NUTRIENT POLLUTION IN NORTH CAROLINA'S WATERS: THE INNOVATION OF NUMERIC CRITERIA AS A MANAGEMENT STRATEGY

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I. INTRODUCTION

In 1972, Congress passed the modern Clean Water Act ("CWA") with the goal of restoring and maintaining the nation's waters.[1] In doing so, Congress emphasized the importance of developing and implementing "area-wide treatment management planning processes" to control the sources of pollutants.[2] To achieve Congress' goal, the CWA governs the standards and enforcement of effluent limitations to, in part, address nutrient pollution in the nation's waterways.[3] A 1996 report to Congress, which provided a national summary of water quality conditions, cited nutrient pollution as a major cause of impaired water quality nationwide.[4] Nutrient pollution is caused by excess nutrients, such as phosphorus and nitrogen, which are naturally occurring elements in aquatic ecosystems, in both the air and water.[5] Nutrients such as nitrogen and phosphorus are essential for plant growth, which in turn support habitat functions; however, in excess concentration, these elements can cause problems.[6]

High levels of nutrients in waterways, particularly excess nitrogen and phosphorus, can cause algae to grow faster than ecosystems can handle.[7] Such an increase can reduce water quality, impact food resources and habitats, and decrease the level of oxygen that fish and other aquatic life need to survive.[8] A common consequence of excess nutrients in a waterway is algal blooms, essentially large growths of algae, which can significantly reduce or eliminate oxygen in the water, and lead to fish kills.[9] In fact, nutrients were cited as a cause of hypoxic events in the Gulf of Mexico and Eastern states in the 1990s, triggering a national call to action.[10] In addition, the resulting elevated toxins and bacterial growth from algal

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1. *See* 33 U.S.C. § 1251(a).

2. 33 U.S.C. § 1251(a)(5).

3. 33 U.S.C. § 301(a).

4. U.S. ENVTL. PROT. AGENCY, NATIONAL SUMMARY OF WATER QUALITY CONDITIONS (1996), http://www.epa.gov/sites/production/files/2015-09/documents/1996_national_water_quality_inventory_report_to_congress.pdf (last visited Feb. 1, 2016).

5. *Id.* at 9.

6. *Id.*

7. *Id.* at 9–10.

8. *National Strategy for the Development of Regional Nutrient Criteria Factsheet,* U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/nutrient-policy-data/national-strategy-development-regional-nutrient-criteria-factsheet (last visited Feb. 1, 2016).

9. U.S. ENVTL. PROT. AGENCY, *supra* note 4, at 52.

10. U.S. ENVTL. PROT. AGENCY, STATE ADOPTION OF NUMERIC NUTRIENT STANDARDS (1998-2008), EPA-821-08-007 (Dec. 2008) at 3.

blooms can cause harm and illness to humans through contact or consumption of polluted water, or ingestion of tainted seafood.[11] Such issues do not only negatively affect ecosystems and public health, but also may have adverse economic impacts through beach closures or restricted access to public waterways.[12]

The U.S. Environmental Protection Agency ("EPA") identifies nutrient pollution as a costly and challenging environmental problem.[13] In the late 1990s, the EPA found significant evidence that the traditional narrative nutrient criteria used by states to develop water quality standards failed to adequately deter increasing nutrient levels.[14] As a result, the EPA Administrator issued a report calling for states to adopt numeric nutrient criteria ("NNC") by December 2003.[15] In 2004, the State of North Carolina responded to the EPA's new commitment to nutrient criteria management by developing a nutrient criteria implementation plan to address the State's water quality issues.[16] Currently, state officials in North Carolina are working with the EPA and other stakeholders to adopt NNC in a manner that best serves to protect North Carolina's natural resources and the communities relying upon these resources.[17]

Developing and implementing a NNC management strategy includes legal and policy challenges that complicate the process, as exemplified by past NNC development efforts in Florida, New Hampshire, and Virginia.[18] To date, no comprehensive legal and policy analysis of the challenges of developing NNC as a nutrient management strategy exists. This article seeks to fill this gap by outlining: (1) North Carolina's current efforts to adopt NNC; (2) the policy challenges associated with developing a broad suite of NNC

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11. *See id.*

12. *See id.* at 4 (describing economic hardship caused by nutrient pollution).

13. *The Problem*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/nutrientpollution/problem (last visited Apr., 1 2016).

14. U.S. Envtl. Prot. Agency, National Strategy for the Development of Regional Nutrient Criteria, EPA 822-R-98-002 (June 1998) at 2–3.

15. *Id.* at iv.

16. N.C. Dep't of Envtl. Quality, North Carolina Nutrient Criteria Implementation Plan (June 2004), https://ncdenr.s3.amazonaws.com/s3fs-public/document-library/NCNutrientCriteriaImplemPlan-20040601-DWQ-PLN-CSU.pdf.

17. N.C. Dep't of Envtl. Quality, Nutrient Criteria Timeline, http://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/nutrient-criteria-development-plan/nutrient-criteria-timeline.

18. U.S. Envtl. Prot. Agency, Numeric Nutrient Criteria for the State of Florida: Withdrawing the Federal Actions (Sept. 2014), https://www.epa.gov/sites/production/files/2015-07/documents/factsheet-withdrawl-2014.pdf.

variables; and (3) the contemporary legal framework for developing NNC for North Carolina's waterways. In doing so, this Article analyzes current federal and North Carolina regulatory and policy instruments as well as efforts in Florida, New Hampshire, and Virginia to develop NNC. A comprehensive legal and policy analysis can provide useful lessons for North Carolina, as well as other states.

II. CURRENT FEDERAL AND NORTH CAROLINA LEGAL STRUCTURE

A. Clean Water Act

The Federal Water Pollution Control Act,[19] more commonly known as the Clean Water Act, is a "comprehensive water quality statute designed to 'restore and maintain the chemical, physical, and biological integrity of the Nation's waters.'"[20] In order to accomplish the CWA's goal of eliminating discharge of pollutants into navigable waters, the Act created "effluent limitations," which restrict the "quantities, rates, and concentrations of chemical, physical, biological, and other constituents."[21] When Congress adopted the CWA, it primarily entrusted the states with the responsibility of preventing and reducing pollution.[22] Consequently, each state may enforce its own water quality laws with the approval of the EPA Administrator, so long as its effluent limitations are not "less stringent" than those established by the CWA.[23]

The CWA uses three legal terms of art while explaining the roles of the states and the EPA Administrator: "uses," "criteria," and "standards."[24] From a regulatory standpoint, the EPA defines "criteria" as "elements of State water quality standards expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use".[25] A state designates the "uses" for its navigable waters and sets "water

19. 33 U.S.C. § 1251 et seq.

20. PUD No. 1 of Jefferson Cnty. v. Washington Dept. of Ecology, 511 U.S. 700, 704 (1994) (quoting 33 U.S.C. § 1251(a)).

21. 33 U.S.C. § 1311.

22. 33 U.S.C. § 1251(a).

23. 33 U.S.C. § 1370. *See* City of Burbank v. State Water Res. Control Bd., 35 Cal. 4th 613, 108 P.3d 862, 26 Cal. Rptr. 3d 304 (2005) (holding that a state's water quality "board" may consider economic factors to justify imposing pollutant restrictions as long as those restrictions are *more* stringent than the CWA requires).

24. 33 U.S.C. § 1313(c)(2)(A).

25. 40 C.F.R. 131.3(b).

quality criteria" for those waters "based upon such uses."[26] A state also develops "standards", which are comprised of both the uses and corresponding criteria and must "protect the public health or welfare, enhance the quality of water and serve the purposes of" the Act.[27] Additionally, a standard must "be established taking into consideration [the waters'] use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial, and other purposes, and also taking into consideration [the waters'] use and value for navigation."[28]

However, if a state's standard is found inconsistent with CWA requirements, or if the EPA "determines that a revised or new standard is necessary" in order to meet the requirements, then the EPA is mandated to "promptly prepare and publish proposed regulations setting forth a revised or new" standard.[29] Unless a state adopts its own new or revised standard (with approval from the EPA), the EPA must adopt the revised or new standard within 90 days after publication in the Federal Register.[30] However, it remains unclear whether this 90-day limit is judicially enforceable.[31] Generally, there are two main types of standards that state governments utilize to meet CWA nutrient pollution requirements – narrative criteria and numeric criteria.[32]

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26. Fla. Wildlife Fed'n, Inc. v. Jackson, 853 F. Supp. 2d 1138 (S.D. Fla 2012) (quoting 33 U.S.C. § 1313(c)(2)(A)). "Whenever the State revises or adopts a new standard, such revised or new standard shall be submitted to the Administrator. Such revised or new water quality standard shall consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses. Such standards shall be such as to protect the public health or welfare, enhance the quality of water and serve the purposes of this chapter. Such standards shall be established taking into consideration their use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial, and other purposes, and also taking into consideration their use and value for navigation." 33 U.S.C. § 1313(c)(2)(A).

