Hypoxia in the Gulf of Mexico: A Historical and Policy Perspective

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I. INTRODUCTION

> The valley of the Mississippi River stretches north into Canada and south to the Gulf of Mexico, east from New York and North Carolina and west to Idaho and New Mexico. It is a valley 20 percent larger than that of China's Yellow River, double that of Africa's Nile and India's Ganges, fifteen times that of Europe's Rhine. Within it lies 41 percent of the continental United States, including all or part of thirty-one states. No river in Europe, no river in the Orient, no river in the ancient civilized world compares with it. Only the Amazon and, barely, the Congo have a larger drainage basin. Measured from the head of its tributary the Missouri River, as logical a starting point as any, the Mississippi is the longest river in the world, and it pulses like the artery of the American heartland.[1]

Within the boundaries of the United States are two valuable natural water resource systems: the Gulf of Mexico (the Gulf) and the Mississippi River Basin. These two systems are significantly different in many ways. However, there is one overriding environmental issue, known as hypoxia, which interlinks the Gulf of Mexico and the entire Mississippi River Basin. This Article attempts to summarize the evolution of the science and policy implications of hypoxia, including ongoing federal, state, and tribal initiatives. This entails addressing hypoxia in the Gulf of Mexico as a national issue of concern and the challenges faced for implementing any actions.

A. Gulf of Mexico

The Gulf of Mexico (the Gulf) is a semi-enclosed tropical and subtropical sea and is the fifth largest sea in the world.[2] The Gulf region covers more than 600,000 square miles with outlets from thirty-three major river systems and 207 estuaries and has one of the most extensive barrier-island systems of the United States.[3] The Gulf's drainage system covers more than forty percent of the United States.[4] Its U.S. coastline is approximately 1,553 miles (longer than

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1. JOHN M. BARRY, THE RISING TIDE 21 (1997).
2. *See* LOUISIANA ALMANAC 283 (Milburn Clahoun ed., 1997-98 ed. 1997); OXFORD ATLAS OF THE WORLD xiv (Oxford Univ. Press 1992) (1992).
3. *See* ROBERT H. GORE, THE GULF OF MEXICO: A TREASURY OF RESOURCES IN THE AMERICAN MEDITERRANEAN 52-53 (1992).
4. *See id.* at 281.

the Pacific coastline of California, Oregon, and Washington).[5] The northern Gulf of Mexico is the recipient of the flow of a major river system, the Mississippi and Atchafalaya Rivers.[6] The inflow from these two rivers dwarfs the input from any other Gulf Coast system, providing ninety percent of Gulf of Mexico freshwater inflow.[7]

Bordered by the United States, Mexico, and Cuba, the Gulf of Mexico is a bountiful natural resource shared by the international community for a variety of resources and services including transportation, fisheries, natural resources, and recreation. Its diverse and productive ecosystem is very important to the U.S. economy.[8] The Gulf's coastal wetlands encompass over five million acres (about half of the U.S. total), and serve as an essential habitat for a large percentage of the nation's migrating water fowl.[9] Mudflats, salt marshes, mangrove swamps, and barrier island beaches of the Gulf also provide year-round nesting and feeding grounds for abundant numbers of gulls, terns, and other shorebirds.[10] Gulf estuaries serve as a nursery for estuarine-dependent commercial and recreational fisheries.[11] These fisheries provided approximately seventy-two percent of the nation's shrimp, sixty-six percent of the U.S. total oyster production, and fifteen percent of the domestic harvest of commercial fish in 1995.[12] More than one-third of all marine recreational fishing in the U.S. occurs in the Gulf region.[13]

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5. *See id.* at 53.

6. *See* John D. Milliman & Robert H. Meade, *Worldwide Delivery of River Sediment to the Oceans*, 91 J. OF GEOLOGY, 1, 5 (1983).

7. *See* Nancy H. Rabalais et al., *Nutrient Changes in the Mississippi River and System Responses on the Adjacent Continental Shelf*, 19 ESTUARIES, 386, 387 (1996).

8. *See* James G. Hanifen et al., *Potential Impacts of Hypoxia on Fisheries: Louisiana's Fishery-Independent Data*, *in* NO. EPA-55-R-97-001, PROCEEDINGS OF THE FIRST GULF OF MEXICO HYPOXIA MANAGEMENT CONFERENCE (Gulf of Mexico Program, Office of Water, U.S. EPA, 1997) [hereinafter FIRST HYPOXIA CONFERENCE].

9. *See* LOUISIANA ALMANAC, *supra* note 2, at 305-06. *See generally* GORE, *supra* note 3, at 176-80, 193-194 (discussing the importance of wetland habitats to fauna, including water fowl).

10. *See* GORE, *supra* note 3, at 193-94.

11. *See id.*

12. *See* NATIONAL MARINE FISHERIES SERV., U.S. DEP'T OF COMMERCE, CURRENT FISHERY STATISTICS NO. 9500, FISHERIES OF THE UNITED STATES, 1995, at xii, 4 (1996).

13. *See* GORE, *supra* note 3, at 248.

B. Mississippi River Basin

The 1.25 million square mile Mississippi River Basin is home to almost a third of our population.[14] Activities on the land that comprise this huge watershed affect the quality of the Mississippi River (the River) and the Gulf of Mexico into which it drains.

The River is an extremely important resource. It is a drinking water supply for tens of millions of people,[15] it transports barges bearing billions of dollars worth of cargo,[16] and together with its remaining wetlands, it is habitat to large and valuable populations of waterfowl, fish and shellfish.[17] In addition, billions of dollars are spent on recreation associated with the River.[18] At the same time, the River receives run-off laden with fertilizers, other chemicals, and the direct discharge of treated wastewater from cities and factories.[19] The engineering that has been undertaken to control floods and enhance navigation has taken a toll as well. Separating the River channel from the floodplain through flood control and land use conversion measures has reduced the ability of the River to cleanse itself of nutrients and has starved the marshes of Louisiana of sediment needed to offset the loss of land (soils) and sea-level rise.[20] Conventional water quality reporting systems currently in use do not take into account the impact on the hypoxic zone in the Gulf of Mexico, which is strongly correlated with nutrient discharges from the mouth of the Mississippi River.

C. Hypoxia

Hypoxia refers to conditions where levels of oxygen are so low that many organisms cannot breathe.[21] In scientific terms, this relates to water with dissolved oxygen concentrations of less than two parts per million (ppm).[22] A concentration of two ppm dissolved oxygen is

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14. *See* Rose Lew, The Mississippi River: The Challenge of Sustainability 3-4 (1995) (unpublished paper) (on file with author and the Office of Research and Science Integration, U.S. EPA).

15. *See id.* at 3-5.

16. *See* Upper Midwest Envtl. Sciences Ctr., U.S. Dep't of Interior, *About the Upper Mississippi River System* (visited May 28, 1999) <http://www.umexc.usgs.goo/umesc_about/about_umrs.html> [hereinafter *About the Upper Mississippi River*].

