

**Summary Minutes of the  
U.S. Environmental Protection Agency (EPA)  
Science Advisory Board (SAB)  
Hypoxia Advisory Panel (HAP) – Subgroup on Nutrient Sources,  
Fate, and Transport  
October 16, 2006**

Panel Members: See subgroup roster – Appendix A

Date and Time: Monday, October 16, 2006

Location: By telephone only

Purpose: The purpose of this teleconference was to discuss progress toward addressing Panel member assignments related to the current understanding of nutrient sources, fate, and transport within the Mississippi River Basin and delivery to the Gulf of Mexico.

Attendees:

Subgroup Leader: Dr. Judith Meyer

Subgroup Members: Dr. Walter Boynton  
Dr. Alan Blumberg  
Dr. William Crumpton  
Dr. Mark David  
Dr. Richard Lowrance  
Dr. Kyle Mankin  
Dr. Clifford Snyder

HAP Members: Dr. Virginia Dale, Chair  
Dr. Kenneth Reckhow

EPA SAB Staff: Thomas Armitage, Designated Federal Officer  
Anthony Maciorowski  
Holly Stallworth  
David Wangsness

Others Present: Gloria Donnelly, Hach Homeland Security  
Technologies  
Charles Kovach, Florida Department of  
Environmental Protection  
Don Parish, American Farm Bureau  
Thomas Purcell, American Petroleum Institute

## **Meeting Summary**

The discussion followed the issues and timing as presented in the meeting agenda (Appendix B).

## **Convene Teleconference**

Dr. Thomas Armitage, Designated Federal Officer (DFO) convened the subgroup teleconference at 2:00 p.m. He stated that teleconference was being held under the requirements of the Federal Advisory Committee Act (FACA). He reviewed the subgroup's compliance with ethics and conflict of interest requirements and stated that records of subgroup discussions would be maintained. He stated that summary minutes of the teleconference meeting would be prepared and certified by the subgroup leader. Dr. Armitage then asked the Hypoxia Advisory Panel (HAP) members and others on the call to identify themselves.

## **Purpose of the Call and Review of the Agenda**

Dr. Judy Meyer, subgroup leader, thanked the subgroup members for joining the call, reviewed the purpose of the call and reviewed the agenda. She stated that the purpose of the call was to discuss progress toward developing responses to parts of the Panel's charge that had been assigned at the first meeting in September. Dr. Meyer reviewed subgroup assignments listed on the agenda. Dr. Meyer reminded members to consider the following points in developing responses to the charge: 1) whether summaries, conclusions, and recommendations presented in the 2000 Integrated Assessment were inaccurate or invalid (taking into consideration the findings of research completed during the past six years), 2) new findings that are most relevant to the review and how they alter the understanding of nutrient sources, fate, and transport and the ability to model the system, and 3) the strengths and limitations of new findings and models that will determine the level of confidence in conclusions and recommendations and help identify major gaps in understanding.

## **Discussion of Initial Responses to the Charge Questions**

### *Temporal Character of Loads/Fluxes (Part 2A.i)*

The subgroup first discussed issues to be addressed in the draft response to the charge question on the temporal character of loads and fluxes. Dr. David was the lead discussant for this topic. He noted that information on this topic will be presented at the upcoming science symposium to be held in Minneapolis (November, 2006). The response to the charge question will draw upon information presented at the symposium. It was noted that since the 2000 Integrated Assessment, some additional work has been completed to better understand the temporal character of loads, and this can be discussed in the response to the charge. Dr. David noted that there did not appear to be any inaccuracies

or invalid statements in the 2000 Integrated Assessment concerning temporal loads. Subgroup members noted that since 2000 there has been less nutrient monitoring in the Mississippi River Basin than in previous years, and this should be discussed in the response to the charge. In particular, monitoring at a scale that would enable one to assess efficacy of different restoration strategies is very limited. Members noted that some progress has been made in modeling, but this additional work may not provide any new information that was not in the initial assessment.

