call for consideration of a more complex and ecologically relevant

		design of the standard that reflects these linkages" needs to be reflected in the procedures used to develop these standards.
191-192		Section 6.1 seems to be highly redundant with respect to information provided in previous chapters.
193-194		Section 6.2--I agree that future efforts will need to consider how to incorporate results associated with episodic versus chronic responses. This will be especially important in those areas in which snowmelt is a dominant component of the hydrologic cycle.
194-195		The development an Atmospheric Acidification Potential Index (AAPI) has some potential, but this formulation must be sufficiently robust to account for differences in biogeochemical responses among watersheds.
195	15	I agree of the importance of including "including landscape and atmospheric factors" in developing these formulations.
196		As stated previously, much of this discussion and formulation is based upon the development of an aggregated value. This approach may result in erroneous recommendations if spatial variability in watershed components and historical differences in deposition are not included.
198	6	The other ecosystem variables will be very important with respect to predicting sensitivity to acidification.
200-201		The selection of the populations of areas to be considered with respect to sensitivity parameters will be important in developing these predictions. Clearly defining which subset of the overall population is sensitive to acidification and the relative importance of these sensitive populations should be a focal point of the analyses.
201	15-16	The need to exclude "water bodies that are naturally acidic" is a clear example of the need to account for the differences within and among regions with respect to biogeochemical responses of acidification.
201	20-27	The next draft should explore in addition to alternate combinations of the target ANC, but also the known variation in watershed processing of N and S.
203-207		Section 6.5 provides further elaboration (See also Chapter 5) of the rationale for using ANC as an ecological indicator for the acidification of aquatic ecosystems.
207	12-13	The time issue with respect to recovery from acidification needs further elaboration and how the identified approach will address this issue. The time issue needs to be included in earlier discussion related to the application of critical loads.

208		Section 6.6 covers some of the issues related to the more complete evaluation of the various atmospheric chemical species of N and S compounds. With the exception for the need for better quantification of ammonia, the most pressing issues relate to the estimates of dry deposition especially the utilization of deposition velocities.
208-209		Section 6.6.2 considers the issues around sampling frequency. For looking at ecosystem level effects it will be important to have extended periods of measurement. In addition to monitoring current and future concentrations, there is a strong need to have historical measurements of concentration. Having this historical information is critical for looking at long term watershed responses including modeling efforts.
209	27-28	Clarify what is meant by "largely population oriented".
210	1	Not sure of the point indicated by "Ambient monitoring at every watershed may be required due to the nature of the ambient air quality in acid sensitive areas".
210	4	I would not agree that using annual averages dampens "much of the spatial variability"? Do you mean variability of deposition estimates only?
210	6	How will CMAQ concentration values "provide insight into the likely spatial representativeness of monitors" without clear documentation that CMAQ is providing accurate and precise values of atmospheric concentration within region at various spatial scales.
210	8	How was this spatial variation of oxidized nitrogen in the Adirondacks derived? The value of 1.46% for a coefficient of variation seems very small in reflecting changes in oxidized nitrate values across this region.
210		Section 6.7 focuses mostly on the justification of the use of ANC and AAPI. It is not clear whether other parameters need to be considered such as the effect of N addition in sensitive aquatic and terrestrial ecosystems.
213		Section 7.1--In further development of this comparison between terrestrial and aquatic systems a clarification of the relative importance of base cation generation and hence improvement of the Bc:Al ratio in terrestrial ecosystems is linked to ANC recovery in surface waters.
214		Section 7.2–As the role of nutrient enrichment becomes more developed in this analysis this could have a marked effect on the overall approach in developing these standards especially with respect to difference among regions associated with the history of N deposition.

215		Section 7.3–The aquatic nutrient enrichment is not only associated with N effects on estuary eutrophication, but also on changes in the biota in surface waters in the western U.S.
218	19-20	The current focus on acidification is well justified.
219-222		The conclusions indicate the major findings of this review especially the rationale for focusing on acidification in the current version.
222	20	A brief summary that defines AAPI should be provided in the summary.
223		The section yet to be written on key uncertainties will be an important component of this report and associated recommendation. It will likely be necessary to include the effects associated with nutrient alterations that is a critical issue for both the east (Ca depletion in terrestrial ecosystems) and west (N deposition affects on ecosystem structure in both aquatic and terrestrial ecosystems).
223		13-14 It will be impossible to develop “nationwide weathering rates”–since these rates show a high amount of spatial variation as a function of surficial geology and other factors such as climate.
224	8-12	The development of more comparisons with model results with observational data would greatly strengthen this overall approach by clearly showing what the models do well and where there are problems that will limit the ability to set secondary standards.