17. *See* GORE, *supra* note 3, at 176-80, 193-194.

18. *See About the Upper Mississippi River*, *supra* note 16.

19. *See* GORE, *supra* note 3, at 279-82.

20. *See* James D. Giattina, *Protecting the Gulf of Mexico: Leadership or Crisis?* (visited Apr. 19, 1999) <http://www.gmpo.gov/pubinfo/nm981208.html>.

21. *See* Hanifen et al., *supra* note 8, at 4.

22. *See* Lynn Pokryfki & Robert E. Randall, *Nearshore Hypoxia in the Bottom Water of the Northwestern Gulf of Mexico from 1981 to 1984*, 22 MARINE ENVTL. RESEARCH 75, 77

generally accepted by the scientific community as the lower limit for the survival and reproduction of most marine life.[23]

In the Gulf of Mexico, the size of the oxygen-depleted area varies from year to year, but can extend from the mouth of the Mississippi River to near the Texas border.[24] The oxygen-depletion is typically associated with the bottom waters, but can extend above the bottom.[25] The zone of oxygen depletion in the near shore Gulf has, during the summer months, covered more than 6,000 square miles, an area about the size of New Jersey.[26] The zone can begin forming as early as February and last as late as October.[27] However, the most widespread and persistent conditions occur from mid-May to mid-September.[28]

Usually, nutrients, such as nitrogen and phosphorus, are necessary for healthy marine and freshwater ecosystems, but, an overabundance of nutrients can contribute to hypoxic conditions.[29] Too many nutrients can trigger excessive algal growth which results in reduced sunlight, loss of submerged aquatic vegetation, loss of bottom-dwelling animal habitat, and an increase in oxygen consumption.[30]

> In marine systems, when oxygen levels fall to within 1.0-2.0 ml/liter, mobile organisms, such as pelagic fish, begin to migrate out of the affected area; before the oxygen level reaches 1.0 ml/liter bivalves (e.g., clams) and other bottom dwelling organisms emerge from protective burrows; below 0.5 ml/liter physical activity ceases and mass mortalities of fish and other benthic organisms (e.g., shrimp and crab) can occur.[31]

Mobile organisms leave hypoxic waters and congregate where the "dissolved oxygen concentrations are sufficient to sustain life."[32] Animals that cannot move away from developing hypoxic/anoxic

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(1987); Nancy N. Rabalais et al., *Hypoxia in the Northern Gulf of Mexico: Past, Present and Future*, *in* FIRST HYPOXIA CONFERENCE, *supra* note 8, at 25.

23. *See* Pokryfki & Randall, *supra* note 22, at 76.

24. *See* MINERALS MANAGEMENT SERV., U.S. DEP'T OF THE INTERIOR, OCS REPORT NO. MMS 98-0010, THE FLOWER GARDEN BANKS (NORTHWEST GULF OF MEXICO): ENVIRONMENTAL CHARACTERISTICS AND HUMAN INTERACTION 47 (1998) [hereinafter THE FLOWER GARDEN BANKS].

25. *See id.* at 46.

26. *See id.*

27. *See id.*

28. *See* Rabalais et al., *supra* note 22, at 1.

29. *See* Larinda Tervelt & James D. Giattina, Oxygen Depletion, or Hypoxia, in the Nearshore Gulf of Mexico off the Louisiana Coast 37 (1997) (unpublished paper) (on file with author).

30. *See id.*; *see also* Rabalais et al., *supra* note 7, at 386-87.

31. Tervelt & Giattina, *supra* note 29, at 37.

32. Hanifen et al., *supra* note 8, at 46.

conditions, because of their life stage or habit, may die.[33] In addition, nutrient enrichment of coastal waters may directly contribute to effects that are biologically and aesthetically detrimental to humans.[34]

Oxygen-depleted waters are often, but not exclusively caused by nutrient enrichment.[35] Many physical features of the estuary and water column contribute to the formation of hypoxic water masses. Where increased nutrients contribute to organic loading and subsequent decomposition of material and depletion of oxygen, these features are usually coupled with the physical phenomenon of a stratified water column.[36] This density stratification, controlled by temperature or salinity differences, prevents the reaeration of the bottom waters at a rate sufficient to offset the depletion of oxygen during respiration.[37] Salinity affects the density of water, which affects oxygen depletion.[38] Strength of stratification is sensitive to freshwater inflows and climatic conditions forcing tidal waters into estuaries.[39]

II. THE SCIENCE: SCOPE AND HISTORY OF THE GULF HYPOXIA ZONE

Widespread and catastrophic depletion of dissolved oxygen has been observed in coastal areas worldwide.[40] Oxygen-depleted waters have also been identified in numerous estuaries of the United States.[41] However, the largest, most severe and most persistent zone of hypoxia in United States coastal waters is found in the northern Gulf of Mexico.[42] As discussed in Part I, this hypoxia zone is on the continental shelf off Louisiana and occurs at the terminus of the Mississippi River. With an area that has more than doubled over ten years, the largest increase coming after the Mississippi River flood of 1993, it rivals in size the largest hypoxic areas in the world.[43]

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33. *See id.*
34. *See generally*, Romano Viviani, *Entrophication, Marine Biotoxins, Human Health*, *in* MARINE COASTAL ENTROPHICATION 631, 631-62 (R.A. Voltenhenweider et al. eds., 1992) (discussing the undesirable effects of eutrophication).
35. *See* GULF OF MEXICO PROGRAM, U.S. EPA, EPA 800-B-94-004, NUTRIENT ENRICHMENT ACTION AGENDA FOR THE GULF OF MEXICO: FIRST GENERATION—MANAGEMENT COMMITTEE REPORT 14 (1994) [hereinafter NUTRIENT ENRICHMENT ACTION AGENDA].
36. *See* Hanifen et al., *supra* note 8, at 3.
37. *See id.*
38. *See id.*
39. *See id.*
40. *See* Rabalais et al., *supra* note 22, at 1.
41. *See id.*
42. *See id.*
43. *See id.*

Since the record-breaking midwest flood of 1993, everyone, from scientists to fishermen, has become concerned with Gulf hypoxia. Evidence suggests that the hypoxic zone has existed for decades, but when the 1993 flood flushed nutrients from farms, cities, and industrial areas into the river system and down to the Gulf of Mexico, it caused a doubling of the size of the hypoxic zone.[44] Some researchers are concerned that the frequency and intensity of this phenomenon may be increasing.[45] Although the causes of the hypoxic zone have not been conclusively determined, high temperatures in the summer, freshwater runoff which contributes to stratification, and the transport of large quantities of excess nutrients (nitrogen) from the Mississippi River, have been implicated.[46] "The hypoxic conditions vary spatially and seasonally depending on the flow of the Mississippi River discharge and are affected by physical features such as water circulation patterns, saltwater and freshwater stratification, wind mixing, tropical storms and thermal fronts."[47]

