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Wetlands Regulation in an Era of Climate Change: Can Section 404 Meet the Challenge?

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The overwhelming weight of scientific authority supports projections that global temperatures will continue to rise over the next century, precipitation patterns will shift, extreme heat and cold events will become more common, and sea levels will continue to rise.[1] Each of these changes would lead to altered surface and groundwater hydrology, an effect with potentially serious implications for wetlands.[2] Because wetlands are situated in the "transition zone" between water and land, they are sensitive to the hydrological changes likely to occur as a result of climate change.[3] Even today, wetlands are disappearing and degrading more rapidly than other ecosystems, as are the species dependent on wetland habitats.[4] Climate change is projected to exacerbate these losses.[5] Thus, as we celebrate the fortieth anniversary of the enactment of the Clean Water Act ("CWA"), it seems appropriate to look forward rather than backward by assessing how well the CWA is suited to the challenges wetlands will likely face in the coming decades.

Protection of wetlands is a necessary element in the calculus of "restor[ing] and maintain[ing] the chemical, physical, and biological integrity of the Nation's waters."[6] In pursuit of this goal, the CWA protects wetlands, primarily through the section 404 permitting program.[7] Building on the protections embodied in a prohibition of discharges of dredged and fill material in jurisdictional wetlands, every administration since that of President George H. W. Bush has embraced a goal of "no net loss" of wetlands as an adjunct to the modest textual protection afforded by the CWA.[8] Critics have identified numerous shortcomings in the protection afforded wetlands under section 404 and the associated no net loss commitment.[9] Despite section 404's shortcomings, the long-term decline in the pace of wetlands loss (and a short-lived period of net increase in jurisdictional wetland area between 1998 and 2004) is no doubt attributable in part to section 404 and its imple-

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1. *See* Thomas R. Karl et al., U.S. Global Change Res. Program, Global Climate Change Impacts in the United States 13 (2009).
2. *See id.* at 84.
3. Virginia Burkett & Jon Kusler, *Climate Change: Potential Impacts and Interactions in Wetlands of the United States*, 36 J. Am. Water Res. Ass'n 313, 315 (2000).
4. Stuart Butchart et al., Millennium Ecosystem Assessment, Ecosystems and Human Well-Being: Wetlands and Water—Synthesis ii (2005).
5. *Id.* at ii–iii.
6. Clean Water Act of 1972 ("CWA") § 101(a), 33 U.S.C. § 1251(a) (2006); *see* Nat'l Research Council, Compensating for Wetland Losses Under the Clean Water Act 1–2 (2001) ("The U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency define the 'waters of the United States' to include most wetlands. This interpretation recognizes that some wetlands improve water quality through nutrient cycling and sediment trapping and retention; it is based on the judgment that *some goals of the Clean Water Act cannot be achieved if wetlands are not protected*." (emphasis added)).
7. *See* CWA § 404(a), 33 U.S.C. § 1344(a) (2006).
8. *See* Memorandums of Agreement (MOA); Clean Water Act Section 404(b)(1) Guidelines; Correction, 55 Fed. Reg. 9210, 9211 (Mar. 12, 1990); Claudia Copeland, Cong. Research Serv., RL33483, Wetlands: An Overview of Issues, at summary (2010).
9. *See, e.g.*, Copeland, *supra* note 8 *passim* (summarizing U.S. wetlands policy and criticisms of the section 404 program); U.S. Gov't Accountability Office, GAO-01-325, Wetlands Protection: Assessments Needed to Determine Effectiveness of In-Lieu-Fee Mitigation 15 (2001) (finding that in-lieu-fee arrangements under section 404—in which developers pay fees to other entities that then use the accumulated fees to establish wetlands—may be inadequate for mitigating adverse impacts to wetlands); Nat'l Research Council, *supra* note 6, at 2–10 (finding that the section 404 mitigation program had been ineffective in meeting the no net loss goal, and proposing institutional reforms for improving the program's effectiveness); Hope Babcock, *Federal Wetlands Regulatory Policy: Up to Its Ears in Alligators*, 8 Pace Envtl. L. Rev. 307, 328–50 (1991) (discussing federal agency initiatives designed to improve the section 404 program to better protect wetlands); Michael C. Blumm & D. Bernard Zaleha, *Federal Wetlands Protection Under the Clean Water Act: Regulatory Ambivalence, Intergovernmental Tension, and a Call for Reform*, 60 U. Colo. L. Rev. 695, 760–72 (1989) (calling for administrative and legislative reforms to the section 404 program); Oliver A. Houck, *Hard Choices: The Analysis of Alternatives Under Section 404 of the Clean Water Act and Similar Environmental Laws*, 60 U. Colo. L. Rev. 773 *passim* (1989) (analyzing the section 404 alternatives test and proposing modifications to improve it); Oliver A. Houck, *Ending the War: A Strategy to Save America's Coastal Zone*, 47 Md. L. Rev. 358 *passim* (1988) (discussing aspects of the section 404 program that do little to prevent wetlands loss and degradation); Michael C. Blumm, *The Clean Water Act's Section 404 Permit Program Enters Its Adolescence: An Institutional and Programmatic Perspective*, 8 Ecology L.Q. 409 *passim* (1980) (assessing the section 404 program and offering suggestions for its improvement); Rebecca L. Kihslinger, *Success of Wetland Mitigation Projects*, Nat'l Wetlands Newsl. (Envtl. Law Inst., Washington, D.C.), 2008, at 14–16 (concluding that compensatory mitigation under the section 404 program may not have prevented a net loss in wetlands acreage and functions).

mentation.[10] It is uncertain, however, whether the no net loss goal is actually being achieved under the section 404 program.[11] Moreover, a close look at the data suggests that even if the United States were to achieve the ambitious goal of no net loss in jurisdictional wetland area, that success would not eliminate all cause for concern.[12]

