

External Peer Review of the Draft Region 4 Report, “Evaluation of the Role of Nitrogen and Phosphorus in Causing or Contributing to Hypoxia in the Northern Gulf, August, 2004”

Responses and Recommendations

The External Peer Review of the Draft Region 4 report, “Evaluation of the Role of Nitrogen and Phosphorus in Causing or Contributing to Hypoxia in the Northern Gulf, August, 2004,” provided some areas of agreement and other areas of uncertainty related to hypoxia production. The following discussion of agreement and uncertainty is organized according to the nine questions provided as a charge to the nine peer review participants.

Please note: Two of the nine reviewers did not format their comments as direct responses to the charge questions. Information these reviewers provided is included in the general summary comments.

The complete comments from the peer reviewers follow this brief summary.

Charge Questions, Summary Comments, and EPA Responses

Charge Question 1. Do the data presented provide sufficient evidence for P limitation of phytoplankton growth?

All reviewers that specifically responded (7 of 9) agree that there is not sufficient evidence presented here for phosphorus (P) limitation alone controlling the phytoplankton growth that is thought to lead to the development of the hypoxic zone.

All reviewers support a dual nutrient (P and nitrogen (N)) strategy. Six of the reviewers point out that both P and N are potentially limiting in various places and times in the Mississippi River plume, but that control of one nutrient over the other is not warranted from the information in the reviewed report. Several reviewers point out that the Draft Region 4 report while critical of Nancy Rabalais’ use of the Redfield ratio, also incorrectly uses this ratio. See reviewer comments for a more detailed discussion of this point.

Charge Question 2. Do the data presented provide sufficient evidence for N limitation of phytoplankton growth?

All reviewers consider N limitation a significant factor in assessing the hypoxic Zone and in developing management plans to reduce the size of the Zone.

All reviewers that addressed this question again agree that N limitation is likely or does occur (most refer to other peer reviewed publications) but that the report does not address or support N limitation of phytoplankton growth that may lead to hypoxic zone formation. See reviewer comments for a more detailed discussion of this point.

Charge Question 3. Do the data presented support the conclusion that point source P contribute to algal blooms and Gulf hypoxia?

The reviewers state that while point source P contributions may be non-trivial, the data presented here are not sufficient to definitively identify source distributions.

The lack of recent data from the Belle Chasse monitoring site on the Mississippi River is one of the significant data gaps that make it impossible to draw a clear conclusion related to the role of point source contribution of reactive P to the northern Gulf of Mexico.

Charge Questions 4. Is the observed trend on P loading consistent with Gulf reactive P increase?

Seven reviewers specifically addressed the question, but only one reviewer agrees that the P loading may be consistent with reactive P increase.

The other six that responded pointed out the improper assumptions made in the Draft Region 4 report regarding the reactive P data, the variability of reactive P data, and the need for a more thorough accounting of P data (reactive and total P) to support any conclusions regarding P loading and reactive P increases.

Charge Question 5. Are there other mechanisms that cause the N and P increase in the Gulf?

Seven of nine reviewers responded to this question. Some reviewers questioned the basic premise of this question on what was meant by “other mechanisms” that could cause an increase in N and P in the northern Gulf.

The major mechanisms mentioned as affecting delivery of N and P to the Gulf were: loss of wetlands, hydrologic changes, shifts in agricultural production systems, changes in river channel morphology, climatic change, increased release of P from eutrophic sediments, and Mississippi River impoundments.

Charge Question 6. Do the presented data support N and P reduction goals on a seasonal cycle?

Seven of nine reviewers responded to this question and they generally agree that consideration of seasonal goals may have merit. The recommendations for managing N and P reductions varied among reviewers.

Additional analyses were recommended to better understand the relationships between the nutrient loading from the Rivers and the development of the Hypoxic Zone. Specific recommendations include: assess the time lag on nutrient load delivery to the northern Gulf and phytoplankton production; evaluate nutrient recycling in the northern Gulf and its impact on phytoplankton production; and use the Scavia model which correlates N loads in May-June with the size of the Hypoxic Zone and now estimates a 40-45 percent reduction in N is necessary to meet *Action Plan* goals.

Charge Question 7. What is the significance of data from USGS monitoring stations below St. Francesville?

The seven reviewers who responded generally noted the value and significance of USGS monitoring below St. Francesville.

The reviewers used “critical” and “crucial” as descriptors of the significance of data collected at Belle Chasse. It is noted that considerable loadings of N and P from human sources may occur below St. Francesville. A clear recommendation is to re-establish this monitoring station to better assess nutrient loads into the northern Gulf and to track progress on attaining nutrient load reduction targets.

Charge Question 8. The Redfield Ratio as used by Rabalais et al. (1999) in the Mississippi River has been called into question. Please comment on the use of the Redfield Ratio in the Region 4 Report Evaluation, and the use of this calculation to identify the limiting nutrient in the water column of the Mississippi River and the northern Gulf of Mexico.

A consensus of the reviewers is that nutrient limitation cannot be determined solely by using the Redfield ratio of N and P.