27. *Id.*

28. *Id.*

29. 33 U.S.C. 1313(c)(4).

30. *Id.*

31. *See* Miss. Comm'n on Natural Res. v. Costle, 625 F.2d 1269, 1278 (5th Cir. 1980) (missing the 90-day limit was inconsequential when the court finds no consequences of the tardiness).

32. In addition to the two types of nutrient criteria, there are also several generally recognized approaches for developing these standards. "Reference conditions" is an approach that analyzes the historical data and relatively unimpaired water bodies in order to provide a baseline by which criteria can be adopted in a broader class of waters. A "stressor-response" approach calls for a regression analyses or scientific study that relates nutrient inputs to desired environmental outcomes or thresholds. Lastly, a "water quality simulation model" simulates the relationship between physical, chemical, and biological processes to study water quality

1. Federal Policy on Narrative Nutrient Criteria

Under the CWA, water quality criteria is either numeric or narrative.[33] In the federal district court's opinion in *Florida Wildlife Federation, Inc. v. Jackson*, Judge Hinkle explained the difference between these two types of criteria using speed limits as an analogy: a state could adopt a narrative standard for speed limits on roads, such as "don't drive too fast".[34] Therefore, a narrative standard is subject to some level of interpretation.[35] Alternatively, a state could use a numeric standard, such as a speed limit of 70 mph on highways.[36] Lastly, a state could use a combination of both – set a speed limit of 70 mph on highways and a narrative of do not drive too fast under certain conditions.[37] Initially, state governments preferred the narrative criteria for regulating nutrient pollution due to its perceived flexibility.[38] However, beginning in 1998 this preference changed when the EPA released its National Strategy for the Development of Regional Nutrient Criteria,[39] discussed in-depth below.

2. Emergence of Numeric Nutrient Criteria

NNC are expressed as numerical concentrations and/or as mass quantities or loadings, or simply as narrative statements with a scientifically defensible translator mechanism to derive or calculate numerical concentrations and/or mass quantities or loadings.[40] In general, NNC fall into one of two categories—causal or response.[41] Causal NNC's detail the quantity of nitrogen or phosphorus compounds appropriate for a water body.[42] Response NNC's detail quantitative thresholds for environmental responses typically

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scenarios.

33. 33 U.S.C. 1313(c)(2).

34. Fla. Wildlife Fed'n, Inc. v. Jackson, 853 F. Supp. 2d 1138, 1145-1146 (S.D. Fla 2012).

35. *Id.*

36. *Id.*

37. *Id.*

38. For example, Florida's originally adopted standard stated "nutrient concentrations of a body of water [must not] be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." FLA. ADMIN. CODE r. 62-302.530(47(b).

39. *See* 63 Fed. Reg. 34,648, 34,650 (June 25, 1998).

40. U.S. ENVTL. PROT. AGENCY, *supra* note 13 at 3.

41. U.S. Envtl. Prot. Agency, "Criteria Development Guidance for Wetlands Executive Summary," http://www.epa.gov/nutrient-policy-data/criteria-development-guidance-wetlands-executive-summary (last visited Jan. 27, 2016).

42. *Id.*

resulting from nutrient inputs.[43]

B. North Carolina Law and Nutrient Criteria Development Efforts

Under current North Carolina law, it is public policy to maintain, protect, and enhance water quality within the State.[44] To achieve this public policy goal, the State has charged the North Carolina Department of Environmental Quality ("NCDEQ") with the power to administer programs for water conservation and pollution abatement, as well as to implement standards "designed to protect human health, to prevent injury to plant and animal life, to prevent damage to public and private property. . . and the beneficial uses of these great natural resources".[45] In addition, the North Carolina General Assembly entrusts the Environmental Management Commission ("EMC") with adopting rules to protect, preserve, and enhance the state's water (and air) resources.[46] To support these public policy goals, the General Assembly has delegated the authority to classify waters of the State to the EMC to develop applicable standards for each classification.[47] As a part of this delegation, the General Assembly recognizes "that a number of different classification should be provided for (with different standards applicable to each) so as to give effect to the need for balancing conflicting considerations as to usage and other variable factors."[48] In pursuit of this directive, the North Carolina General Assembly left open the possibility that different segments of the same body of water may be classified differently.[49]

The EMC considers five groups of factors when assigning classifications to the identified waters of North Carolina.[50] The first group of factors looks at the physical characteristics of the identified water.[51] Second, the EMC examines the land development occurring on the land bordering the identified water with a particular focus on "dominant economic interest[s] or development, which has become

43. *Id.*

44. *See* N.C. GEN. STAT. § 143.211(b).

45. N.C. GEN. STAT. § 143-211(c).

46. N.C. GEN. STAT. § 143B-282.

47. N.C. GEN. STAT. § 143-214.1(a)(1)

48. § 143-214.1(b).

49. *Id.*

50. § 143-214.1(d).

51. *E.g.,* depth, surface area, volume, rate of flow, gradient and temperature. § 143-214.1(d)(1).

established in relation to or by reason of any particular use of such water."[52] Third, the EMC takes into account the current, future, or potential uses of the water.[53] Fourth, the EMC considers the value and use of the State's waters as well as the environmental impact, the economic and social costs and benefits associated with achieving the proposed standards, and the proposed date of achievement.[54] Finally, when evaluating groundwater, the EMC considers "the natural quality of the water below land surface and the condition of occurrences, recharge, movement and discharge, the vulnerability to pollution from wastewaters and other substances, and the potential for improvement of the quality and quantity of the water."[55]

In comparison, the General Assembly does not provide the EMC with much guidance regarding the criteria for developing the standards applicable to each classification.[56] Instead, the EMC must consider the "extent to which any physical, chemical, or biological properties should be prescribed as essential to the contemplated best usage."[57] Classifications of waters of the State can be found in Subchapter 2B of the North Carolina Administrative Code – Surface Water and Wetland Standards.[58] The rules include separate classifications for freshwaters and tidal salt waters, with supplemental classifications for trout waters, swamp waters, nutrient sensitive waters, outstanding resource waters, high quality waters, future water supply, and unique wetland.[59] The EMC assigns classifications and defines best usage of waters according to the criteria set forth in N.C. Gen. Stat. 143-214.1(d)[60] and according to all existing uses as defined

52. § 143-214.1(d)(2).

53. *See, e.g.,* industrial and domestic consumption, bathing, fish or wildlife, transportation, fire prevention, power generation, research uses, and the disposal of sewage or waste. § 143-214.1(d)(3).

54. § 143-214.1(d)(4).

55. § 143-214.1(d)(5).

56. § 143-214.1(c).

57. *Id.*

58. 15A NCAC 2B .0101 et seq.

59. 15A NCAC 2B .0101(c)-(e) (emphasis added).

60. The criteria the EMC uses for assignments of water classifications include: (1) the size, depth, surface area covered, volume, direction and rate of flow, stream gradient and temperature of the water; (2) the character of the district bordering said water, including any peculiar suitability such district may have or any dominant economic interest or development which has become established in relation to or by reason of any particular use of such water; (3) the uses and extent thereof which have been made, are being made, or may in the future be made, of such water for domestic consumption, bathing, fish or wildlife and their culture, industrial consumption, transportation, fire prevention, power generation, scientific or research uses, the disposal of sewage, industrial wastes and other wastes, or any other uses; (4) in revising

in 15A NCAC 2B .0202.[61] In determining whether to revise a designated best usage for waters through a revision to the classifications, the EMC must follow the federal standards set forth by regulation in 40 CFR 131.10(b)-(d) and (g).[62] It is through this detailed, rigorous classification system that the State of North Carolina has been able to develop its current set of flexible, site-specific nutrient criteria.[63]

In its 1998 report, the EPA issued a statement that the use of narrative criteria inadequately addresses the nation's water-quality issue, stating that roughly 40% of assessed waters nationwide did not satisfy their water-quality goals.[64] As a result of these findings, the EPA and U.S. Department of Agriculture adopted a Clean Water Action Plan in an attempt to improve restoration and protection of waters nationwide.[65] The EPA emphasized that excess nutrients contributed significantly to the pervasive water quality problem and delivered an expectation that all states adopt and implement numeric nutrient criteria.[66] Prompted by the EPA's findings, the State of North

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existing or adopting new water quality classifications or standards, the Commission shall consider the use and value of State waters for public water supply, propagation of fish and wildlife, recreation, agriculture, industrial and other purposes, use and value for navigation, and shall take into consideration, among other things, an estimate as prepared under section 305(b)(1) of the Federal Water Pollution Control Act G.S. 143-214.1Page 2 amendments of 1972 of the environmental impact, the economic and social costs necessary to achieve the proposed standards, the economic and social benefits of such achievement and an estimate of the date of such achievement; and (5) with regard to the groundwaters, the factors to be considered shall include the natural quality of the water below land surface and the condition of occurrences, recharge, movement and discharge, the vulnerability to pollution from wastewaters and other substances, and the potential for improvement of the quality and quantity of the water. N.C. Gen. Stat. §143.214.1(d).