Scholars, practitioners, and legislators who have suggested amendments to the CWA to better protect wetlands have focused many of their recommendations on addressing the problems with compensatory mitigation—compensating for harm to natural wetlands caused by development.[13] These problems include lack of enforcement,[14] failure by permittees to undertake the promised mitigation,[15] failed efforts at wetland creation or restoration,[16] and lack of functional and value equivalence between the wetlands destroyed and those created or restored in compensation.[17] Beyond this well-documented question of the adequacy of compensation, though, looms a broader and potentially even more serious shortcoming with the protections provided by section 404. Threats to jurisdictional wetlands comprise more than the threat of losses due to dredging and filling and the inadequacies of our efforts to mitigate these losses.[18] Certainly, development activity is a major contributor to wetlands loss[19] and it is one that will likely persist well into the future.[20] However, as the U.S. Fish and Wildlife Service ("FWS") noted in its 2011 report on the status and trends of U.S. wetlands, the reasons for the declining wetland acreage "are complex and potentially reflect economic conditions, land use trends, changing wetland regulation and enforcement measures and climatic changes."[21]

This Article raises the question of how we should assess the potential threat to wetlands posed by the impacts of a changing climate and considers the role that section 404 can play both in assessing and responding to that threat.[22] Our inquiry is two-fold. First, should we be concerned about climate impacts on wetlands? And if so, how can section 404 help us to assess and respond to this threat?

Part I surveys the scientific literature on the projected impacts of climate change of particular relevance to wetlands and the impacts anticipated for particular types of wetlands. Part II presents an approach for assessing the extent to which we should be concerned about climate change impacts on wetlands. Part III discusses section 404 and priorities for strengthening it in an era of climate change.

I. Susceptibility of Wetlands to Climate Impacts

Perhaps due to the inherent difficulties associated with climate change projections,[23] few studies have quantified how

10. For the period 1998–2004, U.S. Fish and Wildlife Service ("FWS") reported a net gain in wetland area that equated to an average annual net gain of 32,000 acres per year. T.E. Dahl, U.S. Fish & Wildlife Serv., Status and Trends of Wetlands in the Conterminous United States 1998 to 2004, at 15, 46 fig. 26 (2006) [hereinafter Dahl, Status and Trends 1998 to 2004]. The report concludes that gains resulted from agricultural restoration and conservation programs and other wetlands restoration on conservation lands, some of which restoration was likely mitigation for permitted losses. *Id.* at 15, 63–64. For the period 2004–2009, however, FWS reported that wetlands losses outdistanced gains by 62,300 acres. T.E. Dahl, U.S. Fish & Wildlife Serv., Status and Trends of Wetlands in the Conterminous United States 2004 to 2009, at 16 (2011) [hereinafter Dahl, Status and Trends 2004 to 2009]. Little evidence exists to show a close link between the section 404 permitting program and these outcomes. *See* Nat'l Research Council, *supra* note 6, at 3 (stating in 2001 that there was insufficient data to link the section 404 permitting program to a decrease in wetlands loss).
11. Nat'l Research Council, *supra* note 6, at 3 (identifying as areas of concern the lack of data on the status of compensatory wetlands, whether compensatory wetlands can adequately replace all wetlands functions lost, and that some required mitigation projects are not started or fail to meet permit conditions). *But see* J.B. Ruhl & James Salzman, *Climate Change, Dead Zones, and Massive Problems in the Administrative State: A Guide for Whittling Away*, 98 Cal. L. Rev. 59, 80–82 (2010) (characterizing wetlands loss as a simple aggregation problem that existing policy has effectively addressed).
12. Dahl, Status and Trends 1998 to 2004, *supra* note 10, at 17, 66–68, 76 (noting that net increase masks a replacement of vegetated wetlands with open ponds which do not provide the same values and functions as vegetated wetlands); *see also* Dahl, Status and Trends 2004 to 2009, *supra* note 10, at 76–80 (discussing causes and implications of ongoing increase in acreage of created open ponds); Susan-Marie Stedman & T.E. Dahl, Nat'l Marine Fisheries Serv. & U.S. Fish & Wildlife Serv., Status and Trends of Wetlands in the Coastal Watersheds of the Eastern United States 1998 to 2004, at 5 (2008) [hereinafter Stedman & Dahl, Eastern Coastal Watersheds 1998 to 2004] (noting estimated loss of 361,000 acres in coastal watersheds during the period in which a national net gain was reported).
13. *See generally* Royal C. Gardner et al., *Compensating for Wetlands Losses Under the Clean Water Act (Redux): Evaluating the Federal Compensatory Mitigation Regulation*, 38 Stetson L. Rev. 213 (2009) (discussing the problems with compensatory mitigation and reviewing agency and NGO reports on the status of compensatory mitigation efforts). *See also* Royal C. Gardner, *Banking on Entrepreneurs: Wetlands, Mitigation Banking, and Takings*, 81 Iowa L. Rev. 527, 540–42 (1996) (discussing the ineffectiveness of compensatory mitigation using studies of mitigation projects in Florida and Washington).
14. *See* U.S. Gov't Accountability Office, GAO-05-898, Wetlands Protection: Corps of Engineers Does Not Have an Effective Oversight Approach to Ensure That Compensatory Mitigation Is Occurring 17 (2005); Nat'l Research Council, *supra* note 6, at 22; Gardner et al. *Compensating for Wetlands Losses*, *supra* note 13, at 241–42; Babcock, *supra* note 9, at 323, 333 (citing Office of Tech. Assessment, OTA-0-206, Wetlands: Their Use and Regulation 179 (1984)).
15. *See* Babcock, *supra* note 9, at 333–34 (citing *An Assessment of Wetland Mitigation Practices in Washington State*, Nat'l Wetlands Newsl. (Envtl. Law Inst., Washington, D.C.), 1988, at 3).
16. *See* Nat'l Research Council, *supra* note 6, at 22–27; Royal C. Gardner, *Money for Nothing? The Rise of Wetland Fee Mitigation*, 19 Va. Envtl. L.J. 1, 2 & n.2 (2000).
17. *See* Nat'l Research Council, *supra* note 6, at 2; Joy B. Zedler, *Wetland Restoration: Trials and Errors in Ecotechnology?*, *in* Richard M. Strickland, Wetlands Functions, Rehabilitation, Creation in the Pacific Northwest: The State of Our Understanding 11–16 (1986); J.B. Ruhl et al., *Implementing the New Ecosystem Services Mandate of the Section 404 Compensatory Mitigation Program—A Catalyst for Advancing Science and Policy*, 38 Stetson L. Rev. 251, 256–59 (2009); James Salzman & J.B. Ruhl, *Currencies and the Commodification of Environmental Law*, 53 Stan. L. Rev. 607, 611–12 (2000). In 2009, FWS announced initiation of the National Wetland Condition Assessment—an effort to assess not just quantity but also quality of the nation's wetlands. Dahl, Status and Trends 2004 to 2009, *supra* note 10, at 81–85.
18. *See, e.g.*, Babcock, *supra* note 9, at 322 ("[Section 404] does not apply to many of the activities that have a significant and lasting adverse effect on wetlands. The chemical contamination of a wetland does not require a federal permit; nor does excavating wetland soils, flooding a wetland, shutting off the flow of fresh water into the wetland by constructing an upstream dam, or removing wetland vegetation.").
19. *Id.* at 314–15.
20. *See id.* at 311 (listing continuing development pressures on wetland areas, including water-based activities, mineral deposits and productive farming soil).
21. Dahl, Status and Trends 2004 to 2009, *supra* note 10, at 16.
22. *See id.* at 45 (acknowledging growing awareness of the threat climate change poses to coastal wetland areas).
23. *See, e.g.*, James M. Murphy et al., *Quantification of Modelling Uncertainties in a Large Ensemble of Climate Change Simulations*, 430 Nature 768, 768–69 (2004) (noting the difficulties of developing comprehensive global climate models, including "large but unquantified uncertainties in the modelling [sic] process").