The average annual nitrate-nitrogen concentration in the lower Mississippi River water has doubled since 1960.[48] As human activities have increased within the Mississippi River drainage basin, nutrient loads to the River have increased.[49] Information from the United States Geological Survey indicates that the sources of nitrogen from the Mississippi River Basin include "commercial fertilizers, animal manures, legumes, municipal and domestic wastes, and atmospheric deposition."[50] Human population growth; increased numbers of animals in concentrated feeding operations; application of fertilizers on cropland, parks and lawns; and manufacturing, mining and construction, increased use of fossil fuels for energy, and other associated activities have each contributed to the increase in nutrients. Long-term changes in coastal systems have been documented worldwide where major rivers deliver nutrient enriched waters to coastal seas.[51]

44. *See id.* at 3-4.
45. *See* THE FLOWER GARDEN BANKS, *supra* note 24, at 47.
46. *See id.*
47. *Id.*
48. *See* D.A. Goolsby & W.A. Battaglin, *Effects of Episodic Events on the Transport of Nutrients to the Gulf of Mexico* (visited May 28, 1999) <http://www.gmpo.gov/nutrient/front.html> (presentation at the First Gulf of Mexico Hypoxia Management Conference, Kenner, La., Dec. 5-6, 1995).
49. *See* GORE, *supra* note 3, at 280-82.
50. Goolsby & Battaglin, *supra* note 48, at 1.
51. *See generally*, Milliman & Meade, *supra* note 6 (discussing over twenty-five years of data concerning annual sediment discharges from rivers to oceans).

The impacts of the expanding Gulf of Mexico hypoxia, either currently documented or potential include: (1) altered coastal phytoplankton based food webs, (2) noxious algal blooms, (3) altered benthic ecosystems, (4) reduced economic productivity in both commercial and recreational fisheries, and (5) both direct and indirect impacts on fisheries, such as direct mortality and altered migration which may lead to declines in populations and landings.[52]

The hypoxia problem is complicated by the fact that some nutrient load from the Mississippi River is necessary to maintain the productivity of the Gulf fisheries. Approximately forty percent of the United States fish landings, including a substantial part of the nation's most valuable fishery for shrimp, come from this productive area.[53] The area also supports a large and valuable sport fishing industry.[54] However, it has been shown that both brown shrimp and white shrimp, avoid hypoxic waters.[55] As juvenile brown and white shrimp emerge from coastal wetlands during the summer months, their offshore migration is halted as they encounter, and then avoid, the hypoxic zone with one of the following results: (1) they are subjected to physiological stress, which weakens them and thus leaves them vulnerable to predators, or (2) they are "herded" into unusually dense schools along the edge of the hypoxic zone, at which point they are subjected to more intense intra-species competition for food, increased vulnerability to predators, and potential over fishing by fishermen.[56] To date, the fishing industry in the Gulf of Mexico has not been significantly affected economically, but, because of the hypoxia condition and potential for over fishing, it could collapse in the future.

III. THE POLICY: HISTORY OF THE GULF OF MEXICO PROGRAM

A. Program Description

The Gulf of Mexico contains ecological and commercial resources matched by few other bodies of water. Yet its blue-green waters mask the increasing environmental threats that endanger these resources. In recognition of the tremendous ecological and economic value of the Gulf's resources, and in response to citizen concerns over

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52. *See* Hanifen et al., *supra* note 8, at 1-2, 5-7.
53. *See* GORE, *supra* note 3, at 248.
54. *See id.*
55. *See* Maurice L. Renaud, *Hypoxia in Louisiana Coastal Waters During 1983: Implications for Fisheries*, 84 FISHERY BULLETIN 19, 24 (1986).
56. *See* Hanifen et al., *supra* note 8, at 4-5.

the declining environmental quality of many coastal resources, the United States Environmental Protection Agency (EPA) started the Gulf of Mexico Program (GMP) in 1988 as an intergovernmental, community-based program.[57] From its inception, the GMP was envisioned as a multi-stakeholder endeavor to improve coordination among federal and Gulf State[58] agencies and to directly involve nongovernment organizations in the development and implementation of actions to address key environmental problems confronting the Gulf.[59] The GMP is not a regulatory program. Rather, through the partnership, it works to identify and implement innovative and incentive-based approaches that support Gulf State and coastal community efforts to improve the quality of life for their citizens and their environment.[60]

The goal of the GMP is to protect, restore, and enhance the coastal and marine waters of the Gulf of Mexico and its coastal natural habitats, to sustain living resources, to protect human health and the food supply, and to ensure the recreational use of Gulf shores, beaches, and waters in ways consistent with the economic well being of the region.[61]

B. Participants and Funding

The GMP office, located at the Stennis Space Center in Mississippi, is underwritten by the EPA through its investment of staff and funds from EPA headquarters and regional offices in Atlanta and Dallas. Activities of the GMP are overseen by a Policy Review Board and a Management Committee that includes Governor-appointed Gulf State agencies, representatives from the Federal agencies responsible for natural resource management and environmental protection[62] and representatives from nongovernment organizations, including business and industry, the Gulf State's Farm Bureaus, and the environmental community.

Congressional appropriations for the GMP peaked in fiscal years (FY) 1993, 1994, and 1995. Extramural resources during those years were just over $4 million. Since FY 1995, reductions in the GMP

57. *See* NUTRIENT ENRICHMENT ACTION AGENDA, *supra* note 35, at i.
58. The Gulf States are Alabama, Florida, Louisiana, Mississippi, and Texas.
59. *See* NUTRIENT ENRICHMENT ACTION AGENDA, *supra* note 35, at i.
60. *See id.*
61. *See id.*
62. These agencies include the EPA, Department of Interior, Department of Defense, National Oceanic and Atmospheric Administration, Department of Health and Human Services, Department of Agriculture, and Department of Transportation.

budget have either been directed by Congress or by the Administration. In FY 1999, the extramural budget is $2.2 million. The GMP office has 13.8 full time employees.

C. Key Environmental and Management Issues

The principal issues currently being addressed by the GMP partnership fall under four broad categories: public health, excessive nutrient enrichment, habitat loss, and the introduction of nonindigenous or exotic species.[63] The Gulf States have identified 792 impaired water segments in coastal watersheds and estuaries due to microbial contamination, nutrient enrichment or dissolved oxygen loss, and/or habitat loss.[64] To address nutrient enrichment and hypoxia, the GMP Program has studied the northern Gulf of Mexico oxygen problem for several years through the efforts of the Nutrient Enrichment Issue Committee.[65] The Nutrient Enrichment Issue Committee was originally charged with characterizing nutrient enrichment problems and identifying ways to reduce eutrophication in the Gulf of Mexico through focus on protecting the tidal, estuarine, and near shore waters of the Gulf of Mexico.[66] They developed the following long-term goal for addressing nutrient enrichment in the Gulf of Mexico: "Protect the waters of the Gulf of Mexico from the deleterious effects of nutrient enrichment, from all contributing sources, and thereby enhance biodiversity, and aesthetic, recreational and economic benefits."[67]

The Nutrient Enrichment Focus Team is assisting national efforts to look into all aspects of the hypoxia problem, including other sources of nutrient loads, such as atmospheric deposition and coastal upwelling that are not related to drainage from the watershed.[68] The GMP and the Nutrient Enrichment Issue Committee will work in conjunction with states to evaluate what reductions in nutrient loadings will be needed, if appropriate, to reduce the zone of hypoxia, as well as looking more closely at the linkage between hypoxia and Gulf fisheries.[69]

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63. *See* Giattina, *supra* note 20.

