Subgroup 3: Scientific Basis for Goals and Management Options

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Scientific Basis for Goals and Management Options

The Task Force has stated goals of reducing the 5-year running average areal extent of the Gulf of Mexico hypoxic zone to less than 5,000 square kilometers by the year 2015, improving water quality within the basin and protecting the communities and economic conditions within the basin. Additionally, nutrient loads from various sources in the Mississippi River Basin have been suggested as the major driver for the formation, extent and duration of the Gulf hypoxic zone.

A. Are these goals supported by present scientific knowledge and understanding of the hypoxic zone, nutrient loads, fate and transport, sources and control options?

i. Based on the current state-of- the-science, should the reduction goal for the size of the hypoxia zone be revised?

ii. Based on the current state-of-the-science, can the areal extent of Gulf hypoxia be reduced while also protecting water quality and social welfare in the basin?

Scientific Basis for Goals and Management Options

B. Based on the current state-of- the-science, what level of reduction in causal agents (nutrients/discharge) will be needed to achieve the current reduction goal for the size of the hypoxic zone?

Scientific Basis for Goals and Management Options

C. Given the available literature and information (especially since 2000) on technologies and practices to reduce nutrient loss from agriculture, runoff from other nonpoint sources and point source discharges, discuss options (and combinations of options) for reducing nutrient flux in terms of cost, feasibility and any other social welfare considerations. These options may include:

i. the most effective agricultural practices, considering maintenance of soil sustainability and avoiding unintended negative environmental consequences

ii. the most effective actions for other nonpoint sources

iii. the most effective technologies for industrial and municipal point sources

In all three areas, please address research and information gaps (expanded monitoring, documentation of sources and management practices, effects of practices, further model development and validation, etc.) that should be addressed prior to the next 5-year review.

A. i. should the reduction goal for the size of the hypoxia zone be revised? … can the areal extent of Gulf hypoxia be reduced while also protecting water quality and social welfare in the basin?

I. Goal Setting (Opaluch)

II. Upstream costs and benefits of hypoxia reduction (Kling)
1. CENR Topic 6 report
2. New literature since Task 6 report
3. Cost-effectiveness of practices
4. research r.e. policy design and effectiveness

III. Downstream Effects and Benefits(Opaluch)
1. CENR Topic 2 report
2. New literature since Task 2 report

I. Goal Setting (Opaluch)

1. Technical feasibility
2. Economic feasibility
3. Costs vs. benefits
   - Compares benefits of achieving different levels against their costs.
   - Costs are more straightforward to quantify.
   - Benefits might be difficult or impossible to measure particularly when including for co-benefits (improved quality of drinking water, etc)
   - Despite difficulties in quantifying benefits, one can identify benefits. If costs are large, then large benefits are needed to justify
   - Benefit-cost analysis should compare different water quality goals. For example, no action, versus maintaining status quo for hypoxia, reducing hypoxia to five-year running average of 10,000 sq km, reducing hypoxia to 50year running average of 5,000 sq. km.

II. Upstream Costs and Benefits of Hypoxia Reduction Actions (Kling)

I. CENR Topic 6 report
- a. Summary of key points
- b. What findings are still valid, what may not be?

II. New literature since Task 6 report (and literature not considered)
- a. Basinwide scale integrated economic-biophysical modeling (WRI study, Wu, Kling, etc.)
- b. Smaller watershed scale integrated economics-biophysical modeling (Khanna, etc.)
- c. Basinwide co-benefits, carbon sequestration, local water quality, biodiversity, etc.