61. N.C. GEN. STAT. § 143-214.1(d), 15A NCAC 2B. 0202. "Existing uses" means "uses actually attained in the water body, in a significant and not incidental manner, on or after November 28, 1975, whether or not they are included in the water quality standards, which either have been actually available to the public or are uses deemed attainable by the Environmental Management Commission. At a minimum, uses shall be deemed attainable if they can be achieved by the imposition of effluent limits and cost-effective and reasonable best management practices (BMPs) for nonpoint source control". 15A NCAC 2B. 0202(30).

62. *See* 40 C.F.R. 131.10(b)-(d), (g) (addressing water quality concerns, when to adopt sub-categories of uses, defining "attainable" uses, explaining when states may remove designated uses for lack of feasibility).

63. *See* N.C. Dep't of Envtl. & Nat. Res. Div. of Water Res., *North Carolina Nutrient Criteria Development Plan*, (June 2014) [hereinafter *N.C. Nutrient Criteria Dev. Plan*].

64. Letter from Carol Browner, Adm'r, U.S. Envtl. Prot. Agency and Dan Glickman, Sec'y U.S. Dep't of Agric., to Albert Gore, Jr., Vice President of the U.S.(Feb. 14, 1998).

65. *See* U.S. Dep't of Envtl. Prot. & U.S. Dep't of Agric., *Clean Water Action Plan: Restoring and Protecting America's Waters* 58-59 (Feb. 14, 1998).

66. National Strategy for the Development of Regional Nutrient Criteria, 63 Fed. Reg.

Carolina developed its own nutrient criteria plan, the 2004 Nutrient Criteria Implementation Plan ("NCIP"), which the EPA approved in 2004.[67] In June 2014, in conjunction with the EPA, the State updated its plan, titled the Nutrient Criteria Development Plan ("NCDP").[68] The 2014 update responded to the reality that nutrients continued to negatively affect water quality through adverse impacts to aquatic life, public use of state waters, and drinking water supplies, despite the State's rigorous yet flexible standards.[69] To address the aforementioned issues, the North Carolina agreed to consider additional strategies through development of NNC to protect designated uses for all its waters.

To facilitate public input into the development of the NCDP, the State through the North Carolina Division of Water Resources ("NCDWR") lead a stakeholder process from December 2012–February 2014.[70] This process included a Nutrient Forum in 2010, collection and analysis of stakeholder input from a series of four public forums, and public comment.[71] Public comments called for a scientific advisory council, stakeholder involvement, flexible nutrient criteria, maintaining existing nutrient management rules and Total Maximum Daily Loads ("TMDLs"), and balancing the best science with cost-effective implementation.[72] The NCDEQ submitted the NCDP to the EPA on June 5, 2014.[73] On June 20, the NCDEQ submitted to the EPA a revised version of the NCDP, which included non-substantive changes.[74] In its June 27, 2014 letter to the director of the NCDWR, the EPA referenced its document "Guiding Principles on an Optional Approach for Developing and Implementing a Numeric Nutrient Criterion that Integrates Causal and Response Parameters" when stating that: "numeric values for all parameters developed under the Plan must protect the designated uses and ensure that water quality standards provide for the attainment and maintenance of downstream water quality. . . the State *must* use and

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34,648, 34,650 (June 25, 1998).

67. *N.C. Nutrient Criteria Dev. Plan*, *supra* note 63.

68. *Id.* at 2.

69. *Id.*

70. *Id.*

71. *Id.*

72. *Id.*

73. Letter from James D. Giattina, Dir., Water Prot. Div., U.S. Envtl. Prot. Agency Region 4 to Thomas Reeder, Dir., Div. of Water Resources Plan., N.C. Dep't of Env't and Nat. Resources (June 27, 2014).

74. *Id.*

provide to the EPA scientifically-defensible methods and analyses supporting the development of these protective water quality criteria".[75] The EPA further stated that if North Carolina did not make "reasonable progress" towards the adoption of NNC, the EPA Administrator may exercise her discretion under CWA Section 303(c)(4)(B) to determine any new or revised standards for NNC in accordance with the NCDP.[76] Statements regarding a reasonable progress towards timelines and the use of scientifically defensible methods were critical elements in the leading case on this issue, *Florida Wildlife Federation v. Jackson,* 853 F.Supp.2d 1138 (N.D. Fla. 2012), discussed in the next section.

In response to this call to action from stakeholders, the public, the EPA, and the NCDWR: (1) established a Scientific Advisory Committee ("SAC") to assist the division with NNC development, (2) selected three critical areas for the development of NNC in the near future (i.e., High Rock Lake, Albemarle Sound, and the central portion of the Cape Fear River Basin), and (3) identified a process for NCDWR evaluation of nutrients throughout the state.[77] According to the timeline set forth in the NCDP, the NCDWR plans to adopt NNC for High Rock Lake, Albemarle Sound, and the central portion of the Cape Fear River Basin by 2021,[78] with statewide adoption by 2025.[79] Since June 2014, the NCDWR has established a nutrients work group[80] and continues to work with the EPA, the SAC,[81] local governments, universities, and the private sector to

75. *Id*. (emphasis added); *see* 40 CFR 131.11(a)(1).

76. *Id.*

77. *Id.*

78. According to the schedule agreed upon by NCDWR and the EPA, NCDWR will submit numeric WQS to EPA for review for High Rock Lake by 2018, Albemarle Sound by 2020, and the central portion of the Cape Fear River Basin by 2021. *See* Letter from James D. Giattina, Dir., Water Prot. Div., U.S. Envtl. Prot. Agency Region 4 to Thomas Reeder, Dir., N.C. Dep't of Env't and Nat. Resources Div. of Water Resources (June 27, 2014).

79. *N.C. Nutrient Criteria Dev. Plan*, *supra* note 63, at 3.

80. *See Albemarle-Pamlico National Estuary Partnership: Nutrients Workgroup*, N.C. DEPT'T OF ENVTL. QUALITY, http://portal.ncdenr.org/web/apnep/nutrients (last visited Jan. 8, 2016) (listing activities of the work group, as well as supporting information).

81. The purpose of the SAC is to assist the NCDWR and stakeholders with the development of NNC. The SAC includes individuals with specific expertise in water quality, nutrient response variables, nutrient management, and abatement of point source and nonpoint source nutrients. The responsibilities of the SAC are: (1) review the relevance and quality of nutrient data; (2) identify gaps in scientific and technical information currently being used; (3) recommend additional monitoring and data collection; (4) assist in the development of a management approach for each waterbody; (5) review proposed nutrient criteria for new nutrient management strategies; (6) assist as needed in preparing progress reports; and (7)

develop NNC for the three critical areas identified in the NCDP.[82] Furthermore, the nutrients work group and SAC have met several times, and continue to meet, to discuss data needs and other particulars needed to further develop NNC.[83]

C. Variables to Determine Nutrient Condition and the Role of Numeric Nutrient Criteria

The variables typically used to determine the nutrient condition of waterways are causal variables, response variables, and supporting variables.[84] Causal variables characterize nutrient availability or assimilation, and may include nutrient loading rates and soil nutrient concentrations. Response variables characterize biotic response, and may include community structure and composition of vegetation.[85] Supporting variables provide information useful to hydrologic condition balance and the pH, density, and organic matter content of soil.[86] North Carolina's revised plan primarily focuses on developing a NNC based on "the linkage between nutrient concentrations and protection of designated uses".[87] See the table below for how the NCDP defines "nutrient criteria". Table 1 provides examples of response variables and causal variables.

- Causal and response variables expressed as numerical concentrations and/or mass quantities or loadings; or
- Causal and response variables expressed as narrative statements with a scientifically defensible translator mechanism to derive or calculate numerical concentrations and/or mass quantities or loadings.[88]

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advise the NCDWR on social and economic issues related to nutrient management and implementation. *N.C. Nutrient Criteria Dev. Plan*, supra note 63, at 5.

82. *Id.*

83. *Nutrients Workgroup*, *supra* note 80.

84. U.S. Envtl. Prot. Agency, *Criteria Development Guidance for Wetlands Executive Summary*, http://www.epa.gov/nutrient-policy-data/criteria-development-guidance-wetlands-executive-summary (last visited Jan. 27, 2016).

85. *Id.*

86. *Id.*

87. *Id*. at 3.

88. *N.C. Nutrient Criteria Dev. Plan* (2014) at 3.

Table 1. Response and causal variables for consideration[89]
(Others may be considered)

Response variables	**Causal variables**
Chlorophyll-a Phytoplankton Periphyton Macrophytes Diurnal dissolved oxygen (DO) range Minimum DO Diurnal pH range	Nitrogen Phosphorus

III. LEGAL CHALLENGE

A review of case law revealed little in the way of litigation or precedent regarding the development and implementation of NNCs nationwide. However, one case from the Northern District of Florida provides some guidance on the scientific and policy complexities that have arisen regarding nutrient pollution in Florida.[90] This section will provide an overview of this case, and how it might apply to North Carolina's current NNC efforts.