64. *See* U.S. EPA, NO. EPA-841-R-97-008, NATIONAL WATER QUALITY INVENTORY: 1996 REPORT TO CONGRESS (1998).

65. In 1998, the Nutrient Enrichment Issue committee was renamed the Nutrient Enrichment Focus Team.

66. *See* NUTRIENT ENRICHMENT ACTION AGENDA, *supra* note 35, at ii.

67. *Id.* at 11.

68. *See* Nutrient Enrichment Focus Team, *FY 1999 Operational Performance Plan* (visited June 2, 1999) <http://www.gmpo.gov/nutrient/nesp.html>.

69. *See id.*

IV. RECOGNITION AS A NATIONAL ISSUE

As concern for the Gulf hypoxic zone has grown over the past several years, the issue has attained recognition within the Mississippi River Basin and nationally. Border states of the upper and lower Mississippi River watersheds, other states and tribes within the watershed, and the Gulf States, along with the Gulf of Mexico Program are working in conjunction with national efforts led by a consortium of federal agencies to address the hypoxia problem.[70]

A. *Sierra Club Petition*

On January 24, 1995, the Sierra Club Legal Defense Fund (currently Earthjustice Legal Defense Fund) petitioned officials of the State of Louisiana and the Administrator of the EPA to convene a management conference under section 319(g) of the Clean Water Act (CWA).[71] Section 319(g)(1) states in part that:

> If any portion of the navigable waters in any State which is implementing a management program approved under this section is not meeting applicable water quality standards . . . in whole or in part, of pollution from nonpoint sources in another State, such state may petition the Administrator to convene, . . . a management conference of all States which contribute significant pollution resulting from nonpoint sources to such portion.[72]

The purpose of the conference would be to address the serious threat to the resources and people of the central Gulf of Mexico resulting from nonpoint nutrient pollution in the Mississippi River.[73] The petition requested that the EPA and the states commit to and develop a long-term, and enforceable strategy to eliminate the hypoxic area.[74]

The EPA's response to this petition was, rather than convene a 319(g) management conference, to instruct the GMP to "develop viable solutions through a strategic assessment process, which will assess the existing data and identify and prioritize the areas of greatest need."[75] The Secretary of the Louisiana Department of Environ-

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70. *See* Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, *Draft Charter for MR/GM Watershed Nutrient Task Force—5/98* (visited May 28, 1999) <http://www.epa.gov/surf/surf98/mississippi/charter.html>.

71. *See* Letter from Robert Wiygul et al., Sierra Club Legal Defense Fund, to Carol Browner, U.S. EPA Administrator 1 (Jan. 24, 1995) (Ref. 08-886) (on file with author) [hereinafter Letter from Robert Wiygul].

72. 33 U.S.C. § 1329(g)(1) (1997).

73. *See* Letter from Robert Wiygul, *supra* note 71, at 1.

74. *See id.*

75. Letter from Robert Perciasepe, Assistant Administrator, Office of Water, U.S. EPA, to Robert Wiygul, Sierra Club Legal Defense Fund 2 (Feb. 10, 1995) (on file with author).

mental Quality also decided not to petition for the interstate conference, but rather to work with the GMP to: (1) assist Louisiana in working with the upstream states to take action and (2) coordinate national programs which specifically address nonpoint sources of nutrients in the Mississippi River.[76]

The GMP assisted the State of Louisiana in conducting a meeting in October 1995 with the fourteen member States of the Environmental Council of states that border the Mississippi and Ohio Rivers.[77] Representatives from these States were briefed on the problem and the need for their assistance in reducing nitrogen loadings.[78] The GMP also organized a conference in December, 1995, to present information on the effects of hypoxia, data to link nutrient loadings in the Mississippi and Atchafalaya Rivers as a causative agent, and current watershed management activities underway in the basin.[79]

B. Federal Interactions

Following the December 1995 Kenner Conference, Robert Perciasepe, EPA Assistant Administrator for Water, convened an interagency group of senior administration officials (Principals Group) to discuss potential policy actions and related science needs.[80] Key agencies included the EPA, the United States Department of Agriculture (USDA), the National Oceanic and Atmospheric Administration (NOAA), the Army Corps of Engineers (the Corps), the Department of Justice (DOJ), and the Department of Interior (DOI), as well as the Food and Drug Administration (FDA) and the White House Office of Science and Technology Policy (OSTP).[81] This group formulated the following problem statement:

> A greatly enlarged region of hypoxia in the Gulf of Mexico, resulting primarily from the outflow plume of the Mississippi River, threatens the ecological integrity, sustained use and economic productivity of the affected waters. This enlarged area is associated with excess nutrient loading from the Mississippi River. Ecosystem and human health may also be threatened by other less-understood effects, such as increased blooms of

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76. *See* Letter from William Kucharski, Secretary, State of Louisiana, Dep't of Envtl. Quality, to Robert Wiygul, Sierra Club Legal Defense Fund 1 (Mar. 6, 1995) (on file with author).

77. *See* DEPARTMENT OF ENVTL. QUALITY, STATE OF LOUISIANA, LOUISIANA'S ROLE IN THE HYPOXIA ISSUE 1 (1996) (on file with author).

78. *See id.*

79. *See* FIRST HYPOXIA CONFERENCE, *supra* note 8.

80. *See* U.S. EPA et al., Interagency Meeting on Hypoxia in the Gulf of Mexico (Aug. 1, 1996, Washington, D.C.) (unpublished proceedings on file with author).

81. *See id.*

> toxic phytoplankton and increased nonpoint sources of enteric pathogens associated with the source of such nutrients.[82]

In addition, this group supported the need for developing a watershed-wide strategy for nutrient management and control, and for a long-term research and monitoring effort for hypoxia. As a first step, the federal agencies identified and categorized their current programs which were relevant to addressing hypoxia and nutrient management activities in general.[83] As a second step, the Principals Group recognized the need for state, tribal and public involvement in developing any strategy.