climate change will affect wetlands, and even fewer have focused on wetlands in North America and the United States.[24] Projecting wetlands loss, degradation, and change due to climate change presents several challenges, including the variability of impacts among different types of wetlands and different geographic locations; a limited understanding of how wetland species may respond to climatic changes; a limited understanding of how climatic variables such as temperature, precipitation, water quantity and quality, and atmospheric carbon levels may interact with one another; and the significance of non-climate related impacts—primarily the dredging and filling of wetlands.[25] In its most recent status and trends report on the state of the nation's wetlands, however, FWS included a table summarizing the literature detailing observed changes to the extent or distribution of specific types of wetlands caused by climatic conditions.[26]

This Part begins by examining climate change projections for specific variables that can shed light on potential impacts to wetlands. These variables include changes in precipitation and temperature and sea level rise.[27] The section proceeds with a discussion of potential climate change impacts on specific types of wetlands found in the United States.

A. Precipitation and Temperature Changes

Temperature, atmospheric carbon levels, and precipitation are strongly linked to wetland structure and function.[28] Findings from the U.S. Global Change Research Program's 2009 report indicate that U.S. temperatures will rise up to three degrees Fahrenheit over the next two decades and between four and eleven degrees Fahrenheit by 2099, depending on the emission rates of heat-trapping gases.[29] In addition, projections indicate that precipitation patterns will shift such that northern regions of the United States will likely become wetter and southern regions will become drier.[30] Heavy precipitation events are likely to become increasingly frequent, especially in wetter regions such as the Northeast and Midwest.[31] The combination of increasing temperatures and shifting precipitation patterns will likely significantly impact some wetlands.[32] Scholars have found that wetlands may be particularly vulnerable to changes in annual average temperatures and precipitation levels due to the particular sensitivity of wetland biota to small changes in the proximity of the water table, the restricted capacity of wetland species to migrate due to human-induced wetland fragmentation in the form of dams and roadways, and other human-induced environmental stressors such as eutrophication and pollution.[33]

The type and extent of climate change impacts will differ for hydrologically distinct wetland types.[34] Generally, precipitation-dependent wetlands will be more vulnerable to a drying climate than groundwater flow-dependent ones.[35] Regardless, because wetlands are inextricably linked to the water cycle "[r]elatively small changes in precipitation, evaporation, or transpiration which alter surface or ground water level by only a few centimeters will be enough to reduce or expand many wetlands in size, convert some wetlands to dry land, or shift one wetland type to another."[36] Reduced precipitation levels are likely to cause decreased surface water flow, which will isolate wetlands from primary water sources and species habitat such as stream channels.[37] Disconnected floodplains resulting from a drier climate would harm vulnerable aquatic communities and riverine wetland species.[38] Even wetlands that depend more on groundwater flows, as opposed to precipitation or surface water flows, may be vulnerable.[39] The drawdown of water tables caused by a drying climate could reduce the number of some types of wetlands, such as riverine wetlands that rely on groundwater in arid climates.[40] We can analogize such a situation to several documented examples of wetland loss and degradation due to groundwater pumping: the drying of cypress domes in Tampa Bay due to pumping of aquifers for consumptive use and the dying of riparian cottonwood forests in the western United States due to groundwater pumping.[41]

B. Sea Level Rise

Sea level rise poses another climate-induced threat to wetlands. Rises in U.S. and global temperatures will continue to contribute to sea level rise by inducing thermal ocean expansion, glacial melting, and deterioration of the Greenland and Antarctic ice sheets.[42] Increasing sea levels will likely overtake many coastal wetlands, particularly those unable to keep up with sea level rise by vertical sediment accretion or inland migration.[43] Increased levels of atmospheric carbon