A. Florida Wildlife Federation v. Jackson

Background

When the EPA Administrator issued the "National Strategy for the Development of Regional Nutrient Criteria," in 1998, the Agency recognized the inefficiencies of narrative nutrient criteria, and therefore, directed all states to adopt numeric criteria by December 31, 2003.[91] The Florida Department of Environmental Protection ("FDEP") utilized narrative nutrient criteria — "nutrient concentrations of a body of water [must not] be altered so as to cause an imbalance in natural populations of aquatic flora or fauna."[92] Over time, this narrative criteria proved to be insufficient to address rising nutrient levels, and by at least 2001, the FDEP started developing

89. *Id.*
90. Fla. Wildlife Fed'n, Inc. v. Jackson, 853 F.Supp.2d 1138 (N.D. Fla. 2012).
91. *Id.*
92. FLA. ADMIN. CODE r. 62-302.530(47)(b).

their own NNC.[93]

Developing NNC for Florida's waters was a team effort in which the state's water management districts and the FDEP spent millions of dollars conducting detailed studies and collecting and analyzing data.[94] However, as a result of delays, scheduled completion dates came and went without the adoption of NNC.[95] In December 2003, the FDEP submitted its first plan for developing NNC. In this plan, the FDEP called for NNC rulemaking to commence in August 2004, with the draft rule to be submitted to the Florida Environmental Regulation Commission ("ERC"), which is responsible for approving water-quality criteria, in October 2005.[96] While the FDEP predicted that ERC approval could take 12 months barring dissent, the FDEP stressed its limited control over the ERC's schedule, therefore, making it difficult to predict a completion date.[97]

In July 2004, the EPA responded to the FDEP's proposed 2003 plan, describing the process as "reasonable" and encouraging completion of the process by the FDEP target dates in order to increase the protection of the State's waters from nutrient over-enrichment.[98] The EPA warned the FDEP that failure to meet target dates could lead to the Administrator proposing and adopting new or revised standards.[99] The EPA stated:

> If the State has not met the milestones as scheduled in the plan, EPA will evaluate whether a federal promulgation would be appropriate. At that time, the Administrator may determine that new or revised standards are necessary to meet the Clean Water Act (CWA), and choose to promulgate water quality criteria for nutrients applicable to surface waters within Florida in accordance with Section 303 of the CWA.[100]

After missing the October rulemaking deadline, predicting that the rulemaking would be implemented in April 2006 and submission of a draft rule to the ERC by April 2007, the FDEP extended the

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93. Fla. Wildlife, 853 F. Supp. 2d at 1146 (2012).

94. *See id.*

95. *See id*.

96. *See* Water Quality Standards & Special Projects Program & Watershed Assessment Section, FLA. DEP'T OF ENVTL. PROT., *State of Florida Numeric Nutrient Criteria Development Plan* (Dec. 2003).

97. *Id.*

98. *See* Letter from James D. Giattina, Dir. Water Mgmt. Div. U.S. Envtl. Prot. Agency, to Mimi Drew, Dir., Div. of Water Res. Mgmt., Fla. Dep't of Envtl. Prot. 1 (July 7, 2004).

99. *Id.*

100. *Id*. at 1–2.

schedule by 18 months.[101] While the FDEP continued to compile data, it subsequently missed the 2006 deadline as well.[102] As a result, the FDEP submitted another revised schedule in September 2007, which projected the rulemaking would begin in January 2010 and a draft rule would be submitted to the ERC between January 2010 and January 2011, more than five years after the original projection.[103]

In 2009 the EPA made an explicit "determination" under CWA Section 303(c)(4), 33 U.S.C. Section 1313(c)(4)[104], that new numeric criteria were necessary to meet the Act's requirements.[105] Pursuant to Section 303(a)(1), such a determination by the Administrator creates an explicit statutory duty to "promptly propose and adopt new criteria unless Florida [does] so first."[106] Since Florida failed to adopt new criteria, the EPA Administrator used model and field studies to adopt new lake and spring criteria to determine the levels where nutrient increases cause harmful effects.[107]

The Litigation

The resulting litigation proved highly technical and involved defendants across many special interests.[108] In July 2008, before the EPA Administrator made a determination, five environmental groups ("the Environmental parties") filed the first complaint in federal district court, naming the EPA and the EPA Administrator as defendants.[109] Over time, an additional entities, which included the Florida Department of Agriculture and Consumer Services, the South Florida Water Management District and eleven trade associations, intervened as additional defendants ("the State and Industry parties").[110] The Environmental parties sought relief in federal district court under the CWA's citizen-suit provision, which allows a citizen to sue the EPA Administrator to compel her to perform a duty the

101. *See* Letter from Jerry Brooks, Deputy Dir., Div. of Water Res. Mgmt., Fla. Dep't of Envtl. Prot., to Andrew Bartlett, Water Mgmt. Div., U.S. Envtl. Prot. Agency (Dec. 14, 2004).

102. Fla. Wildlife Fed'n, Inc. v. Jackson, 853 F. Supp. 2d 1138, 1147 (2012).

103. *See* Water Quality Standards & Special Projects Program, Water Res. Div., FLA. DEP'T OF ENVTL. PROT., *State of Florida Numeric Nutrient Criteria Development Plan* (Sept. 2007).

104. Fla. Wildlife, 853 F. Supp. 2d at 1148.

105. *Id.*

106. *Id*.

107. *Id.* at 1148–49.

108. *Id.* at 1150.

109. *Id.* at 1151.

110. *Id.*

CWA makes nondiscretionary.[111] The Environmental parties claimed that the 1998 Clean Water Action Plan constituted a "determination" that Florida's narrative nutrient standard was inadequate and a new standard was necessary.[112] Such a "determination" would have imposed a nondiscretionary duty by the EPA Administrator to "promptly" publish new proposed standards.[113] The Administrator denied that the 1998 action plan amounted to a "determination".[114]

After the EPA's 2009 decision that a numeric standard was necessary to meet the CWA's requirements, the Environmental parties filed an amended complaint, the "third amended supplemental complaint added a claim for relief based on[115] the 2009 determination.[116] Although the form of relief to which the Environmental parties would be entitled depended, in part, on the issue of the claimed 1998 determination, "the 2009 determination rendered the 1998 issue less important."[117] Although some of the intervening defendants attempted to deny that the 2009 determination incurred any corresponding duty, the Administrator "did not deny—and could not possibly have denied—her nondiscretionary duty to promptly publish revised or new standards."[118]

On August 25, 2009, the Environmental parties and the Administrator moved for an entry of a consent decree which would require the Administrator to sign a proposed rule establishing NNC for Florida's lakes and flowing waters by January 14, 2010.[119] However, several conditions attached to this proposed decree.[120] First, unless the State of Florida developed and received approval for its own NNC regarding lakes and flowing waters, the Administrator would adopt such a rule by October 15, 2010.[121] The same process attached to publishing and adopting NNC for coastal and estuarine

111. *Id.*, 33 U.S.C. § 1365(a)(2).

112. Fla. Wildlife, 853 F. Supp. 2d at 1151.

113. *Id.*

114. *Id.* at 1151–52 ("The 2009 determination did not render moot the Florida Wildlife parties' claim based on the 1998 documents, because the publication of new standards could. . .not [have been] sufficiently prompt after a 1998 determination.")

115. *Id.* at 1152.