Members discussed U.S. Geological Survey (USGS) monitoring activities and reductions in monitoring that have occurred since 2000. A member stated that some watersheds are no longer monitored. Members noted that it would be useful to show where monitoring has been eliminated or curtailed. Members noted that monitoring cut-backs will result in the loss of important long-term data. A member stated that it would be helpful to obtain additional information on the nitrogen and phosphorous monitoring work that USGS is planning in the Mississippi Basin. Dr. Meyer asked whether USGS had been monitoring carbon and silica in surface waters. A member stated that he was not sure what carbon and silica monitoring data were available from USGS. Another member stated that reasonable amounts of silica data are available from upper Mississippi River Basin monitoring stations.

David Wangsness (USGS) stated that USGS is now compiling and updating information on nitrogen and phosphorus loads through the years 2005 and 2006. He noted that this information will be provided at the science symposium in Minneapolis. The subgroup leader asked the members who will be attending the symposium to keep this in mind.

Dr. Meyer asked whether specific landscape models have been used to assess the temporal character of loads and fluxes. Dr. David responded that much work has been done in this area since the 2000 assessment and that a range of models has been used.

A member reiterated his opinion that that the deletion of monitoring stations is a very important issue. He stated that monitoring data will be needed to determine whether restoration strategies have been successful. Dr. Meyer stated that it is also important to consider the sizes of the streams that are being monitored. Members discussed the importance of having adequate monitoring data to detect impacts. Members noted that in order to detect impacts, it is important to monitor small watersheds. It was noted that the previous assessment had recommended more monitoring and that additional monitoring is still needed. Members noted that even with small scale monitoring it can be difficult to detect changes resulting from management and restoration strategies. Targeted small scale watershed monitoring is therefore very important. Dr. Dale, the HAP Panel Chair, stated that many recommendations will be considered by the full Panel but the subgroup should carefully consider needs for future research. She stated that the research agenda must be developed and that costs and benefits must be considered.

Dr. Meyer asked the subgroup to continue discussing the available information on temporal patterns in loads and fluxes. Dr. David stated that he had published a number of papers on temporal loads, and that temporal patterns are well known. The panel

discussed the importance of understanding temporal patterns of nutrient loads and fluxes. It was suggested that the subgroup carefully review papers on this issue by Dr. Eugene Turner at Louisiana State University. A member suggested that understanding the seasonality of discharges in sub-basins could lead to a better understanding of sources. Dr. David stated that there is already a good understanding of “when nutrients move” (i.e., what is getting down river, and when it is getting down river). Another member noted that once nitrogen enters Mississippi headwaters it gets to the Gulf of Mexico. Dr. Snyder stated that seasonality is a critical issue to be considered in looking at the effectiveness of best management practices. He suggested that information on the temporal character of loads and fluxes would be important to subgroup 3 of the Panel.

Dr. Meyer stated that before the December meeting of the Panel she would like the subgroup to prepare bullets on temporal loads and timing. Dr. Dale stated that the subgroup should consider science questions, what has been learned, and what has not been resolved. Dr. Dale also stated that at the December meeting of the Panel she would like to discuss the interfaces between issues being developed by the subgroups. She noted that the Panel’s report should be developed from an ecosystem perspective. Dr. Meyer stated that after the next subgroup teleconference she would like to have bulleted statements that can be discussed by the Panel as a whole.

#### *Mass Balance (Part 2A.ii)*

The subgroup discussed issues to be addressed in the draft response to the charge question on mass balance. Dr. David was the lead discussant for this topic. He stated that new information on this topic leads to conclusions that are different from those in the 2000 Integrated Assessment. This topic had been identified as a research need in that assessment. He noted that since 2000 a number of people have redone the mass balance determination. Dr. Gregory McIsaac at the University of Illinois has published work in this area. A number of remaining uncertainties in the mass balance determination were identified. These include:

- How much nitrogen fixation is occurring?
- Although progress has been made in determining in-stream denitrification, the amount of terrestrial field denitrification is occurring is still unknown, and there is no good way to determine this.
- What are long term changes in soil organic nitrogen?

Several other issues regarding phosphorus were noted. Small amounts of phosphorus are lost down river compared to what is present in the system, and phosphorus is not in gas phases. Not much can be done to measure changes in soil storage pools.