24. *See* Michael C. Acreman & Matthew P. McCartney, *Hydrological Impacts in and Around Wetlands*, *in* The Wetlands Handbook 643, 645–46 (Edward Maltby & Tom Barker eds., 2009) (listing quantitative studies of climate change threats to wetlands in India, China, Great Britain and the U.K., Australia, the Mediterranean area of Europe, and Tanzania).
25. Burkett & Kusler, *supra* note 3, at 315.
26. Dahl, Status and Trends 2004 to 2009, *supra* note 10, at 86, 87 & tbl. 5. In doing so, Dahl noted that uncertainty limits any effort to link climate change to observed effects. *Id.* at 86, 87 & tbl. 5.
27. Donald Scavia et al., *Climate Change Impacts on U.S. Coastal and Marine Ecosystems*, 25 Estuaries 149, 149 (2002).
28. Burkett & Kusler, *supra* note 3, at 313.
29. Karl et al., *supra* note 1, at 15, 28–29 (noting that gases include primarily carbon dioxide and methane, which exist in the atmosphere for thousands of years and decades, respectively, after emission).
30. *Id.* at 30.
31. *Id.* at 32.
32. Burkett & Kusler, *supra* note 3, at 315.
33. Mark Brinson, *Consequences for Wetlands of a Changing Global Environment*, *in* Ecology of Freshwater and Estuarine Wetlands 436, 440 (Darold P. Batzer & Rebecca R. Sharitz eds., 2006).
34. *Id.* at 449–56; *see also id.* at 460 tbl. 12.2 (summarizing effects of climate change on different types of wetlands as well as corresponding management options).
35. *Id.* at 450.
36. Burkett & Kusler, *supra* note 3, at 313.
37. *See* Brinson, *supra* note 33, at 450.
38. *See id.* at 450–51.
39. *See* Michael C. Acreman, Ramsar, Managing Groundwater: Guidelines for the Management of Groundwater to Maintain Wetland Ecological Character 8–9 (4th ed. 2010); Garth van der Kamp & Masaki Hayashi, *The Groundwater Recharge Function of Small Wetlands in the Semi-Arid Northern Prairies*, 8 Great Plains Res. 39, 51 (1998).
40. *See* Brinson, *supra* note 33, at 452.
41. *Id.* ("These human-induced changes, however, typically occur more abruptly than those expected from a drying climate.").
42. Karl et al., *supra* note 1, at 37.
43. Burkett & Kusler, *supra* note 3, at 316; *see also* Dahl, Status and Trends 1998 to 2004, *supra* note 10, at 19–20 (observing extensive losses of saltwater

dioxide, however, will cause certain wetland plant species to proliferate.[44] As these plants die and layer over time, the resulting biomass accumulation will allow some coastal wetlands to keep up with sea level rise.[45] This benefit could be offset, however, by an increase in methane emissions from anaerobic microbes in the increased biomass.[46] Emissions of methane, a greenhouse gas, have been shown to contribute to rising global temperatures.[47]

C. Impacts on Specific U.S. Wetland Types

Beyond general hydrological characteristics of wetlands, their variability translates into varying vulnerabilities to climate change impacts, depending on the type and location of a wetland. After a brief discussion of how climate change is likely to impact certain specific wetlands functions, this Part addresses climate change impacts to coastal and inland wetlands in the United States.[48]

Different wetland types have distinct characteristics and perform different functions valued by humans. Commonly accepted functions of wetlands include flood conveyance, protection from storm waves and erosion, sediment control, habitat for fish and shellfish, habitat for water birds and other wildlife, recreation, water supply, timber production, preservation of historic and archaeological values, education and research, open space and aesthetic value, and water quality improvement.[49] If the impacts discussed below come to fruition, however, wetlands will be lost and their associated functions will be degraded.[50]

Some of these functions—such as flood control and water supply—will have even greater value to humans in some areas of the United States in an era of climate change.[51] For example, in coastal areas and areas that see increased precipitation, the flood control and storm surge buffering that wetlands can provide may have increased value.[52] In areas facing drought, the water storage and aquifer recharge services some wetlands provide will be more important.[53] Just when we may need them most, we risk losing these natural services that wetlands provide that could buffer us against climate change impacts.[54]

In an even crueler irony, the loss of wetlands may amplify or accelerate climate change to the extent wetlands' important carbon sequestration, release, and storage function is lost along with the wetlands.[55] Although considerable complexities prevent complete understanding of the overall impact of climate change on wetlands' role as a carbon reservoir, it is likely that the degradation of wetlands will result in substantial releases of carbon to the atmosphere as carbon dioxide.[56] Studies have shown that further temperature rise can contribute to increases in the decomposition of soil organic matter in wetland ecosystems, which can reverse the effects of thousands of years of carbon sequestering and result in substantial releases of carbon dioxide and methane to the atmosphere.[57] In other words, climate change likely will lead to wetlands themselves producing increased net emissions of greenhouse gases relative to the present, potentially creating a positive feedback loop feeding further climate change.

1. Coastal and Estuarine Wetlands

As discussed above, sea level rise will likely destroy at least some coastal wetlands, either by inundation or erosion.[58] Most of the loss of saltwater wetlands along the Atlantic coast and in the Gulf of Mexico in recent years has been caused by inundation or saltwater intrusion.[59] In fact, studies have shown that sea level rise has already played a role in wetlands losses along southeastern and mid-Atlantic coastlines.[60] Some types of more complex wetlands, such as estuarine forests adjacent to coastlines and mangrove forests, may suffer from reduced structural complexity or disappearance.[61] Even coastal wetlands that remain intact, however, will likely experience saltwater intrusion due to increasing sea levels.[62]

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wetlands from Rhode Island Sound to the mouth of Chesapeake Bay as well as in the Gulf of Mexico).