In late 1996, the Principals Group recommended that an assessment of the existing scientific knowledge and understanding of hypoxia be conducted. The EPA, as the lead agency, requested that the White House OSTP conduct this assessment through its National Science and Technology Committee's Committee on Environment and Natural Resources (CENR).[84] NOAA leads this effort which includes teams of academic, federal, and state scientists from within and outside the Mississippi River watershed.[85] The assessment of the causes and consequences of Gulf hypoxia is intended to provide scientific information that can be used to evaluate nutrient management strategies, and to identify gaps in our understanding of this problem.[86] This Hypoxia Assessment Group developed a process for the assessment which includes peer review and general comment periods.[87] Five federal agencies have provided the resources and funding for the assessment which totals about $1.1 million.[88] The CENR Assessment has been peer reviewed and will be made available for public comment in the Spring of 1999. The final assessment report will be delivered to the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (the Task Force) to assist them in

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82. Interagency Interim Working Group on Hypoxia, Recommendations to Alleviate Hypoxia in the Gulf of Mexico (June 17, 1997) (presentation to the Principals of the Hypoxia Interagency Group) (quoted excerpts on file with author).

83. *See* U.S. EPA ET AL., INTERAGENCY HYPOXIA RESPONSE ACTIVITY REPORT 3 (1997) (on file with author) [hereinafter INTERAGENCY HYPOXIA RESPONSE ACTIVITY REPORT].

84. *See* Letter from Robert Perciasepe, Assistant Administrator, Office of Water, U.S. EPA, to Dr. Rosina Bierbaum, Acting Associate Director for Environment, Office of Science and Technology Policy 1 (Sept. 10, 1996) (on file with author).

85. *See* Committee on Env't and Natural Resources Hypoxia Work Group, White House Office of Science and Technology Policy, *Gulf of Mexico Hypoxia Assessment Plan: March 1998* (visited May 28, 1999) <http://www.cop.noaa.gov/HypoxiaPlan.html>.

86. *See id.*

87. *See id.*

88. *See* Gulf of Mexico Program, U.S. EPA, Agency Contributions to Funding the CENR Effort (Nov. 28, 1997) (unpublished report on file with author).

developing policy recommendations and an action plan for addressing hypoxia in the northern Gulf of Mexico.

C. State and Tribe Involvement

In December 1997, the Principals Group expanded to include senior state and tribal officials.[89] The agencies agreed to organize themselves as the Task Force and to combine their expertise, authorities, and programs to better characterize hypoxia and coordinate implementation of their programs to address its likely causes.[90] The agencies further agreed to invite a cross-section of counterpart state agencies and tribes from throughout the Mississippi River Basin to actively participate on the Task Force.[91] The combined Task Force has met three times since December 1997 and will meet again on June 30 and July 1, 1999, in Memphis, Tennessee.[92]

In particular, the GMP has an important role to play in supporting the Task Force in its efforts to reduce the negative consequences of Gulf hypoxia. The GMP will continue to focus on facilitating efforts to understand the ecological and economic consequences of the hypoxic zone, facilitating efforts to monitor and model nutrient loading and changes to the hypoxic zone, and assisting Mississippi and Louisiana in quantifying and reducing nutrient loads from high priority tributaries that contribute to Gulf hypoxia.[93]

D. New Legislation

While the Task Force began drafting an implementation strategy and the CENR hypoxia group was preparing its science assessment reports, Congress enacted the Harmful Algal Bloom and Hypoxia Research and Control Act of 1998 (HABHRCA) on November 13, 1998.[94] This Act requires that the President submit to Congress by March 30, 2000, a plan for controlling hypoxia in the northern Gulf of Mexico.[95] Also, the plan must be published in the Federal Register at

89. *See generally* Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, *Meeting Summary of the First Meeting of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force* (visited May 28, 1999) <http://www.epa.gov/msbasin/tfmtgsum.html> (discussing the events of the December 4, 1997, meeting in Arlington, Virginia).

90. *See id.*

91. *See id.*

92. *See* Mississippi River Basin Organizations, U.S. EPA, *Mississippi River/Gulf of Mexico Watershed Nutrient Task Force: Meetings* (visited May 28, 1999) <http://www.epa.gov/msbasin/organ.html>.

93. *See* INTERAGENCY HYPOXIA RESPONSE ACTIVITY REPORT, *supra* note 83, at 13.

94. Pub. L. No. 105-383, § 601, 112 Stat. 3411, 3447 (1998).

95. *See id.* § 604, 112 Stat. at 3449.

least ninety days prior to that date, with at least a sixty-day comment period, and be done in conjunction with the chief executive officers of the states.[96] The existing Task Force was asked by the White House OSTP to be responsible for developing the plan and also to provide recommendations for addressing hypoxia nationally.[97]

V. CHALLENGES FACING SCIENTISTS AND POLICY MAKERS

In developing the HABHRCA Gulf of Mexico action plan and implementation efforts, numerous challenges exist. The size and complexity, both of the Mississippi River Basin and the hypoxic zone in the Gulf of Mexico, is a major endeavor. For implementation, existing environmental laws and programs will play a significant role, but even without the hypoxia issue, full implementation of these laws and programs is challenging. In a watershed the size of the Mississippi River's, the number of state and tribal governments which need to coordinate with each other parallels any nationally implemented program or new initiative. Another challenge which is often ignored, even though it is important from both a science and policy perspective, is measuring any progress or change in the hypoxia zone. In other words: is what we are doing affecting the size or duration of the hypoxia zone?

A. Size and Complexity

Impacts on living resources caused by the eutrophication of surface waters are seen at many different scales of geographic resolution, for example: small lakes with sources of pollution largely confined to a single watershed; interstate waters that may require coordination among two or more states; coastal systems, such as Long Island Sound or Chesapeake Bay, with not only local sources but also air and water sources of pollution far removed from the point of impact; and as already noted, the Gulf of Mexico whose watershed encompasses over forty percent of the conterminous United States.[98]

The size and complexity of both the Gulf hypoxic zone (as large as 6,000 square miles)[99] and the Mississippi River Basin (thirty-one states and covering 1.25 million square miles)[100] pose challenges to both scientists and policy makers. For example, consider reducing the

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96. *See id.*
97. *See id.* § 603, 112 Stat. at 3448-49.
98. *See* GORE, *supra* note 3, at 281.
99. *See supra* note 26 and accompanying text.
100. *See* Lew, *supra* note 14, at 3.

amount of nutrients discharged into the Gulf. For this, a key concern is the level and duration of the necessary reduction in excess nutrients from watersheds. Many agricultural lands have been saturated with nutrients for numerous years, and it may take a long time to cycle out excess nitrogen and phosphorous, even if application rates are reduced. This problem may have no fast solutions and any management regime considered will need to recognize that progress or improvement may not be apparent for years or even decades. However, some suggest that improved agricultural practices in terms of efficient application of chemical fertilizers and prevention of soil erosion could yield immediate and measurable benefits.[101]