Five of the nine reviewers responded to this question. The reviewers noted the complexity of and value in using the Redfield Ratio in estuarine and near coastal waters to assist in understanding the growth of phytoplankton in the northern Gulf. Some argued for use of DIN:DIP, some for TN:TP and some for a broader consideration all ratios while recognizing the complexities of estuarine and marine systems. One noted that use of DIN:TP, although flawed, might be the closest to appropriate. Others questioned the use of DIN:TP as unusual and leading to confusion. Several reviewers noted research that indicated N or P limitation at a broader range of Redfield ratios. All noted that simplistic comparisons of nitrogen to phosphorus could be easily misconstrued. Factors such as release of particle bound phosphorus, sediment phosphorus releases and phytoplankton recycling made simplistic use of the ratio inappropriate. This issue seemed to be a major concern regarding the Draft Region 4 report since the report relies on application of Redfield ratios for its conclusions.

Charge Question 9. Please identify gaps in the data and information, and provide additional references and data resources where possible.

Five reviewers responded to this question. They provided the following recommended topics for further analysis and research.

All reviewers noted the importance of additional consideration of processes affecting the bioavailability of N and P. The following have been identified as important areas for consideration:

- Addition of bioavailable P from particle bound P in marine waters,
- Release of bioavailable P from sediments (especially under eutrophic conditions),
- Recycling of phosphorus from phytoplankton,
- Nitrification and denitrification,
- Contributions of P from deeper Gulf waters,

- The mechanism related to nearshore Gulf waters stratification,
- Gulf hydrodynamics in relation to Mississippi River Basin discharges,
- Additional bioassay in nearshore northern Gulf waters,
- Further historical evaluation of N and P loadings and flows related to hypoxic response,
- The spatial and temporal dynamics of phytoplankton production

Summary Comments

EPA: All authors agree that the concept of a balanced approach of managing both N and P to reduce the Gulf hypoxia is sound and scientifically justified. Main points made by the reviewers in their summary comments are listed below.

Recommendations Supporting the Control of Both N and P

The concept of a balanced approach to managing both N and P at their source and during transport to decrease loads, which are “significantly” above historic background levels or to restore water quality throughout the Mississippi-Atchafalaya River Basin (MARB), as well as to decrease Gulf hypoxia is scientifically sound and desirable.

Reducing ALL nutrient loading by at least 30%, if not significantly greater, rather than attempting to focus on one nutrient (N or P), is recommended.

Action must be taken to reduce BOTH N and P in receiving waters of the Mississippi River. Lack of action will maintain, or worsen the status quo, with dire consequences for our coastal waters.

The report correctly points out that questions should be raised about justifying N as the only limiting nutrient of concern. However, the general conclusion that point source P contributes significantly to the algal blooms in the Gulf is not justifiable based on the stoichiometric arguments alone.

Hypereutrophy and its associated detrimental water quality impacts are catastrophic and growing problems on local, regional, national, and worldwide scales. The recommendation from the report to control one nutrient, phosphorus, while dismissing the other is incredibly nearsighted.

The fundamental recommendation to reduce N and P loading to the Gulf of Mexico that is reached in this document is sound.

Nutrient Management

A holistic sustainable approach to nutrient management is essential to deal with the major concerns and issues. A technically sound framework must be developed that recognizes critical sources of nutrient export from agricultural watersheds so that optimal strategies at farm and watershed scales can be implemented to best manage both P and N and effect a decrease in nutrient loads to the Mississippi and Atchafalaya River Basins to the Gulf.

When public funds are invested in remediation programs, rapid improvements in water quality are usually expected and often required. Thus, implementation of effective remedial strategies to

decrease nutrient loads in the MARB should consider the re-equilibration of watershed and lake behavior where nutrient sinks may become sources of N and P with only slight changes in watershed management and hydrologic response. Education programs should also be established to highlight the long-term benefits of remedial measures.

The documents reviewed raise serious concerns about a management strategy focused solely on a single nutrient element. Only further monitoring, coupled with an adaptive management approach will resolve some of the questions raised. Such a management program should entail an extensive ongoing program of monitoring both river and shelf water properties, combined with a comprehensive program of modeling that will both enhance understanding and allow for prediction of outcomes in response to different management actions. There is NO DOUBT that excessive introduction of nutrients does degrade the overall quality of coastal zone impacted by river outflow.

The report raises some fundamentally important and pivotal questions, points and issues. These issues need to be addressed to clarify and definitively determine the mechanistic linkages between nutrient supply, productivity and excessive oxygen consumption (hypoxia) in the Gulf.

Replacing wetland and estuarine systems that have been lost by the channelization of these rivers for shipping and commercial trade is important because these systems function as chemical filters and processors of terrestrially-derived nutrients and pollutants. Action plans to restore crucial wetland habitats and dechannelize the current waterways would help curtail the direct 'piping of nutrients' from Midwest agriculture into the Gulf of Mexico.

To obtain more knowledge concerning specific action items deemed critical for making informed management decisions, all federal agencies have to collaborate and provide research and management dollars.

Major Weaknesses of the Report

The report reflects a poor understanding of marine eutrophication. They focus on the Mississippi River plume and do not appear to have an understanding of the context of hypoxia in a dynamic, spatially realistic context.

The report offers little new information or insight, it does not present any information on how much more attention should be directed at P reductions in order to achieve the balanced approach desired, nor does it outline how such an approach might be determined.

The report relies on what is termed in the report as "a more traditional Redfield ratio calculation." The use of this approach in the report is fatally flawed, rendering the report of no scientific use as a guide for policy. There are several more thorough and better supported analyses available to the policy community for guiding the *Action Plan*, and the report obscures far more than it illuminates.