Mr. Rich Poirot

Chapter 5: Conceptual Design of an Ecologically Relevant Multi-pollutant Standard

10. What are the views of the Panel on staff's proposed conceptual framework for the structure of a multipollutant, ecologically relevant standard for NOx and SOx? To what extent does the Panel agree that this suggested structure adequately represents the scientific linkages between ecological responses, water chemistry, atmospheric deposition, and ambient NOx and SOx?

The proposed conceptual framework and the structure of the proposed standard do an excellent job (under very challenging Clean Air Act constraints) of representing the complex linkages between ecological effects, aquatic chemistry, atmospheric deposition and air quality. It is inconvenient that a direct measure of ANC in surface waters, or measurements of deposition of S and (total reactive) N couldn't be used as a more direct basis for a NAAQS. However, given the limitations of the current CAA, the proposed structure employs some clever and innovative mechanisms to link air concentrations to ecological effects, recognize the combined influence of S and N, accommodate the varying inherent sensitivities of different ecosystems, and incorporate – without directly regulating - the additional influence of reduced N.

11. What are the views of the Panel on the relevance of the conceptual design for developing standards to protect against aquatic acidification effects?

a) What are the views of the Panel on staff's proposed options for the ecosystem acidification model to represent the ecological response function?

Others on the panel will have much more informed opinions on this than I could offer. On a related topic, I'm not sure that the concept of episodic acidification is adequately addressed in the acidification model(s) presented chapter – or elsewhere. It seems to be assumed that selection of a specific ANC limit – of say 50 mg/l – would be intended to protect against both chronic and episodic effects. If this is the case, it should be stated explicitly. If there might be exceptions, for certain types of catchments or ecosystems, these should also be presented along with indications of how selection of alternative ANC limits might guard against these effects.

b) What are the views of the Panel on the relative merits of the two techniques for calculating Neco, the parameter representing the amount of deposited nitrogen that is available for acidification due to uptake, denitrification and immobilization?

Others on the panel will have much more informed opinions on this than I could offer. From the text explanation on p. 178, it would seem like equation 3 is both simpler and more readily accessible or "testable" through direct methods than equation 2. I would think it would be applicable, however, only in situations where (or when) "N breakthrough" has already occurred and is directly measurable, and therefore would only reflect current retention rates, which well may decline further with continuing deposition. Equation 2 may be a better, more protective

approach to guard against longer-term future effects and assure that current rates of N deposition are "sustainable".

c) What are the views of the Panel on staff's proposed options for developing acid sensitivity classes to categorize the national landscape? Is it appropriate to base this classification on bedrock geology? Should multiple criteria be used to inform the sensitivity categories?

This sounds like a reasonable approach, and possibly other variables (surface soil composition and depth, weathering rate, slope, elevation, etc. could also be useful. It's difficult to judge this without seeing an example, but in general, I think it could be an extremely valuable exercise to go through in some detail, regardless of what the eventual end use(s) is (are). Conceivably multiple approaches to developing sensitivity classes could be considered and then evaluated – by comparing measured vs. predicted ANC using the different sensitivity classes. Would it be possible to use relatively abundant surface water chemistry data to guide this process?

d) What are the views of the Panel on staff's proposed options for how to aggregate acidification modeling from the catchment-scale to represent acid-sensitivity categories at the national-scale?

It's difficult to evaluate these options in the abstract, without seeing comparative examples. The approach of specifying a percentage of water bodies within a given area sounds reasonable, but would be critically dependent on how the areas were selected. Selecting a critical % of lakes to protect seems like a somewhat arbitrary decision in the first place, and when combined with optional methods of selecting the (size of, and distribution of lake characteristics within) spatial areas, the decision process could be extremely arbitrary. Within a small area at high elevation on the western slopes of the Adirondacks, 100% of lakes will exceed their critical loads to maintain a protective ANC, but as the area is expanded in size, the % of acidified lakes will eventually fall to single digits if aggregated at the statewide level, so where do you draw the line?