A member noted that the transport of phosphorus is tile field and sediment dependent. It is therefore difficult to get good monitoring data. Phosphorous can be exported as solid or dissolved phases and a more intense level of monitoring is needed. At a large scale, phosphorus has a much noisier signal than nitrogen. Tile concentrations of phosphorus can go up at high flow, and during these big flushes it goes down river.

A member asked whether the contribution of nutrients from soybean fields was known. Dr. David responded that this is uncertain. Another member asked whether the contribution of nutrients from manure was known. Dr. David responded that this is an important source in some areas but the contribution is uncertain. A member noted that in some areas manure can contribute half of the nitrogen and more than half of the phosphorus, so it is an important flux. Another member stated that there are ways to estimate this.

Dr. Meyer asked whether work has been completed to determine seasonal mass balance. Dr. David responded that this may not be necessary but Dr. Snyder disagreed. The group discussed this and a member stated that he was not sure how to do seasonal mass balances. He stated that this has not been done. Dr. Snyder stated that different results are obtained when looking at annual vs. seasonal losses of nutrient by crop. He noted that it was important to understand this. Dr. Meyer asked Dr. Snyder to articulate why seasonal mass balance is needed so that this could be addressed in the subgroup's draft report. Another member agreed that it is important to understand when nutrients are lost. A member noted that annual vs. seasonal differences in nutrient loss by crop relate to how quickly plants acquire nutrients.

A member questioned how the balance for nitrogen looked for the Corn Belt. Dr. David responded that it is not possible to make a complete linkage because denitrification in the field and soil organic nitrogen cannot be estimated. However, the balance is approaching zero. A member stated that this relates to the issue of the effect of reducing rates of application on soil balance. Dr. David noted that phosphorus balance is easier to consider than nitrogen because there is a huge amount of phosphorus in the soil compared to what is lost.

#### *Nutrient Transport Processes (Part 2.A.iii)*

The subgroup discussed points and issues to be addressed in the draft response to the charge question on nutrient transport, transformations, sources, and sinks. Drs. Meyer, Howarth, Blumberg, Lowrance, Crumpton, and Boynton were the lead discussants for this topic (Dr. Howarth was not on the call). A number of research needs in this area were discussed. It was noted that progress has been made on the use of landscape models to evaluate nutrient transport. Dr. Meyer stated that the role of small streams is important. She stated that a hydrography layer is needed for small streams. Dr. David responded that the available literature on small streams indicates that denitrification rates are high in small streams but when most of the nitrogen is being exported the flow is too fast to make a difference (see Tank and Royer paper). He stated that this is a difference between streams in the Midwest and the East. Nutrient removal is small unless water is detained in a reservoir or wetland. Another member agreed with this statement. Dr. Meyer asked whether small streams could be made more effective for nutrient removal. Several members responded that if waters are kept as streams there is not much that can be done to increase nutrient removal during the periods of high flow when most of the nitrogen is moving downstream.

A member asked whether mass balance calculations have been completed for streams in the Corn Belt. Several members noted that this is a research gap. A member stated that streams draining areas without tiles contain low nitrate levels. A member reiterated his opinion that unless detention time is increased nutrient levels are not decreased. The subgroup discussed the importance of water depth to nutrient removal. A member stated that a 0.5 m depth of water may be optimal. Members noted that nutrient removal is most effective in wetlands that provide at least one week of detention time, and that available organic substrate limits denitrification. Another member stated that at one time, many Midwestern headwater streams were wet prairies with seasonal water flow and they removed nutrients more effectively. A member asked whether there has been a systematic comparison of transport of nutrients and landscape structure. The group discussed whether this type of analysis had been conducted using the SPARROW model. A member noted that the SPARROW model may be of limited use for this purpose because it is based on regression analysis that requires good nutrient export data. These data may not be available. Another member stated that in areas where there is no tile drainage, nitrate in streams is low. A member noted that as tile drains are eliminated, riparian zone nutrient removal of nutrients is more effective.