III. Cost-Effectiveness of Practices
- a. Costs of adoption of specific conservation practices and control methods
- b. Supply curves for various practices
  - Tillage alternatives
  - Nutrient management
  - Land retirement
  - Etc
- c. Supply curves for edge-of-field environmental gains (erosion, N, P, etc.), requires linking adoption models with biophysical models or data

II. Upstream Costs and Benefits of Hypoxia Reduction Actions (Kling)

IV. Research Assessing Policy Design and Effectiveness

- a. Purely voluntary
  - In context of agriculture
  - Non-agricultural industries (Khanna voluntary programs in industry, Segerson, etc)
- b. Incentives
  1. Analyses of specific agricultural conservation programs, CRP, WRP, WHIP, EQIP, etc.
  2. Trading programs , Point/nonpoint trading, watershed based trading
  3. Issues in cost-effective design
     - Targeting (by costs and benefits)
     - Efficient bidding systems
     - Enforcement
     - Multiple environmental goals
     - Removal of Subsidies
- c. Taxes
- d. Mandatory: regulations, conservation compliance
- e. Literature on adaptive management, uncertainty, irreversibilities, etc?

III. Downstream Effects and Benefits (Opaluch)

I. CENR Topic 2 report

a. Literature very limited. Had to carry out their own exploratory analysis.

b. The assessment of fisheries data failed to detect effects of hypoxia.
- A. Landings relatively constant for at least the last few decades
- B. Catch per unit effort for brown shrimp, while variable, has trended down since the late 1970s.
- C. Failure to identify clear effects on catch does not necessarily mean no effect
- D. Fish and shrimp may avoid hypoxia,

c. Effect of hypoxia in the northern Gulf of Mexico is intertwined with other stressors.
- A. Need to determine the contribution of other natural and anthropogenic sources of mortality and growth to population dynamics.
- B. Need to determine functional aspects of the ecosystem are specifically affected by hypoxia.

d. Comprehensive research plan is needed
- A. Current efforts hampered by lack of data
- B. New research plan must direct new research and synthesize existing data.
- C. Total ecosystem approach needed to consideration how hypoxia and other stressors interact with all aspects of the Gulf ecosystem

III. Downstream Effects and Benefits (Opaluch)

II. New literature since Task 2 report

a. Quantifying biological effects of hypoxia is very difficult.
b. Many species can avoid hypoxic areas, Effects to non-mobile species, and food webs
c. Potential impacts on a particular species will depend strongly on species-specific factors.
d. Shrimp is key species, high economic value, Hypoxia overlaps with habitat and fishing grounds, Significant relationship between hypoxia and landings of brown shrimp, both Catch and CPUE decline for brown shrimp
e. Other possible impacts
- Loss of habitat
- Block migratory corridors
- Potential for fisheries collapse, as observed elsewhere
- "Jubilee" effect.
- May make bottom dwelling organisms move vertically in the water column, which may also make them more vulnerable to predators
- May kill benthic invertebrates (e.g., annelid worms) off which shrimp feed
- Lipids in a shrimp's body tends to be 20 to 25 percent lower in animals caught in low-oxygen areas than in those caught in fully oxygenated water.(Craig)
- Ecosystem change create habitat that favors jellyfish over the commercially valuable finfish, crabs, and oysters, as observed elsewhere.
- Irreversibilties. It might take many years or decades for ecosystems to recover after nutrient inputs are stopped,

B. Based on the current state-of- the-science, what level of reduction in causal agents (nutrients/discharge) will be needed to achieve the current reduction goal for the size of the hypoxic zone?

- We believe this belongs largely to Subgroup 1.

C. Discuss options for reducing nutrient flux in terms of cost, feasibility and any other social welfare considerations.

i. the most effective agricultural practices, considering maintenance of soil sustainability and avoiding unintended negative environmental consequences.