116. *Id.*

117. *Id.*

118. *Id.*

119. *Id.*

120. *Id.*

121. *Id.*

waters by January 14, 2011, and October 15, 2011 respectively.[122] The consent decree also maintained the ability of the Administrator to extend the deadlines by motion subject to the court's discretion.[123]

On December 30, 2009, after allowing all parties involved to address the motion for entry of the consent decree, the Court entered the proposed consent decree after finding that it met all the applicable standards for consent decrees.[124] Subsequently, after granting a motion for an extension on the October 15, 2010 deadline, the court held that the Administrator complied with the consent decree.[125] In 2011, two of the parties the Florida Water Environment Association Utility Council, Inc. and the South Florida Water Management District, attempted to appeal the consent decree to the Eleventh Circuit Court of Appeals.[126] However, the Eleventh Circuit dismissed this appeal for lack of standing, "essentially agreeing with [the judge's] ruling that the 2009 determination – not the consent decree – was the source of any harm alleged by the appellants."[127] As a part of the dismissal, the Eleventh Circuit did not address the validity of the 2009 determination.[128]

After all was said and done, in *Florida Wildlife Federation v. Jackson*, the District Court addressed 13 consolidated cases challenging the validity of the 2009 determination, as well as the rule adopting the NNC.[129] Additionally, the court considered the original action as well as "two actions filed after the determination but before adoption of the rule and 10 cases that were filed after adoption of the rule."[130] Consequently, the court considered six claims:

1. Whether the determination if invalid and that even if valid the rule goes too far";
2. Whether the 2009 determination is arbitrary or capricious and thus should be set aside under the Administrative Procedures Act;

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122. *Id.*
123. *Id.*
124. *Id.*
125. *Id.*
126. *Id.* at 1153.
127. *Id.* (citing Fla. Wildlife Fed'n, Inc. v. S. Fla. Water Mgmt. Dist., 647 F.3d 1296 (11th Cir. 2011)).
128. *Id.*
129. *See id.*
130. *Id.*

3. Whether Congress's delegation of discretion to the Administrator was unconstitutional;
4. Whether the determination violated the Fifth Amendment;
5. Whether the Administrator violated the Regulatory Flexibility Act; and
6. Whether the rule is valid but does not go far enough and thus, to that extent, is arbitrary or capricious.[131]

In its ruling on these claims, the District Court:

1. Upheld the Administrator's determination that numeric nutrient criteria are necessary for Florida waters to meet the CWA's requirements, due to the combined impacts of urban and agricultural activities to the state's "important and unique" aquatic ecosystems;
2. Upheld the Administrator's lake and spring criteria;
3. Invalidated the stream criteria;
4. Upheld the decision to adopt downstream-protection criteria;
5. Upheld some, but not all, of the downstream-protection criteria; and

   Upheld the Administrator's decision to allow—and the procedures for adopting—site-specific alternative criteria.[132]

The sub-sections below will provide detail about the courts invalidation of the stream criteria and partial invalidation of downstream protection criteria (or values).

The District Court's Invalidation of EPA's Stream Criteria

While the District Court upheld a majority of the EPA Administrator's actions, including her determination of the necessity of NNC for Florida's waters, the court invalidated the stream criteria and some of the downstream protection criteria.[133] Unable to develop acceptable stream criteria based on modeling and field studies, the EPA Administrator adopted stream criteria using a different

131. *Id.* at 1143–44.

132. *Id.* at 1142, 1150.

133. *See id.* at 1142 (including the EPA Administrator's determination of the necessity of NNC for Florida's waters).

approach.[134] Initially, the EPA planned to develop criteria based on models and field studies, but correlations observed between nutrients and results did not yield any consistent pattern.[135] As a result of the EPA's concerns with the reliable criteria produced from this approach, the Agency divided Florida into five geographic regions and developed rules based on representative samples of "minimally disturbed streams for which nitrogen and phosphorus were available".[136] While each side criticized the EPA's approach, the District Court deferred to the EPA's scientific judgment.[137]

However, the District Court did not defer to the EPA's translation of Florida's existing narrative criteria into numeric criteria.[138] The court based its finding on the language in Florida's established narrative criterion: "nutrient concentrations of a body of water [must not] be altered so as to cause an *imbalance* in natural populations of aquatic flora and fauna."[139] The District Court interpreted "imbalance" as preventing harmful changes in nutrient levels.[140] The FDEP and the EPA apparently differed in interpretations, as the EPA asserted during oral argument that it interpreted Florida's narrative criterion to apply to any change in nutrient levels.[141] However, the court quickly noted that the EPA was not required to meet Florida's target; in fact, the Agency was free to determine its own standard.[142] Therefore, that the EPA and the State of Florida disagreed whether the standard should be any increase in nutrient levels versus a harmful change in nutrient levels proved insufficient for the court to rule that the EPA's stream criteria were arbitrary or capricious.[143] The EPA's "fatal error," so to speak, resulted from the Agency's failure to defer to Florida's judgment, previously agreed by the EPA, and then the EPA failure to "adequately explain" its decision.[144]

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134. *Id.* at 1143.
135. *Id.* at 1167.
136. *Id.*
137. *Id.* at 1168.
138. *Id.* at 1169.
139. *See id.* at 1168 (quoting Fla. Admin. Code r. 62-302.530(47)(b)) (emphasis added).
140. *Id.* at 1160.
141. *Id.*
142. *Id.* at 1143.
143. *Id.*
144. *See id.* at 1169.

The District Court's Partial Invalidation of Downstream Protection Values

The EPA also adopted downstream-protection criteria, also known as "downstream protection values" ("DPVs").[145] Through the adopting of DPVs, the EPA sought to protect lakes from nutrient pollution introduced through upstream waters.[146] The District Court did not find the EPA's decision to adopt DPVs as arbitrary or capricious.[147] However, the court took issue with the fact the EPA set the DPVs through modeling or, in the absence of modeling, at one of two "default" levels.[148] For an impaired lake, which is a lake not in compliance with the lake criteria, the default DPVs would be the same as the lake criteria.[149] The District Court ruled that neither the provision for DPVs based on modeling nor the default DPVs for an *impaired* lake were arbitrary or capricious.[150] However, the court believed setting the default DPVs for an *unimpaired* lake as well suffered from a flaw similar to that in the stream criteria.[151] The default DPVs for an unimpaired lake are the ambient conditions at the "pour point", which is the point at which the stream enters the lake.[152] The EPA's theory seemed to be that any increase from ambient conditions ordinarily causes a change in flora and fauna, not that it causes a *harmful* change.[153] Applying the same logic the court applied to the stream criteria, that the Administrator cited no basis in sound science for disapproving any nutrient increase, not just a nutrient increase that causes a harmful increase in flora or fauna, the District Court ruled it arbitrary and capricious.[154]

B. Potential Lessons for North Carolina

Even though the ruling in the *Florida Wildlife* case results from a highly particularized fact pattern and lacks precedential value as a federal district court case, this case nevertheless offers potential lessons for North Carolina, as the State, EPA, and stakeholders

145. *Id.* at 1143.
146. *Id.*
147. *Id.* at 1170.
148. *Id.* at 1143.
149. *Id.*
150. *Id.*
151. *Id.*
152. *Id.* at 1143–44.
153. *Id.* at 1144.
154. *Id.* at 1170.

continue their process to adopt and implement NNC. While there may be disagreements between government agencies, experts, and stakeholders on the specifics of NNC development, making reasonable progress on timelines[155] and also basing any criteria developed in sound science is an important lesson from *Florida Wildlife*.

There appears to be little debate, at least between NCDWR and the EPA, that NNC is necessary to enhance water quality and to protect public health and welfare in North Carolina.[156] However, making reasonable progress on the proposed timeline, a timeline agreed upon by NCDWR and the EPA Region 4, is essential to ensure that the State of North Carolina maintains the lead role in developing NNC. What "reasonable progress" means likely will be context-dependent, which is why communication between the agencies and stakeholders remains critical. It is important to note that the EPA Region 4 representatives serve on both the SAC and nutrients work group, thereby acting to facilitate meaningful communication between the respective agencies.[157]

The major reason the District Court in *Florida Wildlife* invalidated the stream criteria and only partially upheld the DPVs is that the EPA, despite its intent to defer to the State of Florida's judgment that criteria should prevent harmful increases in nutrient levels,[158] instead developed criteria to prohibit *any* change in nutrient levels rather than to prohibit *harmful* changes.[159] The court also took notice that the EPA applied this same goal when setting DPVs, which included default criteria for streams entering lakes currently in compliance with the rules and not just streams entering lakes not in

155. In *Fla. Wildlife*, the district court directly addressed the timeline issue. One of the plaintiffs' arguments again EPA acting to develop criteria was that FDEP already was working towards this goal. Given that FDEP had started working on NNC in 2001 and had to push back its schedule numerous times, the district court called EPA's decision to address the necessity of NNC in Florida waters a "rational conclusion". *See* Fla. Wildlife, 853 F. Supp 2d at 1158.

156. *See*, *e.g.*, N.C. Dep't Env't & Nat. Res., Div. of Water Res., North Carolina Nutrient Criteria Development Plan (2014); Letter from James D. Giattina, Director, Water Protection Division, U.S. Environmental Protection Agency Region 4 to Thomas Reeder, Director, Division of Water Resources Planning, North Carolina Department of Environment and Natural Resources (June 27, 2014).

157. *See* meeting minutes from the nutrients workgroup meetings, N.C. Dep't Envtl. Quality, Albemarle-Pamlico National Estuary Partnership, Nutrients Workgroup, http://portal.ncdenr.org/web/apnep/nutrients (last visited Jan. 8, 2016).