I wonder if it would be possible to modify the geographical area concept to include only the population of surface waters within that area to include only those considered "potentially susceptible" to acidification – based on characteristics of their underlying bedrock, soils, etc. This would minimize the importance of the specific areal selection, since the % affected metric would apply only to the lakes considered susceptible in the first place. Or maybe model estimates of preindustrial ANC levels could be used as an index of inherent sensitivity and a decision of adverse affects could be based on shifts in ANC categories over time, or based on a limit to the % change in ANC from preindustrial conditions within the population of potentially susceptible lakes in a given area.

In areas where acidified streams are at issue, it would be necessary to have some metrics for selecting the appropriate sections of streams to be evaluated, and this doesn't seem to be discussed in much detail in the Policy Assessment. As with the affected lakes, some metric that reflects past ANC changes over time might be a useful way to judge adversity of current conditions. Conversely, in might be useful to consider a progress-based metric (% increase in ANC, or % shift between ANC categories over time) to determine future compliance with the

NAAQS. I think there are other examples where one test is applied to get an area into non-attainment, but a different test is required to get out of non-attainment.

e) What are the views of the Panel on staff's suggested method to account for reduced nitrogen in the deposition metric?

It's unfortunate that reduced N can't be more directly recognized as an important, unregulated pollutant and steps taken to reduce its emissions to the atmosphere and surface waters. However, given the constraints in the CAA definition of nitrogen oxides, staff have devised a rather ingenious method of accommodating its influence without regulating it directly. I would assume, however, that if NH_X deposition rates were reduced in an acid sensitive area, then proportionately higher levels of S + N_{OX} deposition could be accommodated.

12. What are the views of the Panel on the relevance of the conceptual design for developing standards to protect against terrestrial acidification effects? Terrestrial nutrient enrichment effects? Aquatic nutrient enrichment effects? Does the panel have suggestions on additional data or methods that might enable EPA to expand the current aquatic acidification approach to cover additional effects?

The conceptual design for protection against terrestrial acidification effects seems reasonable and consistent with recent advances in the science and assessment methods. The BC/Al ratio seems like an excellent "chemical indicator" (directly measurable and predictable via models), which is directly responsive to deposition changes on one end and directly predictive of ecological effects on the other end. The currently considered range of levels (0.6 to 10) seems rather broad (relative to ANC ranges of 50 to 100, although from the comparisons of aquatic and terrestrial sensitivities provided, would seem to suggest that a BC/Al of 10 at the most protective upper limit considered is most similar (similarly protective) to ANC at 50 mg/l (least protective) lower limit. In a general way, it would seem logical to expect that if chronic long-term deposition of acids, passing through soils supporting terrestrial ecosystems enter aquatic systems sufficiently un-buffered by associated cations or enriched in toxic Al to cause adverse aquatic effects, then we should <u>expect</u> that there would also be long-term terrestrial effects in those upstream watershed areas. That is, we should expect that ideal aquatic and terrestrial effects indicators might show similar sensitivities.

Your approach for aquatic effects is more completely developed, and you could probably justify a position that it is logical to start simply with a single indicator to protect against aquatic acidification – which would in many cases also afford added protection against terrestrial acidification effects. However, I think you could also make a good argument that an approach using both ANC and BC/Al indicators (& associated deposition & AQ limits) would provide better protection and over somewhat broader areas as there may be sensitive soils within catchments that have more well-buffered soils in other areas such that there are terrestrial effects upland of lakes or streams which are relatively insensitive.

Confidence is lower for setting specific standards for terrestrial and aquatic nutrient enrichment in the present review cycle, and a focus on acidification could be justified. I think however that the consideration of the carefully derived loading limits – and approaches to apportioning and

reducing them – that have been / are being developed through EPA's TMDL process might be given more consideration in the future. There might be some innovative ways of combining TMDLs and NAAQS (for both acidification and for nutrient enrichment effects). In seeking reductions from point source or direct runoff discharges, some TMDL exercises (CT River discharge to Long Island Sound, for example) are assuming specific future CAA reductions in atmospheric N deposition loadings as part of their basis to specify and allocate reductions in direct N discharges. Conceivably a N deposition-related NAAQS could be considered exceeded throughout a watershed where downstream TMDLs are exceeded, and in the implementation phase, costs & ancillary benefits of decreasing N emissions from various source categories could be considered jointly. It should also be noted that TMDLs for critically acidified lakes have been developed in some states (VT & NH – based I think on ANC limits of 50 & 60 mg/l respectively) and there may be some logic to combining the NAAQS & TMDL processes – as if there were a single EPA…

13. What are the views of the Panel on the critical uncertainties associated with the conceptual design of an ecologically relevant multi-pollutant standard that need to be characterized in terms of their potential implications for the secondary standards?