Due to the size of the Mississippi River Basin, a comprehensive strategy is necessary to coordinate federal, state and local governments as they work with private interests to address those impacts involving actions by a variety of sources over a broad geographic area. Problems of eutrophication of surface waters at the sub-Basin level are largely attributable to phosphorus runoff that involves sources predominantly within a limited area and may be solved at the local level.[102] However, because nitrogen is not the limiting factor in fresh, surface water systems, concerted efforts must be undertaken locally to reduce nitrogen output from smaller watersheds into the Gulf via the Mississippi River. "In addition, local efforts to alleviate nitrogen contamination of groundwater supplies will also contribute to reductions in the total load of nitrogen to the Mississippi River and Gulf of Mexico."[103]

Gulf hypoxia is a symptom of broad physical, ecological, economic and social changes throughout the Mississippi River Basin from Minnesota to Mississippi and from Wyoming to North Carolina. It is therefore difficult to "connect" sociologically and emotionally with constituencies located far from the Gulf. Once people understand what hypoxia is, they are willing to acknowledge that the problem exists, but may not understand how it relates to them. In other words: Does what they do on their land or in their factory really affect the Gulf? Politically, the reality is that people care most about the issues that affect them at home or in their backyards.[104] This has proven to be the case in other areas where major environmental water quality issues are being addressed. Both the Chesapeake Bay Program and the Great Lakes Program have faced challenges in

101. *See* Rabalais et al., *supra* note 7, at 401.
102. *See* Tervelt & Giattina, *supra* note 29, at 45.
103. *Id.*
104. *See id.*

coordinating efforts within their basins which include fewer States than those involved in the Mississippi River Basin. A possible solution to the size and complexity could include short and long-term educational efforts throughout the Mississippi River Basin, focusing on the local water quality improvements. Goals for reducing nutrient loadings in the River and reductions in the hypoxia zone in the Gulf must be founded on a long-term, scientifically valid and coordinated, research and monitoring program.

B. Implementation Activities

Many federal agencies are mandated by legislative statutes to address eutrophication.[105] However, implementation of these laws as they relate to Gulf hypoxia is another challenge facing decision makers. The statutes which can be used to aid implementation activities to address the hypoxia issue include the Clean Water Act,[106] the Coastal Zone Management Act,[107] the Safe Drinking Water Act,[108] the Federal Agricultural Improvement and Reform Act of 1996,[109] the Clean Air Act,[110] the Magnuson-Stevens Fisheries Conservation and Management Act,[111] and the Endangered Species Act.[112]

One of the difficulties of undertaking ecosystem management and addressing a rather specific problem, such as nutrient pollution in the Gulf of Mexico, is that the statutory basis for action is a complex array of policy approaches. These policies are based on a long history of relationships among Congress, the executive federal agencies, the state agencies, and their respective constituencies. Blending the action of the agencies will be a challenge because of this history.

One example of this is the concern expressed by the agricultural community regarding the possible future regulation of nitrogen fertilizers. Farm policy in the environmental and conservation areas is distributive. Consequently, the government subsidizes private activities that are beneficial to society but that would not usually be

105. *See generally* INTERAGENCY HYPOXIC RESPONSE ACTIVITY REPORT, *supra* note 83 (comprising a compilation of existing Federal programs which could be or are being used to aid in alleviating hypoxia in the Gulf of Mexico).

106. 33 U.S.C. §§ 1251-1387 (1997).

107. 16 U.S.C. §§ 1451-1465 (1997).

108. 42 U.S.C. §§ 300(f)-300j-26 (1997).

109. 7 U.S.C. §§ 1932-2206(a) (1997).

110. 42 U.S.C. §§ 7401-7671q.

111. 16 U.S.C. §§ 1801-1883.

112. *Id.* §§ 1531-1544.

undertaken by the private sector.[113] Contrast this with the protective regulatory policy employed for many point sources, wherein the government protects the public by regulating private activities.[114] The variety of sources, both point and nonpoint, that must be considered to address Gulf hypoxia will require a conscious blending of these differing policy approaches and the formation of new institutional relationships such as the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force.

1. Clean Water Act

Because *nonpoint sources* are believed to be major contributors of nutrient loadings to the Mississippi River system, the Clean Water Act is arguably the most appropriate legal framework for addressing future nutrient inputs. Under section 319 of the Clean Water Act, states are required to assess water quality impacts caused by nonpoint source pollution and to develop management programs for nonpoint source control.[115] The EPA has the authority to approve the state management programs and provides grants to support program implementation.[116] For states in the Mississippi River Basin, funding is about $65 million per fiscal year.[117] NOAA and the EPA are responsible for approving Coastal Nonpoint Pollution Control Programs under section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA).[118] Louisiana and other states in the Mississippi River Basin have initiated nonpoint source control programs that seek to combine local, state, and federal agency resources to address pollution from nonpoint sources within each state.[119] To effectively address concerns, however, nonpoint-source programs would need to be encouraged, funded and implemented throughout the Mississippi River watershed. In addition, agricultural research and educational outreach and assistance to farmers might complement regulatory efforts.

Point sources account for about seventeen percent of the nitrogen loadings delivered to the Gulf.[120] Although often less of a contributor

113. *See* SUSAN J. BUCK, UNDERSTANDING ENVIRONMENTAL ADMINISTRATION AND LAW 29 (1996).

114. *See id.* at 30-31.

115. *See* Clean Water Act § 319(a)-(b), 33 U.S.C. § 1329(a)-(b) (1997).

116. *See id.* § 319(a)-(h), 33 U.S.C. § 1329(a)-(h).

117. *See* INTERAGENCY HYPOXIC RESPONSE ACTIVITY REPORT, *supra* note 83, at 4.

118. *See* 16 U.S.C. § 1455(b) (1997).

119. *See* INTERAGENCY HYPOXIC RESPONSE ACTIVITY REPORT, *supra* note 83, at 4.

120. *See* Don Goolsby, Address at the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (Sept. 24, 1998) (transcript on file with author).

than nonpoint sources, the Clean Water Act provides the legal framework for addressing point sources. The National Pollutant Discharge Elimination System (NPDES) permit program authorizes states (if they are delegated by the EPA to do so), or the EPA to review and enforce regulations for point source dischargers.[121] Municipal sewage treatment facilities, which are one source of nutrient discharges, treat domestic and pretreated industrial wastewaters prior to discharge.[122] For the states within the Mississippi River Basin and the Gulf of Mexico coastal area, there are about 12,400 sewage treatment plants with secondary treatment capabilities.[123] With secondary treatment, municipalities can reduce nitrogen loadings by an average of thirty percent.[124] To achieve greater reductions, costly nitrification and denitrification processes would be needed. However, these processes might be considered for use in areas with significant local nutrient water quality issues. Discharges from industrial facilities, such as fertilizer manufacturers, are also considered point sources.[125] In states located in the Mississippi River Basin, there are about 3,900 industrial permits for primarily major sources which control the discharge of nutrients.[126] Certain feedlot operations are also considered point sources and are covered by NPDES permits.[127] In the Mississippi River Basin and Gulf of Mexico states there are about 3,200 feedlot operations subject to permitting.[128] This number is likely to change as a result of the Confined Animal Feedlot Operations (CAFOs) strategy which recommends targeting additional animal feeding operations that significantly impact water quality.[129]