158. Fla. Wildlife Fed'n, Inc. v. Jackson, 853 F. Supp. 2d 1168 (2012).

159. *Id.*

compliance.[160] While the court did not find the EPA's decision to adopt DPVs arbitrary or capricious, it found the decision to set default DPVs for unimpaired lakes arbitrary and capricious, i.e., the equivalent of setting criteria to prevent any changes in nutrient levels rather than harmful changes.[161]

It is difficult to determine whether the disagreements between EPA and the State of Florida about the stream criteria and DPVs resulted from communication issues, differences of opinion on the interpretation of state-level narrative criteria, or a combination of both. However, for North Carolina's NNC efforts, it will be important that the State and the EPA come to a mutual agreement and understanding regarding the deference the EPA will afford to North Carolina's judgment on NNC development, and to what extent the two entities and stakeholders can agree on specific sets of numeric criteria. Based on North Carolina's current rules, it appears that the State's goal is to prevent changes in nutrient levels that would impair the best usage of a water body – keeping in mind that best usage of a water body depends on the classification under which it falls.[162] During the NNC development process, it would be critical for the State, the EPA, and stakeholders to agree on which water quality values are important and the meanings of "best usage", "existing uses", and "designated uses" to minimize disagreements, such as those that plagued the various agencies and stakeholders in *Florida Wildlife*. That is a potential policy challenge, since "existing uses" and "best usage" are defined in the N.C. Administrative Code[163], but "designated uses" is not, despite being used in numerous places in the rules. It likely will be a challenge to determine to what extent any of the terms are interchangeable at this point, but given the NCDEQ-wide environmental rules review currently taking place,[164] there is an

160. *Id.*

161. *See id*. at 1170–71.

162. *See, e.g.,* N.C. Admin. Code. 15 NCAC 2B .0201 (2007) ("It is the policy of the Environmental Management Commission to maintain, protect, and enhance water quality within the State of North Carolina); N.C. Admin. Code, 15 NCAC 2B .0202(8) ("Best usage of waters as specified for each class means those uses as determined by the Environmental Management Commission in accordance with the provisions of G.S. 143-214.1"); N.C. Admin. Code, 15 NCAC 2B .0211(3)(a) (". . .the Commission or its designee may prohibit or limit any discharge of waste into surface waters if. . . the discharge would result in growth of microscopic or macroscopic vegetation such that. . . the intended best usage of the waters would be impaired"). It is important to reiterate that North Carolina's nutrient control strategies are designed to be flexible and site-specific.

163. *See*, N.C. Admin. Code. 15A NCAC 02B .0211 (2007).

164. N.C. GEN. STAT. § 150B-21.3A (2013) requires state agencies to review existing rules

opportunity for the agency to clarify these definitions and how they should be used. The other potential challenge is keeping clear the distinction between uses protected by rule and the actual uses of a water body. For example, one protected use of a lake could be for recreation, but the lake is not currently being used for boating or swimming. It would be important for the SAC and nutrients workgroup to keep in mind that it is the uses outlined in the rules that need to be protected when adopting NNC, not current actual uses. This further illustrates the importance of communication between the SAC and workgroup, which includes EPA representatives,[165] to make sure the group can agree upon terms. Moreover, it will be equally important for these groups to agree on a definition of NNC, whether it includes Total Nitrogen ("TN") and Total Phosphorus ("TP") only, or whether the definition also includes nutrient-related criteria such as chlorophyll-a and dissolved oxygen.[166]

IV. NNC EFFORTS IN OTHER STATES

State water quality standards are key to the effective implementation of the CWA. According to the EPA, there are three basic elements that describe the optimal, or desired, conditions of water: (1) designated use (e.g., fishing, swimming, and drinking water); (2) criteria that specifies the amount of various pollutants that may be present in a water without impairment; and (3) policies that provide for the protection of existing water uses and places limits on the degradation of high-quality waters.[167] Therefore, the Agency recommended that states consider developing numeric nutrient standards in order to provide for quantitative measures for nitrogen and phosphorus.[168] In making its case for NNC, the EPA has asserted numerous benefits: (1), objective baselines to measure progress against nutrient pollution; (2) facilitation of the writing of permits; (3) more effective evaluation of nutrient runoff minimization programs; (4) broader partnerships to implement Best Management Practices,

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every 10 years. An initial review of existing rules is currently taking place and is scheduled to be complete in 2018. After that time, rules will be reviewed every 10 years.

165. It's also important to note that there should be agreement within EPA itself on the definitions of terms as well, meaning agreement between Region 4 and headquarters.

166. Current North Carolina rules includes standards for chlorophyll-a and dissolved oxygen, as well as standards for total Nitrogen and total Phosphorus. *See* 15A NCAC 2B .0211(4) and (6).

167. U.S. Envtl. Prot. Agency, State Adoption of Numeric Nutrient Standards (1998-2008), EPA-821-F-08-007 (Dec. 2008) at 4.

168. Fla. Wildlife Fed'n, Inc. v. Jackson, 853 F. Supp. 2d 1164 (2012).

wetlands protection, and control of urban water runoff; and (5) enhance greater public understanding of established water quality goals.[169] To this end, the EPA encourages states to develop NNC as a part of their own nutrient management strategies.[170] Given the scientific and policy objectives involved in developing NNC for a state's waters, a comparative analysis of other states will provide a clearer picture of the challenges North Carolina may face when the two objectives do not necessarily align. This can lead not only to a fractured process, but also to the possibility of legal challenges. This section will review NNC development efforts in Florida, New Hampshire, and Virginia. Both the SAC and nutrients workgroup in North Carolina consider case studies, which highlight methodology used as well as challenges and lessons, to be critical in their own efforts to establish NNC.[171] In fact, the nutrients workgroup relies on information collected from California, Delaware, Hawaii, New Jersey, Georgia, Massachusetts, and others.[172]

A. Florida

Introduction

Although Florida's NNC development efforts led to litigation, much has happened since *Florida Wildlife Federation v. Jackson*. In fact, the FDEP established numeric standards in most waters in the state by 2015.[173] For the purpose of NNC adoption in these waters, Florida's coast was separated into coastal and estuary segments, and NNC have been established for all estuary segments for TN, TP, and chlorophyll-a.[174] For the State's coastal ocean waters, NNC were established for chlorophyll-a, based on derived from satellite remote sensing technologies.[175] Practically, this means that NNC have been adopted for a majority of Florida's freshwater streams, lakes, and springs.[176] However, wetlands (other than wetlands within the Everglades Protection Area) and South Florida canals are not

169. *See id.,* at 1150.

170. *Id.* at 1146.

171. *See N.C. Nutrient Criteria Dev. Plan* (2014) at 3, 6-14.

172. *See* Albemarle-Pamlico National Estuary Partnership, *Nutrients Workgroup*, http://portal.ncdenr.org/web/apnep/nutrients (last visited Feb. 1, 2016).

173. *See* Fla. Dep't of Envtl. Prot., *Numeric Nutrient Standards for Florida's Waters*, http://www.dep.state.fl.us/water/wqssp/nutrients/ (last visited Feb. 1, 2016).

174. *See id*.

175. *See id.*

176. *See id.*

currently covered by NNC; and non-perennial streams, human-made or physically altered canals or ditches used primarily for irrigation and flood control, and tidal creeks currently are only covered by narrative criteria pending additional data analysis.[177]

Approach

Over the past few years, the State adopted a series of rules, approved by the EPA, with respect to numeric interpretations of narrative criteria. For a majority of Florida's estuaries, the "healthy conditions" approach, this implies that most estuaries are currently healthy, guided NCC development.[178] A standard list of nutrient sources were used, including agricultural operations, domestic and industrial wastewater facilities, urban stormwater, and phosphorus deposits in Southwest Florida (which are naturally occurring).[179]

Current and Proposed NNC

The first rule-making, adopted by the State of Florida in December 2011 and approved by the EPA in November 2012, focuses on the South and Southwest coasts of the State.[180] The first rule contains estuary-specific numeric interpretations of narrative criteria for TP, TN, and chlorophyll-a for Tampa Bay, Clearwater Harbor, Sarasota Bay, and Charlotte Harbor. This criteria resulted from the collaborative effort to improve and restore seagrass for South Florida marine waters, which were grouped based on water quality and a determination that the estuaries were healthy and met designated uses.[181] The FDEP utilized information about the biological communities, water quality conditions, and nutrient sources to determine whether a system, or part of a system, met its designated,.[182] Based on this determination, the FDEP could calculate criteria that reflected healthy conditions of a particular waterbody.[183]

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177. *See* Fla. Dep't of Envtl. Prot., *Implementation of Florida's Numeric Nutrient Standards*, at 28, 50 (Apr. 2013), http://www.dep.state.fl.us/water/wqssp/nutrients/docs/NNC_Implementation.pdf.

178. *See* Fla. Dep't of Envtl. Prot., *supra* note 173.

179. *See generally* Fla. Dep't of Envtl. Prot., *supra* note 177.

180. *See* FLA. ADMIN. CODE 62-302.530(47)(b), 62-302.532. Maps of these areas may be found at Florida Administrative Code and Florida Administrative Register, *Maps of Florida Estuary Nutrient Regions*, (Oct. 2014), https://www.flrules.org/Gateway/reference.asp?No=Ref-05420.