The group discussed the issue of nutrient sinks and sources (including the effectiveness of nutrient removal by wetlands). Several members of the group had previously discussed sinks and sources and decided that this issue should be addressed by both subgroups 2 and 3. Members noted that there has been much new research in this area since the publication of the CENR Report in 2000. Research has been conducted on the timing and rate of fertilizer application. Buffers have been installed but there has not been much research on the effectiveness of buffers. Conclusions have been provided in the Upper Mississippi River Sub-Basin Hypoxia Nutrient Committee (UMRSHNC) workshop document that was provided to the Panel. Subgroup members stated that they will look more closely at the UMRSHNC workshop document. A member stated that there is new evidence concerning the issue of excess nitrogen showing less excess nitrogen because yields have increased. There has been new research concerning fall vs. spring applications of fertilizer, but changes in timing appear to result in a small impact on export. A member noted that there is not adequate information on whether less nitrate coming out of drains will improve soil quality, and that the group may have to conclude that there is no scientific consensus on this. Members discussed whether current practices are “mining the soil for nitrogen,” how systems can become sinks for greenhouse gases, and the benefits of planting different crops. A member stated that the corn/soybean system leaks nutrients and that a more diverse cropping system is needed.

Dr. Meyer asked the group to consider new nutrient management approaches and solutions that have been proposed in the past six years. A member stated that if present amounts of corn and soybeans continue to be grown, reductions in the amount of nutrients transported may not be possible. He stated that surface water quality is better in watersheds where only a portion of the land is cropland. He suggested that a solution to the nutrient problem might be to grow crops that are less fertilizer and energy intensive or to grow corn and soybeans on less of the land. A member stated that the group needs to

find out whether this kind of analysis has been completed. Another member stated that the economic impacts of these kinds of changes should be considered.

Dr. Boynton stated that in the lower Mississippi Basin (estuarine area) an interesting story is being told about sinks, but most of the information is based on concentration measurements. Processes have infrequently been measured. Dr. Boynton stated that it makes sense to measure process rates. He described reported measurements of denitrification in the lower Mississippi but stated that most measurements were in areas where hypoxia is not a problem.

The group discussed the importance of wetlands in reducing nutrient transport to the Gulf. Dr. Crumpton noted that the CENR report recognized the importance of wetlands. He stated that new information on wetland processes indicates that fewer acres of wetlands would be needed for nutrient removal than previously estimated. It was previously assumed that wetlands removed 10 g of nitrogen per square meter per year. It is now recognized that much more nitrogen can be removed if wetlands are strategically placed. Placing wetlands higher in the landscape is more effective, but placing them lower in the landscape (e.g., forested floodplains) is less expensive. Dr. Crumpton noted that 20% of the landscape generates 90% of the load, so targeting wetlands placement is a priority. The effectiveness of wetlands for removal of phosphorus has not been addressed. There have not been many demonstrations of this. The effect of wetlands on greenhouse gases is not clear. Another wetland issue to be considered is regulatory impediments to placement of wetlands. Dr. Crumpton noted that the general conclusions of the CENR report still hold but it is now possible to more precisely specify how much nutrient removal can be expected from wetlands. A member asked whether the CENR report described how much nitrogen can be removed by wetlands at different times of the year. Dr. Crumpton stated that the report did not provide much information about this. A member noted that seasonal mass balance is an important issue to consider. Dr. Crumpton stated that it may be important to summarize data in the gray literature or in datasets. The group discussed the importance of forested swamp wetlands to denitrification. A member noted that there is some evidence that these wetlands are not important for denitrification but not much is known about this. In the Upper Mississippi, high rates of denitrification have been measured, but the contribution of these systems to nitrogen removal in river water is limited because of poor mixing. A member wondered if increasing connectivity is a potential management option and stated that more input from the USGS and the Army Corps of Engineers would be helpful to look at ways to manage the upper parts of the Mississippi Basin.

The group discussed tile fields and drainage modification issues, which received superficial consideration in the CENR report. A member stated that drainage maps are not available for many areas. It was noted that tools are available to examine drainage modification on a landscape scale, although questions were raised as to the ability of these techniques to provide the detailed information needed on depth and spacing of tiles. The CENR report stated that 40% of the area of concern may have tile drainage but it is not known where the tile is located. A member stated that there is a relationship between tile drainage and nitrogen export. If the intensity of drainage (which includes tile length,

diameter, slope, depth, spacing) is increased subsurface transport will increase. He expressed the opinion that developing an understanding of where the drainage is located is a clear research need. The group discussed how to incorporate this kind of information into models. It was noted that the SWAT model can deal with tile drained areas. However the model provides very coarse information because the location of the tile is not known. A member stated that the DRAINMOD model can deal with depth of tiles, but he noted this it is a field scale model not a watershed scale model. It was noted that the Natural Resource Conservation Service of the U.S. Department of Agriculture has been doing work on drainage management and that it might be useful to invite someone from that organization to speak to the Panel. Dr. Reckhow stated that he would talk to the developer of DRAINMOD (Wayne Skaggs) to find out how it has been applied.