44. Burkett & Kusler, *supra* note 3, at 316 (explaining that increased atmospheric carbon dioxide levels will cause greater growth rates of wetland plants using the C_3 photosynthetic pathway than ones using the C_4 pathway).
45. *See* Univ. of Fla. Academic Tech., *Global Change Impacts on Wetland Vulnerability to Sea Level Rise*, Univ. of Fla. (Oct. 3, 2011), http://mediasite.video.ufl.edu/Mediasite/Play/4a939da4bb994.34c9eea7715a65669b61d.
46. *Id.*
47. Karl et al., *supra* note 1, at 14.
48. Wetlands are commonly categorized as coastal or inland. *See What Are Wetlands?*, U.S. Envtl. Prot. Agency, http://water.epa.gov/type/wetlands/what.cfm (last updated Sept. 29, 2011). The terms coastal and inland are often used interchangeably with tidal and non-tidal, respectively. *See id.*; *see also* William J. Mitsch & James G. Gosselink, Wetlands 260 (4th ed. 2007) (classifying wetlands into coastal, which includes salt marshes, tidal freshwater marshes, and mangroves, and inland, which includes freshwater marshes, peatlands, freshwater swamps, and riparian systems).
49. John A. Nyman, *Ecological Functions of Wetlands*, *in* Wetlands: Integrating Multidisciplinary Concepts 115, 116 tbl. 6.1 (Ben A. LePage ed., 2011).
50. *See infra* Part I.C.1–2.
51. *See* Butchart et al., *supra* note 4, at 1–3.
52. *See* Nyman, *supra* note 49, at 125.
53. *See* Butchart et al., *supra* note 4, at 38 tbl. 3.2.
54. *See id.* at 10.
55. Edward Maltby, *The Changing Wetland Paradigm*, *in* The Wetlands Handbook 37 (Edward Maltby & Tom Barker eds., 2009).
56. Nancy Dise, *Biogeochemical Dynamics III: The Critical Role of Carbon in Wetlands*, *in* The Wetlands Handbook 259, 262 (Edward Maltby & Tom Barker eds., 2009).
57. Brinson, *supra* note 33, at 441–43, 458.
58. *See* James G. Titus, *Sea Level Rise and Wetland Loss: An Overview*, *in* U.S. Envtl. Prot. Agency, EPA-230-05-86-013, Greenhouse Effect, Sea Level Rise and Coastal Wetlands 10, 20 (James G. Titus ed., 1988), *available at* http://papers.risingsea.net/federal_reports/sea-level-rise-and-wetlands-chap1-Titus.pdf.
59. Dahl, Status and Trends 2004 to 2009, *supra* note 10, at 16, 40 (noting 84,100 acres of lost marine and estuarine intertidal wetlands, seventy-three percent of which was to deepwater bay bottoms or open ocean; ninety-nine percent of all estuarine emergent (salt marsh) wetland losses were associated with saltwater inundation and/or coastal storm events). In some areas of the Gulf of Mexico, however, these effects result from land subsidence, compaction of sediments, and oil, gas, and groundwater extraction which contribute to relative sea level rise. *Id.*; *see also* Stedman & Dahl, Eastern Coastal Watersheds 1998 to 2004, *supra* note 12, at 19–20 (noting that FWS reported during the period 1998 to 2004, only 1.5% of saltwater wetland losses were due to urban and rural development).
60. Burkett & Kusler, *supra* note 3, at 316; *see also* Dahl, Status and Trends 2004 to 2009, *supra* note 10, at 16, 87 tbl. 5.
61. Dahl, Status and Trends 2004 to 2009, *supra* note 10, at 87 tbl. 5.
62. *Id.* (collecting literature documenting changes); Robert J. Nicholls et al., *Coastal Systems and Low-Lying Areas*, *in* Climate Change 2007: Impacts, Adaptation and Vulnerability—Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel

Saltwater intrusion in the coastal zone may extend to brackish and freshwater wetlands.[63] This hydrological change will alter the composition of wetland flora and fauna species.[64] Although the pace, location, and extent of the loss is unknown, even projections assuming low emissions scenarios (relative to other scenarios) show sea level rise, which would impact coastal wetlands.[65]

The value of these coastal and estuarine wetlands is indisputable. Numerous reports cite their ecological, economic, and social importance.[66] A recent FWS report notes that wetlands (including freshwater wetlands) "provide an essential link of the life cycle of 75 percent of the fish and shellfish commercially harvested in the United States and up to 90 percent of the recreational fish catch."[67] Wetlands support fisheries that contribute $111 billion annually to our national economy, employing 2 million people.[68] Restoration or reestablishment of these wetlands has met with very limited success[69] and depends on a variety of physical processes such as flow, circulation, transport of nutrients, salinity, and sediments.[70]

One source of hope is that coastal wetlands may naturally adapt through inland migration or vertical sediment accretion, if sea level rise is sufficiently gradual.[71] Human activities and development patterns and natural coastal features, such as cliffs, may prevent this process, however.[72] Manmade landward constraints, such as roads and buildings, can prevent wetlands from migrating inland.[73] Even where adjacent land is not completely developed, if it is privately owned, landowners may take steps to prevent wetlands from forming, thereby preventing any protection from attaching before the incipient wetland has time to develop.[74] Given the intensity of human development along our coastlines, migration seems unlikely to provide significant mitigation to losses of coastal wetlands.[75]

Human activities also can cause disruption to natural sediment deposition processes, preventing vertical sediment accretion.[76] Without the natural land building process, a wetland can succumb to sediment erosion, lose elevation, and become more vulnerable to flooding.[77] Louisiana's coastal wetlands provide an illustration. The state lost more than seventy percent of its substantial coastal wetlands between 1956 and 2000 and continues to lose more coastal wetland acreage each year.[78] The wetlands exist in a state of quasi-equilibrium in which land-building and land decay are part of a constant cycle dictated by riverine flooding, sea level rise, natural land subsidence, and Gulf storms.[79] The construction of levees and canals, the introduction of an exotic animal species (the nutria), and oil and gas extraction, among other human activities, have altered the ecosystem hydrology and accelerated land subsidence.[80]

The uncertainties surrounding the precise effects of climate change in a given region make prediction of the effects on particular coastal areas difficult. Nevertheless, ongoing unmitigated loss of coastal wetlands seems virtually certain,[81] and there is a distinct possibility that the loss will accelerate as climate change unfolds.[82] Uncertainty limits our ability to estimate both the cost of the potential loss and the cost of adaptation. Experience to date—including the ongoing loss in Louisiana—suggests, however, that section 404, standing alone, is not likely to slow the pace of coastal wetland loss measurably.[83]

2. Inland Wetlands

Temperature and shifting precipitation patterns associated with climate change will significantly impact inland wetlands,[84] including freshwater marshes and peatlands, prairie pothole wetlands, and permafrost and alpine wetlands.[85] Many of these wetlands are periodically dry and many are located in low-lying areas, making them susceptible to subtle hydrological changes.[86]

Peatlands—bogs and other wetlands composed of mainly organic matter[87]—are particularly sensitive to changes in groundwater level, which affects organic matter accumulation and decay.[88] Decreasing soil moisture levels are likely to accompany increasing temperatures, causing degradation of peatlands in the southern United States.[89] This degradation may be exacerbated by decreasing precipitation in the southern regions of the United States.[90] Droughts, accompanied by increased frequency and intensity of wildfires, would

on Climate Change 319, 331–33 (M.L. Parry et al. eds., 2007); Burkett & Kusler, *supra* note 3, at 316.