I. Agricultural Drainage (Crumpton)

II. Wetlands and Deepwater Habitats (Crumpton)

III. Conservation Buffers (Lowrance)

IV. Cropping Systems (Lowrance, Sharpley and Snyder)

V. In Field Nutrient Management (Lowrance, Sharpley and Snyder)

I. Agricultural drainage: (Crumpton)

1. Current extent and patterns of agricultural drainage, including cropland "benefiting" from field drainage as well as cropland contributing to drainage networks
2. Effects of agricultural drainage on N and P transport
3. Potential effects of alternative drainage system design and management on N and P transport from cropland (including controlled drainage and bioreactors) within the basin

II. Wetlands and Deepwater Habitats (Crumpton)

1. Current extent and distribution of wetlands and deepwater habitats
2. Effects of wetlands and deepwater habitats on N and P transport
3. Potential effects of creation and management of wetland and deepwater habitats on N and P transport within the basin

III. Conservation Buffers (Lowrance)

1. How have conservation buffers been applied and are there any estimates of N and P reduction benefits and the mechanisms involved?
2. How can conservation buffers be integrated into tile-drained landscapes, specifically where changes in drainage management has the potential to increase surface runoff?
3. What new information on hydrogeologic settings can be used to better design conservation buffers within the basin?

IV. Cropping Systems (Lowrance, Sharpley and Snyder)

1. Row crops, perennials, cover crops, living mulches, relay crops
2. Current extent, distribution, and effects of major cropping systems on N and P export
3. Potential effects of alternative cropping systems on N and P export
4. Effects of changes in cropping practices and rotations for bio-fuel production on N and P transport

V. In Field Nutrient Management (Lowrance, Sharpley and Snyder)

a. Current practices

1. Potential effects of changes in rate and timing of fertilizer application on N and P export (taking into account current rates and timing of application for different areas of the basin)
2. Effects of N management on soil resource sustainability
3. Effects of manure management and proper accounting of manure N and P

V. In Field Nutrient Management (Lowrance, Sharpley and Snyder)

b. Newer technologies for reduction in nitrate-N discharge

1. Precision ag technologies
   - In-season N sensing technologies (e.g. corn, cotton, wheat)
   - N rate reference strips (ramped and non-ramped) for the above
   - Management zone delineation
2. Controlled-release N fertilizers (e.g. polymer coated urea)
3. Need for more properly replicated on-farm research, using farmer equipment, to better define site-specific N rates?

V. In Field Nutrient Management (Lowrance, Sharpley and Snyder)

c. Older technologies that could receive greater implementation for improved effectiveness of applied N and reduced losses from farm fields

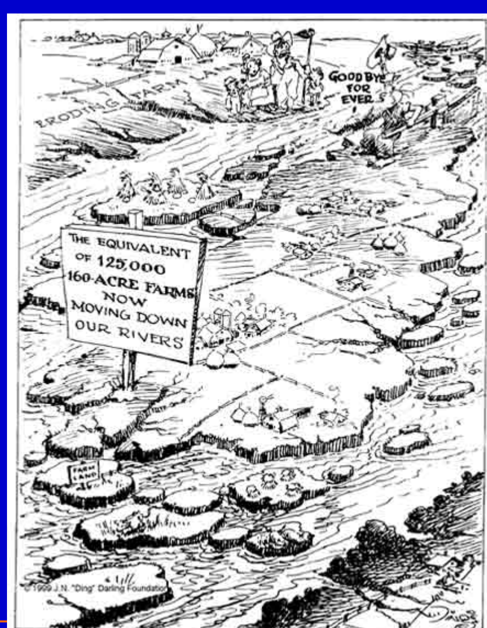
1. Soil nitrate test: pre-plant, pre-sidedress, end-of-season nitrate tests
2. Targeted tissue sampling in-season (e.g. petioles: cotton, potatoes)
3. Nitrification inhibitors, urease inhibitors (beyond Minnesota) to enhance N use efficiency (potentially reducing applied N rates)
4. Appropriate N timing and rates
5. Other BMPs- as outlined by NCSU , and others

ii. the most effective actions for other nonpoint sources

- Opaluch

ii. the most effective actions for industrial and municipal sources.

Crumpton



"What that Mud in Our Rivers Adds up to Each Year"

Ding Darling, 1946