181. *See id.*

182. *See id.*

183. *See id.*

The second rule-making, adopted by Florida in November 2012 and approved by the EPA in September 2013,[184] focuses on the Panhandle region of the state and includes TP, TN, and chlorophyll-a within six estuaries from Perdido Bay to Appalachicola Bay.[185] The third rule-making, adopted by the State in June 2013 and approved by the EPA in September 2013, established criteria for TP, TN, and chlorophyll-a within seven estuaries located on the east and west coasts of Florida.[186] The fourth rule-making, which was approved by the EPA in September 2013, established criteria for TP, TN, and chlorophyll-a for 48 coastal (offshore) and estuarine areas throughout the state.[187]

A fifth rule, adopted by Florida in November 2014, is under EPA review at the time of this writing.[188] This rule seeks to establish and codify into rule TP, TN, and chlorophyll-a for all estuaries in the State and also includes several portions of the Intercoastal Waterway connecting estuarine systems and parameters for estuaries not currently covered by their adopted nutrient TMDLs (i.e., Kings Bay, Upper Escambia Bay, Indian River Lagoon, Lower St. Johns River, St. Lucie Estuary, and Caloosahatchee Estuary).[189] Although it remains to be seen whether the EPA will approve this fifth rule, Florida's post-*Florida Wildlife* efforts to establish NCC by rule are considerable.[190] The story continues, not just with respect to rule adoptions, but with water quality monitoring to determine the impact of adopted numeric standards.

B. New Hampshire: Great Bay Estuary

Introduction

When the EPA Administrator first recommended that states develop NNC, New Hampshire's water quality standards contained

184. *See* LAUREN PETTER & DARYLL JOYNER, ESTUARINE CRITERIA CASE STUDY: FLORIDA (2016) (on file with Duke Environmental Law & Policy Forum).

185. *See* FLA. ADMIN. CODE 62-302.532. Maps of these areas may be found at Florida Administrative Code and Florida Administrative Register, *Maps of Florida Estuary Nutrient Regions* (Oct. 2014), https://www.flrules.org/Gateway/reference.asp?No=Ref-05420.

186. *See* FLA. ADMIN. CODE 62-302.532.

187. *See* FLA. ADMIN. CODE 62-302-532.

188. *See* Lauren Petter & Daryll Joyner, *Estuarine Criteria Case Study: Florida*, https://drive.google.com/a/ncsu.edu/folderview?id=0Bxb1vduf_PLwa0lzQWNWQm9FRHc&usp=sharing&tid=0Bxb1vduf_PLwdHJJcjNRa3R1Y1k (last visited Feb. 1, 2016).

189. *See* FLA. ADMIN. CODE 62-302-532.

190. *See* Petter & Joyner, *supra* note 188.

only narrative criteria for nutrients to protect designated uses.[191] Even though the New Hampshire Department of Environmental Services ("DES") is charged with the responsibility of developing nutrient criteria for New Hampshire's estuaries, in 2005 the Piscataqua Region Estuaries Partnership ("PREP") formed a technical working group to provide input and support for establishing NNC.[192] The designated uses included in this analysis predominantly relate to contact recreation, swimming use, and aquatic life-use support.[193] In order to accurately analyze aquatic life-use support, DES investigated nutrient thresholds for the protection of the benthic invertebrate community, dissolved oxygen, and eelgrass.[194] For contact recreation designated use, DES evaluated chlorophyll-a and nitrogen concentrations.[195]

Approach

The DES divided the estuary into twenty-two different segments, and then developed correlations between median values and other statistics for nutrients and response variables in the segments.[196] While states with a variety of estuaries can compare median nutrient concentrations and response variables, New Hampshire could not follow this approach because there is only one large estuary in the state, Great Bay Estuary.[197] The Great Bay Estuary includes eight tidal rivers and several distinct embayments, and each with differing nutrient concentrations and differing levels of eutrophic response.[198] As a result, the DES divided the estuary into twenty-two segments of roughly homogeneous water quality to determine the existence of correlations.[199] This approach removed "variability in the datasets . . . by taking median values for each assessment zone, [thereby], improve[ing] the quality of the correlations".[200] Additionally, this

191. *See* N.H. Dep't of Envtl. Servs., *Nutrient Criteria for the Great Bay Estuary*, at 2 (June 2009), http://des.nh.gov/organization/divisions/water/wmb/wqs/documents/20090610_estuary_criteria.pdf.

192. *Id*.

193. *Id.*

194. *See id.*

195. *Id*.

196. *Id.* at 3.

197. *Id.*

198. *Id.*

199. *Id.*

200. William K.W. Li,, Marlon R. Lewis, & W. Glen Harrison, *Multiscalarity of the nutrient-chlorophyll relationship in coastal phytoplankton*, 33 ESTUARIES AND COASTS 440 (Nov. 2008), http://link.springer.com/article/10.1007/s12237-008-9119-7.

approach finds support in previous studies of Canadian estuaries finding correlations between nitrogen and chlorophyll-a present only when data was aggregated over longer time periods and across biogeochemical ocean provinces.[201] Despite, the loss of the variability of water quality within an assessment zone, the DES ultimately determined that the advantages of dividing the estuary outweighed the disadvantages.[202]

The DES developed several different nutrient concentration thresholds for different designated uses and environmental conditions.[203] This was necessary as "different eutrophication indicators occur for different levels of nutrient enrichment".[204] For example, the nutrient concentration threshold to protect against large phytoplankton blooms would be expected to be higher than the threshold to maintain submerged aquatic vegetation."[205] Additionally, the DES developed thresholds for response variables, such as chlorophyll-a and water clarity.[206] These thresholds determined impairments by measuring eutrophic effects, and would be used together with the nutrient thresholds to make impairment determinations.[207]

Conceptual Model

The estuarine eutrophication model utilized by the National Oceanic and Atmospheric Administration categorizes external nutrient inputs to "primary" and "secondary" symptoms of eutrophication.[208] Phytoplankton blooms, as measured by chlorophyll-a concentrations, and macroalgae are considered primary symptoms of eutrophication, while low dissolved oxygen and harmful algal blooms are considered secondary symptoms.[209] Harmful algal blooms, the proliferation of certain species of phytoplankton or cyanobacteria that produce toxins, typically occur offshore in the Gulf of Maine.

201. *Id.*

202. N.H.Dep't Envtl. Servs., *Nutrient Criteria for the Great Bay Estuary* (June 2009).

203. *Id.* at 3.

204. *Id.*

205. NHDES, *Nutrient Criteria for the Great Bay Estuary*, at 3 (June 2009).

206. *Id.* at 3–4.

207. NHDES, *Nutrient Criteria for the Great Bay Estuary*, at 3–4 (June 2009).

208. S.B. Bricker et al., *Effects of Nutrient Enrichment In the Nation's Estuaries: A Decade of Change*, 8 HARMFUL ALGAE 21 (Dec. 2008), http://www.sciencedirect.com/science/article/pii/S1568988308001182..

209. *Id*. at 25.

Therefore, for Great Bay Estuary this indicator is irrelevant.[210] Instead, secondary effects of accumulated organic matter in sediments on benthic fauna were considered.[211] The DES utilized a variety of data sources in order to estimate thresholds for nutrients and response variables for each of the primary and secondary indicators in the conceptual model.[212]

Proposed NNC

The DES ultimately proposed the following NNC for New Hampshire estuarine waters in the Great Bay Estuary to protect the primary designated use of aquatic life, as represented by dissolved oxygen and water clarity in the table below.[213] Before being promulgated as water quality criteria in Env-Wq 1700, the DES relied on the water quality standards narrative criteria.[214]

210. David W. Townsend, Neal R. Pettigrew, & Andrew C. Thomas, *On the nature of* Alexandrium fundyense *blooms in the Gulf of Maine*, 52 DEEP SEA RESEARCH 2603 (Nov. 2005).

211. NHDES, *Nutrient Criteria for the Great Bay Estuary*, at 4 (June 2009); *see also* James Cloern, *Our evolving conceptual model of the coastal eutropication problem*, 210 MAR. ECOL. PROG. SER. 223 (2001), http://www.int-res.com/articles/meps/210/m210p223.pdf (discussing the benefits of this approach).

212. *Id.*

213. *Id.*, at 52.

214. *Id.*, at 2.