63. Nicholls et al., *supra* note 62, at 329 ("Climate change will likely have its most pronounced effects on brackish and freshwater marshes in the coastal zone through alteration of hydrological regimes.").
64. *Id.* at 328.
65. *See* Intergovernmental Panel on Climate Change ("IPCC"), *Summary for Policymakers*, *in* Climate Change 2007: Synthesis Report 8 (M.L. Parry et al. eds., 2007).
66. *See, e.g.*, Dahl, Status and Trends 2004 to 2009, *supra* note 10, at 48 (discussing the importance of wetland resources with regard to rising sea levels).
67. *Id.* at 57.
68. *Id.* at 58.
69. *See id.* at 48.
70. *See id.* at 52.
71. *See* Matthew Heberger et al., Cal. Climate Change Ctr., CEC-500-2009-024-F, The Impacts of Sea-Level Rise on the California Coast 27 (2009), *available at* http://www.pacinst.org/reports/sea_level_rise/report.pdf; Burkett & Kusler, *supra* note 3, at 317.
72. *See* Heberger et al., *supra* note 71.
73. *See id.*
74. Such steps may include river flow management, construction of bulkheads and levees to prevent coastal flooding, or draining and impoundment for agricultural purposes. *See* Burkett & Kusler, *supra* note 3, at 318; Titus, *supra* note 58, at 18.
75. *See, e.g.*, Dahl, Status and Trends 2004 to 2009, *supra* note 10, at 55 (noting, in the context of estuarine shrub wetlands, that "wetlands have continued to decline over time as losses to the estuarine emergent category have overshadowed the small gains . . .").
76. *See* Denise J. Reed & Lee Wilson, *Coast 2050: A New Approach to Restoration of Louisiana Coastal Wetlands*, 25 Physical Geography 4, 13 (2004).
77. *See id.* at 5, 8.
78. *Id.* at 4.
79. *Id.* at 5.
80. *Id.* at 4–8.
81. *See id.* at 4.
82. *See id.* at 10.
83. *See id.* at 8–9.
84. *See* Burkett & Kusler, *supra* note 3, at 316–18.
85. *Id.* at 317–19.
86. *See What Are Wetlands?*, *supra* note 48.
87. Burkett & Kusler, *supra* note 3, at 317.
88. *Id.*
89. *Id.*
90. Karl et al., *supra* note 1, at 30.

also result in the destruction and degradation of peatlands.[91] Because peatlands are major storage sites for carbon, this destruction and degradation could result in the release of significant amounts of accumulated carbon to the atmosphere as carbon dioxide, further contributing to global warming.[92]

The prairie pothole wetlands in the northern U.S. Great Plains region are projected to decline in size over the next fifty to one hundred years due to increasing temperatures and decreasing precipitation in the region.[93] These wetlands, which provide important waterfowl habitat, are composed of isolated, wet depressions.[94] Prairie pothole wetlands, as well as wetlands with similar features such as playas and basins, will experience significant degradation and destruction with the projected increase in the frequency of droughts.[95]

Permafrost underlies eighty-five percent of Alaskan lands, including many inland wetlands.[96] Global warming has already led to some permafrost thawing, and scientists expect the trend to continue.[97] The thawing will result in large scale hydrological changes, including changes in surface and groundwater flow.[98] Increased flow rates will increase sediment loads into rivers and lakes, threatening riparian wetlands.[99] Accompanying changes in temperature, precipitation, and soil moisture threaten species dependent on alpine wetlands.[100] Many alpine plants are slow growing and will have little opportunity to migrate with the snow cover as it moves upslope over the next century.[101]

The most salient observation emerging from this examination of climate change impacts on wetlands is that even subtle hydrological changes are likely to significantly impact the location, size, functions, and biodiversity of wetlands.[102] If we value sound natural resource management and its accompanying benefits to both humans and the environment, our regulatory approach to wetlands should take these observations into account.

II. Assessing the Threat

As discussed above, increasing temperatures and shifting precipitation patterns associated with climate change will likely cause wetlands to migrate, expand, or diminish in size.[103] For instance, inland migration of a coastal wetland could cause the wetland to overtake a highway or someone's backyard.[104] Wetlands may diminish either through inundation, especially along the coast, or because of reduced surface or groundwater.[105] Increasing precipitation could cause new wetlands to appear inland as well.[106] But even under best case scenarios for the establishment of new wetlands—more water in some areas—the reality is that more water will not necessarily lead to increased wetland acreage.[107] Impervious surfaces and private landowners' preemptive actions may hinder wetland formation.[108] In addition, wetlands require time to become established.[109] Draining or hardening of the coastline may halt the process.[110] Even if a wetland overcomes these hurdles and forms inland, its protection is uncertain. Presumably, a property owner could fill an area that develops hydrology that could support a wetland before any significant vegetation can take root. If the property owner does allow the wetland to form, there is still a question as to its value.[111]

In the face of anticipated climate change and inevitably limited resources, it is important that we develop a framework for assessing the threat to wetlands posed by climate change in order to develop a response that reflects our values and priorities. Ideally, such an assessment would begin with identifying the values and functions of wetlands of different types and of wetlands in different locations and would incorporate an assessment of the likelihood that climate change will affect the values and functions of specific wetlands positively or negatively. In addition, the relative importance of the identified values and functions, the feasibility and cost of seeking to preserve these values and functions by preserving relevant wetland acreage, and the costs and uncertainties of trying to replicate the values and services through alternate strategies would be relevant to developing a response. Such an assessment would benefit from efforts to estimate the costs—either in terms of the market value of lost services (e.g., wetlands' contributions to fisheries) or the anticipated economic costs from loss of the services (e.g., increased flooding or lost jobs from fisheries collapse)—and the likelihood that costs or losses of a particular magnitude will ensue. Beyond the lost values that can be quantified, we must also recognize the substantial noneconomic values associated with wetlands and consider whether we are pre-