Others on the panel will have much more informed opinions on this than I could offer. I think each of the acidification models and the CMAQ model have been subjected to periodic performance evaluations and sensitivity analyses, and that some of the most critical (most uncertain) model inputs, processes and parameters have been identified. Associated efforts are also periodically undertaken to identify and strengthen the weakest links in these models (or to develop better new ones) such that we can expect model-associated uncertainties to improve in the future. A strength of the proposed approach is that the AAPI is in effect a estimate derived from atmospheric measurements which has an approximate, measureable aquatic counterpart (ANC) indicator (and there are also various intermediate modeled deposition metrics that can be evaluated with measurements). As such, the net effect of the cumulative uncertainties and biases of the proposed regulatory metrics can be continually evaluated and refined.

14. To what extent do the figures and examples aid in clarifying the text? Should more or less information of this type be included in the second draft?

Given the complexity of the subject matter, the many associated equations and difficulty (for me at least) of "seeing" many of these concepts in the abstract, I found all of the illustrations and example calculations (from actual data) very helpful and would like to see more of the same. One figure in particular that seems important and could be presented more clearly is the display of modeled VS/N ratios (barely legible) in Figure 5-5. Larger-scale versions of these plots would help, along with scales selected to better show the ranges of values. Possibly use of the same scales for both the S and N ratios could be informative. It could also help to show zoomed-in versions the cover identified sensitive areas in the Adirondacks, Shenandoah, etc. It strikes me also that the accuracy of these CMAQ estimates could be tested (easily for S, not so easily for N) by comparing the modeled ratios to those from CASTNET & NADP measurements. You presented some CMAQ model performance evaluation information previously, but when model results are ratio-ed, there's a potential for errors/biases to get compounded (or offset)

I had a difficult time making it through this chapter with confidence that I was understanding the details of all the points being presented (in the 23 separate equations). I think this was due partly to it being outside my expertise, partly to the introduction of many new unfamiliar variables, and partly due to the inherent complexity of the subject (further confounded by the CAA constraints). However, I also think that the information could be presented more clearly, and here are some suggested approaches toward making this no more confusing than it needs to be:

- Be precise and consistent in your terminology (and triple check for typos especially in the equations). I see no useful reason whatsoever to use the terms NO_X and NO_Y to mean the same thing. NO_X has inherent meaning (sum of NO and NO_2, including the oxygen) to the air quality community and you can't revise this meaning with a disclaimer up front that "when we say night we really mean day". This gets further confused by the occasional use of the term N_{OX} to mean oxidized nitrogen". I actually like this term (we can pronounce it "ennox") and think it could be used nearly interchangeably with NO_Y, with the possible distinction that the former relates to the concept and the latter relates to our attempts to measure it. But I also see an occasional N_{OY} – which I assume is a typo (pronounced as "annoy"), but then that makes me wonder if/when N_{OX} is used as intended. Is g(·) the same as g the same as G? If you mean $SO4^{=}$, write it that way and don't use Cl when you mean Cl^-. Use BC/Al or Bc/Al, but not both, etc.
- Number the equations sequentially from the beginning of the document – or at least from the beginning of each chapter (rather than anew each subchapter) so that there won't be 3 different equations #4 in a single chapter.
- For each chapter, or at least for chapter 5, or maybe as a stand-alone appendix applying to all chapters: develop a glossary-like list or table of all terms used in your equations, along with definitions and other pertinent information – possibly including things like how the term would be measured or estimated, its units, etc. The Table A-3 list of variables used in the SSWC model presented in Appendix A is a good example of what I mean.

Other comments on Chapter 5

P 145 & 6: The text describing Figure 5-1 refers to squares, triangles and circles, but the figure contains only rectangles, diamonds and ovals.

P 148, lines 9-12: Its difficult to grasp this concept in the abstract. Could you give an example? Are you thinking about 5 bins or 25?

P 148, lines 16-18: It might help to have a diagram to illustrate this concept.

P 150, line 21: Add "of" after "deposition".

P 153, lines 29, 30: Try to be consistent with use of charge signs for ions.

P 167, line 10 (& elsewhere): Be consistent in your use of terms: BC/Al or Bc/ Al?
P 167, lines 26-30: This summary of aquatic vs. terrestrial CL sensitivity seems inconsistent with the similar summary on p ES-13 of the executive summary.