Table 2. Proposed NNC for New Hampshire Estuarine Waters in the Great Bay Estuary[215]

Designated Use/ Regulatory Authority	**Parameter**	**Threshold**	**Statistic**	**Comment**
Primary Contact Recreation 1,2 (Env-Wq 1703.14)	Chlorophyll-a	20 ug/L	90th Percentile	This criterion has been used by DES for 305(b) assessments since 2004.
Aquatic Life Use Support – to protect Dissolved Oxygen 1,3 (RSA 485-A:8 and Env-Wq 1703.07)	Total Nitrogen	0.45 mg N/L	Median	
	Chlorophyll-a	10 ug/L	90th Percentile	
Aquatic Life Use Support – to protect Eelgrass 1,4 (Env-Wq 1703.14)	Total Nitrogen	0.30 mg N/L 0.27 mg N/L 0.25 mg N/L	Median	The range of values for the criteria corresponds to the range of eelgrass restoration depths: 2m, 2.5m, and 3m.
	Light Attenuation Coefficient (Water Clarity)	0.75 m-1 0.60 m-1 0.50 m-1	Median	

It is important to note that while New Hampshire proposed NNC standards for the Great Bay Estuary, criteria have not yet been adopted, possibly due to concerns with the methodology used to

215. *Id.*

derive criteria recommendations.[216] A peer review panel convened in 2013 to evaluate the proposed nutrient criteria documentation report believed there was an overemphasis on the Conceptual Model without consideration of important estuarine processes in the bay.[217] The panel also determined the necessity for further evaluation to better understand whether a cause and effect relationships exist.[218] Presently, it is unclear whether and when the DES plans to address the comments of the review panel so that new criteria may be proposed and possibly adopted.

C. Virginia: Chesapeake Bay

Introduction

The ecological history of Chesapeake Bay is plagued by excessive nutrient loading, leading to increasingly harmful water quality conditions throughout the area over the years.[219] In response, the EPA released revised water quality criteria guidelines in 2003, seeking to reduce the amount of phosphorus and nitrogen to acceptable levels.[220] In response to the EPA's recommendations, an Estuarine Nutrient Criteria Study was carried out in an attempt to link so-called "response variables" (such as water) clarity to the excessive nutrients phosphorus and nitrogen.[221] This novel approach has helped avoid the difficulty in achieving the recommended water quality nutrient levels when concentrating on each individual nutrient.[222]

Approach

The Estuarine Nutrient Criteria Case Study of Chesapeake Bay is unique in that it focused not on the specific nutrients at issue, but

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216. *See* Victor J. Bierman et al., *Joint Report of Peer Review Panel for Numeric Nutrient Criteria for the Great Bay Estuary*, New Hampshire Department of Environmental Services (Feb. 13, 2014), http://scholars.unh.edu/cgi/viewcontent.cgi?article=1001&context=rtr.

217. *See id.*

218. *See id.*

219. *See* U.S. DEP'T OF ENVTL. PROT., *NPDES Permitting Approach for Discharges of Nutrients in the Chesapeake Bay Watershed* (Dec. 2004).

220. *Id.*

221. *See* Clifton Bell, *Estuarine Nutrient Criteria Case Study: Chesapeake Bay*, https://drive.google.com/a/ncsu.edu/folderview?id=0Bxb1vduf_PLwMEpndll4MlBzVmM&usp=sharing&tid=0Bxb1vduf_PLwdHJJcjNRa3R1Y1k. Note that the Google Drive is the official file-sharing drive for the nutrients work group.

222. *Id.*

on other related variables, thought to be more useful in reducing the quantities of each problematic nutrient.[223] The Study focused on three major response variables: dissolved oxygen ("DO"), water clarity criteria, and chlorophyll-a.[224] DO criteria was chosen because minimum DO concentrations are "needed to support various types and life stages of aquatic life."[225] Furthermore, EPA-mandated DO criteria are stratified by depth, which allowed scientists to carefully set attainable levels that would balance protection with pragmatism.[226] The study also measured water clarity criteria as another indicator of excessive nutrient loading.[227] Lastly, chlorophyll-a was chosen because concentrations of this nutrient are associated with "a variety of deleterious effects" such as harmful algal blooms and low water quality.[228] However, the Study found it difficult to use chlorophyll-a as a reliable predictor of impact on the aforementioned effects.[229] Therefore, the Study recommended that chlorophyll-a criteria only be measured in case-specific situations where effects such as algal blooms persist.[230]

Completed and published in 2010, the Study's results showed that the Chesapeake Bay only met approximately 29 percent of water quality standards based on the aforementioned response variables.[231] A large number of stations located in the Chesapeake Bay that are operated by various Bay Program partners helped gather this data.[232] These stations collect data through continuous monitoring or alternatively 2-D water quality mapping is conducted on specific areas as needed.[233] This extensive data collection, while costly, provides the Chesapeake Bay area with an abundance of data that can be utilized in a "powerful modeling framework."[234]

Both Virginia[235] and Maryland[236] adopted the criteria established

223. *Id.*
224. *Id.*
225. *Id.* at 3.
226. *Id.*
227. *Id.*
228. Bell, *supra* note 221, at 3.
229. *Id.*
230. *Id.* at 4.
231. *Id.*
232. *Id.*
233. *Id.*
234. *Id.*
235. 9 VA. ADMIN CODE 25-260-185 (2005).
236. MD. CODE REGS 26.08.02.03-3 (2005).

for the Chesapeake Bay. In Virginia, the implementation followed the recommendations of the study in directing that "attainment of these criteria shall be assessed through comparison of the generated cumulative frequency distribution of the monitoring data . . . ."[237] This language closely follows the effects-based response criteria method that the Study endorses. Maryland lawmakers also incorporated effects-based response criteria into the state's water quality criteria regulation.[238] The Maryland regulation includes numerous effects-based response criteria such as turbidity, color, and temperature.[239]

Applicability to NC

The Chesapeake Bay effort can provide useful application in North Carolina, in that the methods used can be imitated regardless of the specific type of nutrient at issue. This method is a departure from the common method that focuses on specific problematic nutrients. While such investigative methods can be effective, the Chesapeake Bay effort suggests that focusing on effects-based response criteria gives a broader view of the entirety of the environmental issues that plague any given area.

One of the principal barriers to any environmental action is the financial burden.[240] The methods used by the Chesapeake Bay Case Study are no exception, as there are "high costs associated with developing and maintaining the modeling and monitoring frameworks."[241] Further adoption of the technology and methods used in the Study will provide more data in regards to the costs of implementation that could be expected in a particular jurisdiction.

V. CONCLUSION

North Carolina has embarked on a "once in a generation" opportunity[242] to revise and refine its nutrient pollution rules. Protecting water quality and best usage of waters across the state is a highly complex task that will require careful deliberation, application of sound science, and will include experts from across sectors and disciplines (i.e., physical and social sciences, engineering, law, and

237. 9 VA. ADMIN CODE 25-260-185 (2005).

238. MD. CODE REGS 26.08.02.03-3 (2005).

239. *Id.*

240. *Id.*

241. Bell, *supra* note 221, at 5.

242. Credit for applying this adage to NNC development goes to Jim Hawhee, N.C. Division of Water Resources.

policy) and from the public. Based on the case studies discussed in this article and the events in Florida that led to litigation, North Carolina has a long and winding road ahead of it as it proceeds with NNC development efforts for these first three critical areas, in addition to NNC development for all state waters. North Carolina recently reached a milestone of more than 10 million residents, with growth mainly in the Charlotte and Raleigh metropolitan areas.[243] Effectively managing nutrient impairments in a rapidly growing state is a challenge, since additional development and urbanization to accommodate this growth likely is to result in increased nutrient runoff in state waters. Thus, the time is ripe for North Carolina to take advantage of this once in a generation opportunity to gather additional data about the condition of State waters, consider future uses of individual waterbodies, consider the cost to implement any NNC that is ultimately adopted, deliberate how to balance existing uses and anticipated future uses of its waters with cost, and provide opportunities for meaningful public input.

While this task might appear insurmountable, North Carolina has two distinct advantages at its disposal. First, North Carolina's strong track record of proactive and adaptive nutrient management of its waters makes North Carolina a leader in the field. It appears the State plans to continue its role as a leader, based on the steps already taken–both historically and currently—to involve the public[244] in the adoption of nutrient management strategies and its decision to include a diverse group of experts in the SAC and nutrients workgroup to ensure that development of NNC is based on sound science. Second, North Carolina can draw from the numerous case studies from other states, in addition to engaging with numerous experts in the field, to facilitate this process. It is this combination of rich intellectual capital and lessons learned that will help North Carolina remain innovative in its approach to nutrient management. The article was written at the beginning of North Carolina's NNC

243. *See* U.S. Census, *Quick Facts North Carolina*, http://www.census.gov/quickfacts/table/PST045215/37,00 (last visited Jan. 26, 2016); *see also As NC population tops 10 million, investment must keep up with growth*, NEWS & OBSERVER, http://www.newsobserver.com/opinion/editorials/article51710130.html (last visited Jan. 26, 2016).

244. Public engagement and buy-in on any NNC that is developed will be critical to both criteria adoption and implementation. Including the public during the development of numeric criteria offers the State, EPA, and relevant committees and workgroups the opportunity to consider local knowledge in its decisions. This local knowledge can be in the form of impacts communities are seeing in nearby waterbodies due to nutrient levels and potential impacts new criteria and rules could have on these communities.

development process, and the authors will watch with great interest as the process unfolds. This article represents only the first part of the story, and additional articles in the future, whether by the authors or others, will help complete the story and allow North Carolina to impart to others its own lessons learned.