91. Burkett & Kusler, *supra* note 3, at 317.
92. Dise, *supra* note 56, at 262. As Dise notes, the risk of wetland degradation triggering the release of carbon to the atmosphere is difficult to quantify. *Id.* The amount of carbon sequestration and release will depend on the extent to which various biogeochemical processes are at play and their variation due to climate change. *Id.* at 259–60.
93. Burkett & Kusler, *supra* note 3, at 318.
94. *See* Office of Wetlands, U.S. Envtl. Prot. Agency, America's Wetlands: Our Vital Link Between Land and Water 4 (2003), *available at* http://water.epa.gov/type/wetlands/upload/2003_07_01_wetlands_vital_wetlands.pdf.
95. Burkett & Kusler, *supra* note 3, at 318.
96. *Id.* at 317.
97. *Id.* ("The southern boundary of continuous permafrost is projected to shift northward by about 500 km over the next 50 years.").
98. *Id.*
99. *Id.*
100. *Id.* at 318.
101. *Id.*
102. *Id.* at 315.
103. *Id.*
104. *See* Heberger et al., *supra* note 71, at 27.
105. Burkett & Kusler, *supra* note 3, at 313.
106. *Id.*
107. *See* Butchart et al., *supra* note 4, at 7.
108. *See* Interagency Workgroup on Wetland Restoration, An Introduction and User's Guide to Wetland Restoration: Creation and Enhancement 13 (2003), *available at* http://water.epa.gov/type/wetlands/restore/upload/pub_wetlands_restore_guide.pdf.
109. *See id.* at 38.
110. *Connecting Science and Management for Virginia's Tidal Wetlands*, Rivers & Coast (Ctr. for Coastal Res. Mgmt., Gloucester Point, Va.), Fall 2008, at 7, *available at* http://ccrm.vims.edu/publications/pubs/rivers&coast/vol3_no1_science&mgt.pdf.
111. Studies of island biogeography suggest that the lack of resources often accompanying isolated, fragmented habitat—as may be the case for a newly formed wetland on private land—may not support significant biodiversity. *See* Mark V. Lomolino, James H. Brown & Dov F. Sax, *Island Biogeography Theory: Reticulations and Reintegration of "a Biogeography of the Species," in* The Theory of Island Biogeography Revisited 14 (Jonathan B. Losos & Robert E. Ricklefts eds., 2010).

pared to lose those. This information on the economic and noneconomic value of wetlands can inform our assessment of the risks we face and the appropriate response. This may include decisions on whether we are willing to roll the dice and risk suffering the loss of these wetlands and their associated values and services or should prioritize efforts to avoid the impacts, and also decisions on whether we can or should prioritize the affirmative protection of particular wetlands.

A. *Valuing Wetlands*

Assessments of the value associated with wetlands are not new and have already been undertaken for some wetlands. Wetlands valuation is one application of ecosystem services valuation, a set of techniques for measuring the benefits people acquire from the environment's natural capital.[112] It associates dollar figures with ecological and physical functions and services of wetlands.[113] By valuing a specific wetland function or service based on the benefit it provides, valuation can enable the explicit recognition and prioritization of those wetlands that merit protection based on the relevant values.[114] Efforts to quantify the value of natural systems remain somewhat controversial because of the techniques' limitations, but they may prove important tools to help make concrete the risks associated with climate change and to inform decisions about wetland protection both now and in the future.[115]

Wetlands provide humans value through humans' direct and indirect use of wetland services and resources.[116] Direct use values of wetlands include the provision of commercial and recreational fishing and hunting areas, energy resources, and natural materials, as well as wetlands' value as an amenity and a place for other recreational activity.[117] Indirect values of wetlands include flood and storm protection, water supply and quality, climate stabilization, and reduced global warming.[118] In addition to direct and indirect use values, wetlands also provide economic value apart from any use or service provided to humans: so-called non-use values.[119] For example, the existence value of the habitat and species that comprise a wetland is one non-use value.[120] An array of methods exists for measuring the economic value associated with direct, indirect, and non-use values of wetlands.[121] Studies use these valuation methods to assess the value of various wetland types, services, and functions.[122]

Two major meta-analyses of wetland valuation studies are useful in gaining a broad understanding of the economic values associated with wetland functions and services. The two studies, one by Woodward and Wui and another by Brander et al., compared 39 and 190 wetland valuation studies, respectively.[123] In one meta-analysis, Woodward and Wui ranked the following values from most valuable to least: birdwatching, commercial fishing, water quality, flood protection, recreational fishing, habitat, storm protection, water quantity, bird hunting, and amenity.[124] In the other study, Brander et al. found that biodiversity was the most valuable function, while the use of wetlands for raw materials ranked lowest in value.[125] Brander et al. also found that some wetland functions, such as certain ecological functions, may require a threshold acreage to provide any calculable value.[126]

These meta-analyses can help to identify general trends, but they have significant limits because they cut across studies that apply varying methodologies to many different types of wetlands. Individual wetland valuation studies can provide greater detail and help us to better understand the values associated with wetlands[127] at the scale of individual wetlands, wetlands in a particular region, or wetlands of a particular type.[128]

Of course, geographic location influences the value of a particular wetland function. For instance, the storm protection provided by coastal wetlands in certain areas is a particularly important value because of the serious impacts caused by storm surges on those segments of coastline.[129] Costanza et al. have valued coastal U.S. wetland storm protection in the aggregate at over $23.2 billion per year.[130] Their calculation took into account the probability of storms in the area, the gross domestic product ("GDP") in the area, and the wetlands acreage in the area.[131] Under this approach, wetlands represent a particularly high value in areas with high storm probability, high coastal GDP, and high wetlands acreage.[132]