#### *Predicting Nutrient Delivery to the Gulf (Part .2B.i)*

The subgroup discussed issues to be addressed in the draft response to the charge question on predicting nutrient delivery to the Gulf. Drs. Reckhow, Blumberg, and Mankin were the lead discussants for this topic. Dr. Reckhow stated that he had contacted Richard Alexander to find out what he will be presenting on the SPARROW model at the upcoming science symposium in Minneapolis. Drs. Crumpton, David, and Snyder indicated that they will be attending the symposium. Dr. Meyer asked them to talk to Richard Alexander about the SPARROW model.

Dr. Blumberg stated that since the 2000 assessment not much has been written about how water moves and mixes on the Louisiana Shelf. He stated that he has talked to several modelers about this. He has had discussions with Drs. Victor Bierman (Limnotec) and Rob Hetland (Texas A&M) and has gotten a good sense of what they have been doing. A member stated that it would be useful to talk to Robert Ambrose at the EPA ORD Athens lab about modeling work that may have been completed. Dr. Meyer asked the subgroup whether researchers had been looking at nutrient delivery from the Atchafalaya River. Dr. Blumberg stated that Dr. Hetland's work addressed this issue. Dr. Blumberg stated that he would include this in the written material he will provide on this topic.

Dr. Meyer thanked the members for their contributions and stated that subgroup had made considerable progress toward developing material for the responses to the charge. She asked members to provide written material for discussion on the next subgroup teleconference in November. These materials are due 15 November.

#### *Experts to be Invited to the December Meeting of the Panel*

Dr. Meyer stated that the agenda for the next Panel meeting in December was under development and she asked the subgroup to identify outside experts who should be invited to the meeting. She noted that several members had expressed the opinion that it would be helpful to invite Richard Alexander (USGS) and Victor Bierman (Limnotec) for presentations on models. Several members reiterated the opinion that it would be helpful to hear from these people. Others stated that it would be helpful to invite people who could speak about the wetland and agriculture compartments of models. Another

member suggested inviting Bill Battaglin from USGS to discuss fluxes. Another member stated that it would be helpful to invite Don Skavia from the University of Michigan. Other possible invitees were discussed. These included: Bob Kellog, USDA (SWAT, CEAP), Dan Jaynes, USDA (SWAT and drainage systems), and David Mulla, University of Minnesota (for work on phosphorus). Dr. Meyer thanked the members for their suggestions.

*Public Comments*

Dr. Meyer asked whether there were any public comments and the DFO stated that no requests to make public comments had been submitted.

*Review of Action Items and Assignments*

Dr. Meyer stated that the next subgroup 2 teleconference would be held on November 21 at 10:00 eastern time. She asked subgroup members to prepare assigned written material before the call. She stated that this material should be provided to the DFO by November 15. Dr. Meyer stated that after she has received the minutes of today's call she would send an email to the members concerning the next teleconference.

Before adjourning, the group continued to discuss the issue of drainage intensity. A member stated that the importance of knowing the location of tile drainage is not clear. He noted however that the Panel report should explain what is known about tile drainage systems. A member stated that knowledge of how tile drainage intensity changes through time is needed. Dr. Meyer stated that it will be important to understand drainage intensity over space and time, but not necessarily to map tile in a watershed. A member stated that a map of drainage intensity is not available. Members discussed how to develop a better understanding of drainage intensity. Several approaches were discussed including examining hydrology and using aerial photography. It was noted that these approaches do not provide information on depth of tiles.

At the conclusion of the discussion, Dr. Meyer thanked the members for their contributions and asked them to provide more specific written suggestions about the kinds of research that will be needed. There were no additional comments so Dr. Meyer adjourned the teleconference.