One section of the Clean Water Act addresses both point and nonpoint sources. Section 303 of the Clean Water Act requires that states identify water-quality-limited segments of their waters which are not meeting standards, and then establish Total Maximum Daily Loads (TMDLs) for each listed water and each pollutant (e.g., nitrogen and phosphorus) which is not meeting current water quality standards.[130] The mission of this TMDL Program is to "protect public health and secure the health of impaired aquatic ecosystems by

121. *See* Clean Water Act § 402, 33 U.S.C. § 1342 (1997).
122. *See id.* § 402(p), 33 U.S.C. § 1342(p).
123. *See* INTERAGENCY HYPOXIC RESPONSE ACTIVITY REPORT, *supra* note 83, at 6.
124. *See id.*
125. *See* Clean Water Act § 402(p)(3)(A), 33 U.S.C. § 1342(p)(3)(A).
126. *See* INTERAGENCY HYPOXIC RESPONSE ACTIVITY REPORT, *supra* note 83, at 7.
127. *See* Clean Water Act § 502(14), 33 U.S.C. § 1362(14).
128. *See* INTERAGENCY HYPOXIC RESPONSE ACTIVITY REPORT, *supra* note 83, at 7.
129. *See id.*
130. *See* Clean Water Act § 303(d)(1), 33 U.S.C. § 1343(d)(i).

ensuring attainment of water quality standards, including beneficial uses."[131] The TMDL developed by the states and tribes, or the EPA when not done by the states or tribes, prescribes the allowable loadings of pollutants (nutrients for the hypoxia issue) from significant sources (both point and nonpoint) which will maintain water quality standards.[132]

2. The TMDL Program

The TMDL Program can aid in implementation efforts to address hypoxia in the Gulf. However, this Program alone faces scientific, political, legal, and policy challenges. Many of these TMDL Program challenges were addressed recently in the Report of the Federal Advisory Committee on the Total Maximum Daily Load Program.[133] Several are of particular relevance to the hypoxia issue implementation efforts, especially for developing TMDLs, and in the areas of coordination of technical support, and capacity-building. When developing TMDLs in the Mississippi River Basin, scientists and policy makers will need to consider geographic scope, address nonpoint sources, and address difficult areas of concern such as air deposition and tile drainage. Some water quality problems (e.g. hypoxia in the Gulf of Mexico) are characterized by the need to consider large geographic areas (e.g. Mississippi River Basin) in terms of both the size of the area in which the problems exist and the geographic range of the sources of the problem. To address this challenge, the Federal Advisory Committee on the TMDL Program (the Committee) emphasized the importance of fully identifying the geographic range where the problem exists, having adequate monitoring and assessment done to develop TMDLs, and considering the idea of "nesting," where appropriate.[134] "Nesting" of monitoring, public participation, and implementation activities must be conducted at the appropriate geographic scale.[135] When addressing jurisdictional coordination for shared pollution problems, the Committee recommends that some mechanism must be used so that "all

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131. NATIONAL ADVISORY COUNCIL FOR ENVTL. POL'Y & TECH., OFFICE OF THE ADMR., U.S. EPA, EPA 100-R98-006, REPORT OF THE FEDERAL ADVISORY COMM. ON THE TOTAL MAXIMUM DAILY LOAD (TMDL) PROGRAM at i (1998) [hereinafter REPORT OF THE FEDERAL ADVISORY COMM.].

132. *See id.* at 3-4.

133. *See id.* at i-iv.

134. *See id.* at 27-30.

135. *See id.* at 30.

responsible decision-makers participate in the TMDLs development process."[136]

To address nonpoint sources, including those contributing to the pollutant parameters listed as the largest causes (nutrients, sediments and pathogens), the Committee recommends that "the combination of best management practices and any requirements of State and Federal law for nonpoint sources, along with existing and new controls adopted by point sources (where appropriate), are to be sufficient to meet water quality standards."[137] They also recommend that the EPA, in its review and approval process for TMDLs, assure that the TMDL is designed to result in attainment of water quality standards.[138] Furthermore, the states are responsible for determining what nonpoint source best management practices and measures are to be included in the implementation plan and which of these practices and measures are to be regulatory, nonregulatory, incentive-based and/or voluntary.[139] One challenge in addressing the hypoxia issue is the lack of nutrient criteria for developing water quality standards for the TMDL process.

In coordinating the development and evaluation of TMDLs, the Committee recommended that the state environmental management agencies coordinate the TMDL activities for any shared pollution problems across jurisdictions, but that the EPA would also have a role in multi-jurisdictional cases when asked by the states or when there is a need for making better progress.[140] The Committee also recognized the gaps in technical guidance and support and the need for additional efforts by the EPA to fill these voids.[141] In the area of addressing capacity problems, the Committee recognized the need for other federal agencies to contribute more resources to the TMDL-related activities and encouraged states and stakeholders to participate and seek additional funds for effectively implementing the TMDL program.[142] In the case of tribal capacity, the Committee recommended that the EPA increase its efforts to strengthen tribal capacity and also provide financial assistance to the tribes to support TMDLs.[143] One final key recommendation made by the Committee dealt with commitment: "The Committee recommends that EPA lead a national dialogue

136. *Id.*
137. *Id.* at 42.
138. *See id.* at 33.
139. *See* Clean Water Act § 319(a)(1)(C), 33 U.S.C. § 1329(a)(i)(C) (1997).
140. *See* REPORT OF THE FEDERAL ADVISORY COMM., *supra* note 131, at 68.
141. *See id.* at 70-72.
142. *See id.* at 56, 64-65.
143. *See id.* at 62-63.

involving high level policymakers in State and federal government, as well as local governments and other stakeholder groups, to promote political and fiscal commitment to attaining water quality standards and restoring impaired waters."[144] The same dialogue will need to occur throughout the Mississippi River Basin to address implementation efforts for hypoxia in the Gulf.

3. New Initiatives

New initiatives and the efforts of the Task Force should aid in implementation activities. In particular, the Clean Water Action Plan (CWAP) places new emphasis on all the water quality statutes and programs discussed.[145] Most of these programs apply nationwide and are expected to have significant benefits in water quality throughout the watershed, as well as in the Gulf. The CWAP contains key actions which relate to the hypoxia issue. It identifies nutrient over-enrichment as a problem nationwide and a key action is for the EPA to establish numeric criteria for nutrients (nitrogen and phosphorus) by the year 2000.[146] In addition, monitoring needs for nutrients of both point and nonpoint sources need improvement and several key action items address monitoring and assessment.[147] As for implementation activities, the Task Force will be working to improve the effectiveness of actions and coordinate them with the Clean Water Action Plan activities.[148] They will also work to reduce uncertainties about the causes and effects of hypoxia in the Gulf of Mexico, as well as to reduce significant loadings of nutrients from all sources. These implementation efforts will aid in confronting the many challenges faced by both scientists and policy makers to address this national issue.