P 168, lines 1 & 2: Is this observation that for the Shenandoah, the aquatic CLs provided much greater protection than terrestrial true for BC/Al ratios of both 10 and 1.2?

P 169, line 3: Add something like “addressing” between “for” and “these”.

P 171 line 2: aggregated deposition.

P 172, line 25 “Table 1” should be changed to “Table 5-3”.

P 172, line 28: The importance of large particle S & N deposition may be overstated here – especially with respect to acidification effects, which will tend to occur at higher elevation locations remote from coarse particle sources (which don’t transport very far). Also, S or N in coarse particles is often in association with crustal material (containing Ca^{++}, MG^{++} K^{+}) or Na^{+} from sea salt – hence carrying its own buffers. At CASTNet sites (where open-faced particle samplers presumably include coarse particles), all particles contribute less than 6 % of total S deposition at sites with S dep > 5 Kg/Ha/yr. For CASTNet nitrate deposition, total particle nitrate deposition averages < 2% of total nitrate deposition across the whole network. So its not likely that coarse particle deposition accounts for much of the total S + N deposition load at any sites where aquatic acidification is a problem.

P 173, line 1 simulations of.

P 173, line 5: text refers to “inverse” $V_{S/N}$ but Figure 5-5 caption does not indicate “inverse”.

P 173, line 10: “6 for”. Also this seems like an example of something I’ve noted on several occasions of referring to something “deposition load tradeoff curves” that hasn’t been explained yet. Makes it harder to understand…

P 173, line 11: “Figure 1” should be “Figure 5.5”, I think.

P 173 line 15: “Figure 3” should be Figure 5.7.

P 174, Figure 5-5: I would like to see these at larger sizes with scales that better show the range of values. These ratios seem very important (see response to Q 14). On a somewhat related topic, I would think that of all the NO_Y components, NO is likely to have the lowest deposition velocity, and otherwise be least reflective of N deposition at any specific location. I believe that in making NO_Y measurements the sampling is typically switched through and then bypassing the converter, such that concurrent NO and NO_Y data are available. Possibly then [NO_Y minus NO] might actually be a better AQ indicator of N_{OX} deposition than total NO_Y – both in reality and in CMAQ output. I would imagine this could be tested relatively easily with CMAQ.

P 178, line 28: Is this basically the equation for “deposition load tradeoff curves” referred to previously and later in this section? If so, why not describe it as such here.

P 179, line 19: Is it really the “high variability in the data set” per se that results in “only 32%” of water bodies not exceeding their critical loads, or is it more that the selected population of lakes

includes many which are relatively well buffered? Or are you making a point that use of "mean $DL_{\%ECO}$" can be problematic for areas with high variability? This isn't clear to me, but I'm concerned that use of a metric based on % lakes in "an area" becomes an important, but arbitrary factor (based entirely on how the areas are spatially defined).

P 180, 2nd line of Table 5-4 caption note: Delete either "across" or "on".

P 180, Table 5-4: From the descriptions of equations 2 and 3 on p 178, I would have assumed that for a given catchment either one equation or the other would apply (# 2 projecting the long-term additional N a system could handle before leaching – or # 3 based on measurements where saturation has already been reached). So I'm surprised to see in Table 5-4 that there are summary statistics for N_{eco} presented using both equations. I'm also surprised that the results for both N_{eco} and $DL_{\%ECO}$ are so different depending on which equation was used. Can this be explained more clearly?

P 184, lines 1, 2: Eight significant digits for these "aggregate effective deposition velocities" seems a bit much. I also agree with your plans to change the term to something like "deposition ratio" for clarity. Why not do it the other way around and call it a deposition ratio in the text and use your footnote to explain that you used to use another, less appropriate term.

p. 187, line 9: You indicate here that equation 5 describes the "atmospheric concentration tradeoff curves". Is this correct or should it be equation 6?

P 187, line 2 & elsewhere: I think the term N_{OX} is a logical way to describe "oxidized nitrogen", but think it might be helpful to add a footnote caution that this should not be confused with NO_X (which you have already confused with NO_Y sometimes but not always). Also, I note that in equation 11, p 186 you use the new term N_{OY} which I assume is the same as NO_Y?

P 187, lines 11, 22: The tern "g(·)" in equation 11 has become just "g" in equation 12 (then back to "g(·)" in equation 13). Do these changes have a meaning (that I don't understand because I don't know what (·) means)? And are either of these the same thing as "G" referred to on p 198, line 23 and elsewhere in the PA?