Respectfully Submitted:

Certified as True:

*/Signed/*

*/Signed/*

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Dr. Thomas Armitage  
Designated Federal Officer

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Dr. Judith Meyer, Leader  
Hypoxia Advisory Panel -- Subgroup  
on Nutrient Sources, Fate, and  
Transport

## APPENDICES

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Appendix A: Roster of Subgroup 2

Appendix B: Meeting Agenda

## Appendix A – Subgroup Roster

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### **U.S. Environmental Protection Agency Science Advisory Board Hypoxia Advisory Panel Subgroup on Nutrient Sources, Fate, and Transport**

#### **LEADER**

**Dr. Judith L. Meyer**, Distinguished Research Professor, Institute of Ecology,  
University of Georgia, Athens, GA

#### **MEMBERS**

**Dr. Alan Blumberg**, Professor, Civil, Environmental and Ocean Engineering, Stevens  
Institute of Technology, Hoboken, NJ

**Dr. Walter Boynton**, Professor, Chesapeake Biological Laboratory, Center for  
Environmental Science , University of Maryland, Solomons, MD

**Dr. William Crumpton**, Associate Professor & Coordinator of Environmental Programs,  
Ecology, Evolution, and Organismal Biology, Iowa State University, Ames, IA

**Dr. Mark David**, Professor, Natural Resources & Environmental Sciences, University of  
Illinois, Urbana, IL

**Dr. Robert W. Howarth**, David R. Atkinson Professor , Dept. of Ecology and  
Evolutionary Biology, Cornell University, Ithaca, NY

**Dr. Richard Lowrance**, Research Ecologist, Southeast Watershed, Agric. Research  
Serv., USDA, Tifton, GA

**Dr. Kyle Mankin**, Associate Professor, Biological and Agricultural Engineering, Kansas  
State University, Manhattan, KS

**Dr. Clifford Snyder**, Southeast Director, Potash & Phosphate Institute, Conway, AR

**SCIENCE ADVISORY BOARD STAFF**

**Dr. Thomas Armitage**, Designated Federal Officer, U.S. Environmental Protection Agency, Washington, D.C

## Appendix B – Teleconference Agenda

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### AGENDA

U.S. Environmental Protection Agency  
Science Advisory Board  
Hypoxia Advisory Panel -- Subgroup on Nutrient Sources, Fate and Transport  
Public Teleconference  
**October 16, 2006, 2:00 p.m. (Eastern Time)**

**Purpose:** The purpose of this teleconference is for members of the Hypoxia Advisory Panel's Subgroup #2 to discuss each panelist's progress toward addressing their assignments related to the current understanding of nutrient sources, fate and transport within the Mississippi River Basin and delivery to the Gulf of Mexico.

2:00 p.m.	Meeting Convened	Dr. Tom Armitage Designated Federal Officer
2:10 p.m.	Purpose of Call & Review of Agenda	Dr. Judy Meyer Subgroup Leader
2:15 p.m.	Discussion of Draft Outline Responses to the Charge:	Dr. Meyer and Subgroup
	Temporal Character of Loads/Fluxes (part 2.A.i)	Lead Discussants: Drs. Mark David & Robert Howarth
	Mass Balance (part 2.A.ii)	Lead Discussant: Dr. Mark David
	Transport, Transformations, Sources, & Sinks (part 2.A.iii)	Lead Discussants: Drs. Judy Meyer, Robert Howarth, Alan Blumberg, Richard Lowrance, William Crumpton, & Walter Boynton
	Predicting Nutrient Delivery to the Gulf (part 2.B.i)	Lead Discussants: Drs. Kenneth Reckhow & Kyle Mankin
	Routing & Transport Processes from Source to Gulf (part 2.B.ii)	Lead Discussants: Drs. Kenneth Reckhow, Alan Blumberg, & Kyle Mankin
4:00 p.m.	Technical Briefings Needed and Questions to be Answered	Dr. Meyer & Subgroup
4:30 p.m.	Public Comments	
4:45 p.m.	Review of Action Items & Assignments	Dr. Meyer

5:00 p.m.      Adjourn