C. Measuring Progress

The HABHRCA implementation plan and any activities proposed will need to produce observable environmental improvements to the quality of waters in the Mississippi River Basin and the Gulf of Mexico. These measures or indicators of success or progress will need to be identified and tracked by the agencies and stakeholders involved. NOAA and the United States Geological

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144. *Id.* at 74.

145. *See* U.S. EPA, EPA 840-R-98-001, CLEAN WATER ACTION PLAN: RESTORING AND PROTECTING AMERICA'S WATERS 54-68 (1998) [hereinafter CLEAN WATER ACTION PLAN].

146. *See id.* at 58-59.

147. *See id.* at 66-68.

148. *See id.* 67-68.

Survey (USGS) have a major role in monitoring water quality conditions within the Mississippi River Basin and the Gulf of Mexico, in addition to developing models to better evaluate water quality trends and quantifying sources and loads of nutrients.[149] The indicators selected need to reflect a range of both environmental (changes measured in the resource, e.g., reductions in the size of the Gulf hypoxia zone) and programmatic ("bean counting," e.g., the number of TMDL water segments listed because of nutrient impairment) results. The efforts of the Task Force in developing and tracking the indicators will need to be coordinated with CWAP key action activities. One of the key actions important to this effort is that "in 1999, EPA in collaboration with other federal agencies and states, will initiate a tracking system to report key indicators of the success of programs to reduce nutrient runoff to waters."[150]

VI. CONCLUSIONS

Although the challenges discussed in this Article appear to be overwhelming, there are three courses of action which can lead to the protection of the Mississippi River and the Gulf of Mexico. These courses of action are: (1) sort and identify the science, legal, and policy issues of relevance to Gulf hypoxia, (2) accept and address the commitment and responsibilities needed for reducing Gulf hypoxia, and (3) promote a "building block" or "nesting" approach for implementation actions.

When sorting and identifying the science issues relevant to Gulf hypoxia, there needs to be an understanding by all parties that science is about seeking knowledge and will never provide 100% of the answers. Recognizing that there will always be gray areas in the scientific information available, the challenge is to determine how to cope with these uncertainties and work cooperatively to make positive progress. There needs to be recognition that the hypoxic zone is a concern because of its size, and attempts need to be made to reduce its size and intensity, but it is not necessary to eliminate it entirely. One example where this approach is working, albeit slowly, is in the TMDL program. The technical issues can be identified, but they are challenging and complex (e.g., for addressing nutrient loads there is variability in the conditions, the soils, transport mechanisms, temperature differences, and other uncertainties). However, once all

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149. *See id.*
150. *Id.* at 68.

the technical issues are identified, stakeholders from all sectors will have a more cooperative approach to work toward specific solutions.

The legal and policy issues related to Gulf hypoxia are difficult to address. The existing laws and the regulatory environment create a more brightline-oriented decision making structure. The laws, along with politics and hidden agendas, can create adversarial relationships among the stakeholders. When addressing the hypoxia problem, which includes thirty-one states, numerous tribes, federal agencies, the fishing, agricultural and regulated communities, and numerous citizens, adversarial relationships are intensified. Within the Mississippi River Basin, the complexities across jurisdictions are enormous. One solution would be to focus on specific technical solutions which can be used in the Gulf State areas and throughout the Mississippi River Basin to draw stakeholders with similar solutions together.[151] The major challenge in this approach would be agreeing on common technical goals for the Mississippi Basin and the Gulf of Mexico, and setting goals locally that would improve overall water quality.

Another course of action for stakeholders throughout the Mississippi River Basin and the Gulf of Mexico to accept and address is the commitment and responsibility needed to reduce Gulf hypoxia. If all stakeholders could agree that a problem exists, accept responsibility, and commit sufficient time and resources, there would be no need for new regulatory mechanisms. Citizens and other parties could address their backyard local issues and problems concerning nitrogen and phosphorus with the understanding that it would aid in alleviating problems in the Mississippi River Basin and the Gulf. Key players would include federal agencies (in particular, EPA, USDA, the Army Corps of Engineers, USGS, and NOAA), and local, state, and tribal governments that would need to work across political jurisdictions to make this approach work. Other key players would include intergovernmental organizations such as the Gulf of Mexico Program, and sub-basin associations such as the Mississippi River Basin Alliance, along with environmental organizations. It would be necessary for all parties to recognize that it will take time to overcome political barriers.

Also, there is a need to recognize that, while requests for some additional resources are needed and should be honored, some

151. Nitrates are a problem in drinking water supplies in several areas throughout the Basin which, when addressed, will reduce the final nitrogen loadings transported to the Gulf of Mexico. *See* CLEAN WATER ACTION PLAN, *supra* note 145, at 28-29.

distribution of existing resources to address the nutrient loadings transported to the Gulf of Mexico both in the Mississippi River Basin and along the Gulf coast would be necessary. The Gulf of Mexico Program is doing a good job with existing focus teams and has accepted some responsibility. More time is needed, however, to evaluate their effectiveness. The existing Task Force is in its infancy and is attempting to address recent legislative and political changes within the states. The latest legislative requirements push the group to take action. However, the timeframe for taking action is short, and therefore creates some drawbacks. All interested parties should recognize that similar nutrient enrichment problems (e.g. the Chesapeake Bay and Long Island Sound) have taken years to address and still remain unresolved.

Finally, parties must implement and evaluate activities designed to reduce nutrient loading. As mentioned in the TMDL Federal Advisory Committee Report, the "nesting" approach is recommended for grouping similar geographic or technical strategies.[152] Complex Gulf hypoxia issues, can be addressed by "nesting" actions on a local and a sub-basin scale. The EPA is currently attempting to use this approach to address any water quality problems in the Mississippi River Basin and has formed a multi-regional team.[153] The Mississippi River Basin includes six sub-basins (using USGS's hydrologic units) along with the Gulf of Mexico.[154] This team was formed in 1997 and is supported by the EPA Regional Administrators in Regions 3 through 8, the Gulf of Mexico Program Office, and the headquarters Office of Water.[155] This approach can be used by the Task Force and the Gulf of Mexico Program for securing commitment and coordinating implementation activities to address Gulf hypoxia.

Whatever steps are taken to address Gulf hypoxia now will probably not yield results for five to ten years. Keep in mind John Barry's metaphor, likening the Mississippi River to the artery of the American heartland. Just as our early dietary habits later affect the condition of our arteries and heart, years of "clogging" the Mississippi River system with an overabundance of nutrients has affected its heart, the Gulf of Mexico. Once there is acceptance of Gulf hypoxia as an environmental problem, the healing process can begin.

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152. *See* REPORT OF THE FEDERAL ADVISORY COMM., *supra* note 131, at 30.

153. *See* U.S. EPA, St. Louis Compact: EPA Supports a Systems-Approach to the Mississippi River 2 (1998) (unpublished paper) (on file with author).

154. *See id.*

155. *See id.*