112. *See* Shuang Liu et al., *Valuing Ecosystem Services: Theory, Practice, and the Need for a Transdisciplinary Synthesis*, 1185 Ann. N.Y. Acad. Sci. 54, 54 (2010).
113. *See* Luke M. Brander et al., *The Empirics of Wetland Valuation: A Comprehensive Summary and a Meta-Analysis of the Literature*, 33 Envtl. & Res. Econ. 223, 226 (2006). Aside from an exchange value or price, ecosystem valuation may assign value by importance, utility, or other measure. *See, e.g.*, Rudolf de Groot et al., Ramsar, Ramsar Technical Report No. 3, CBD Technical Ser. No. 27, Valuing Wetlands: Guidance for Valuing the Benefits Derived from Wetlands Ecosystem Services 3 (2006) (identifying three types of valuation: economic, ecological, and sociological), *available at* http://www.ramsar.org/pdf/lib/lib_rtr03.pdf.
114. *See* James Salzman, *Valuing Ecosystem Services*, 24 Ecology L.Q. 887, 902 (1997).
115. *See generally* Lynn E. Blais, *Beyond Cost/Benefit: The Maturation of Economic Analysis of the Law and Its Consequences for Environmental Policymaking*, 2000 U. Ill. L. Rev. 237 (2000) (explaining the role economic analysis has in the development of environmental law and policy and the historic shifts in focus in determining the worth of environmental initiatives).
116. *See* Brander et al., *supra* note 113, at 227.
117. *See id.* at 226 tbl. 1; Richard T. Woodward & Yong-Suhk Wui, *The Economic Value of Wetland Services: A Meta-Analysis*, 37 Ecological Econ. 257, 259 tbl. 1 (2001).
118. Brander et al., *supra* note 113, at 226 tbl. 1; Woodward & Wui, *supra* note 117, at 259 tbl. 1.
119. Brander et al., *supra* note 113, at 226–27.
120. *Id.* at 226 tbl. 1.
121. *Id.* at 234; Woodward & Wui, *supra* note 117, at 259.
122. Brander et al., *supra* note 113, at 233 fig. 2.
123. *Id.* at 223; Woodward & Wui, *supra* note 117, at 258.
124. Woodward & Wui, *supra* note 117, at 268.
125. Brander et al., *supra* note 113, at 235–36.
126. *Id.* at 236.
127. *Id.* at 242.
128. Valuation of U.S. wetlands is not comprehensive, but the Ecological Research Program of the U.S. Environmental Protection Agency ("EPA") is currently compiling nationwide data on ecosystem services including wetlands services. *See Ecosystems Research*, U.S. Envtl. Prot. Agency, http://www.epa.gov/research/ecoscience/ (last updated Dec. 20, 2012).
129. *See, e.g.*, Robert Costanza et al., *The Value of Coastal Wetlands for Hurricane Protection*, 37 Ambio 241, 247 (2008).
130. *Id.* at 241, 245.
131. *Id.* at 245–46.
132. *See id.* at 246 fig. 4 (providing an insightful graphical representation of coastal wetlands storm protection).

B. *Linking Values to Climate Change Projections*

Just as location is a factor in determining the value of wetlands, location is a determining factor for the type and severity of the threat a given wetland faces from climate change. For example, coastal wetlands are also among the wetlands most evidently threatened by climate impacts, particularly sea level rise.[133] One useful step in assessing the threat to wetlands from the potential impacts of climate change is to combine information from valuation studies on wetlands in a particular location or a certain type of wetland with information on the likely impact of climate change on that subset of wetlands. Several examples, described below, illustrate the type of information this approach can yield.

Today, sea level rise is overtaking U.S. coastlines at a rate of a few inches to over two feet per century, and climate change is expected to accelerate the rate of loss.[134] In the Gulf of Mexico region, the loss of wetlands due to sea level rise threatens the values and services wetlands provide, including fish and wildlife habitat, commercial and recreational fishing opportunities, storm surge protection, water quality improvement, and greenhouse gas sinks.[135] In Louisiana alone, studies have estimated that by 2050, nearly 233,000 acres of land will be lost to sea level rise.[136] With respect to the commercial fisheries industry alone, a 1997 report to Congress noted that such an acreage loss could translate to annual economic losses of at least $58 million.[137] In worst case sea level rise scenarios, that figure increases.[138]

In California, coastal wetlands comprise approximately 550 square miles.[139] Under a best-case scenario, assuming low greenhouse gas emissions relative to other scenarios, the California Climate Change Center ("the Center") predicted that by 2099, California will experience 6 to 14 inches of sea level rise, a 3.0 to 5.4 degree Fahrenheit temperature rise, 30 to 60% loss in Sierra snowpack, increased heat wave days, up to 1.5 times the number of critical dry years, a 7 to 14% decrease in pine forest yields, and a 10 to 35% increase in the risk of large fires.[140] The authors projected 14 to 22 inches of sea level rise under a moderate emissions scenario, and twenty-two to thirty inches of rise under a high emissions scenario.[141] The Center valued the state's coastal wetlands by the public's willingness to pay to restore them, which ranged from $5,000 to $200,000 per acre for a total of $1.8 to $70 billion.[142] Even at the low emissions scenario corresponding with sea level rise of 6 to 14 inches, the losses are significant.[143] One potential mitigating factor is the possibility that areas adjacent to submerged wetlands could become wetlands due to the change in sea level. This is not certain, however, because these areas may not be amenable to wetland creation if they are paved or otherwise developed land[144] or they otherwise lack the necessary characteristics for wetland formation.

Some upland areas in the Great Lakes region may be suitable for wetland expansion or migration if the areas become wetter due to climate change, as some models project.[145] In estimating the value of current uplands for future wetland expansion or migration, we should consider the potential impacts on migratory birds and the values associated with them.[146] Aside from the biodiversity value of increased bird habitat, recreational activities such as hunting and bird watching add economic value to these areas.[147]

These are just a few examples of ongoing efforts to assess the wetlands' functions and values we may lose due to climate change and to identify areas where gains are possible. Further work may permit more fine-grained and more comprehensive assessment of the types and specific locations of the most vulnerable wetlands and the costs associated with their loss. An approach that integrates projections of impacts and valuation studies can produce better assessments of anticipated impacts and economic effects on regional activities such as wildlife tourism, recreational and commercial fishing and associated businesses, as well as the potential cost to all residents of lost services such as flood and storm protection. As with all efforts to quantify values of natural services, one problem is that non-quantifiable and non-use values are easily overlooked. Incorporating qualitative assessment of the impacts on these values is an important additional step.

The examples above highlight how important detailed data on wetlands values and functions is if we are to gain a comprehensive understanding of not only the distribution of wetland functions and services, but also the costs associated with their potential loss. The U.S. Environmental Protection Agency ("EPA") is currently developing methods to assess various effects, including climatic ones, on ecosystem and wetland services.[148] Much more data and analysis will be required, however, to systematically assess the threats we face.

III. Wetlands Protection Under Section 404 in an Era of Climate Change

The available information surveyed in Parts I and II suggests that potential climate impacts to wetlands present a risk

133. Burkett & Kusler, *supra* note 3, at 315.
134. Karl et al., *supra* note 1, at 25–26.
135. Virginia D. Engle, *Estimating the Provision of Ecosystem Services by Gulf of Mexico Coastal Wetlands*, 31 Wetlands 179, 179 (2011).
136. La. Coastal Wetlands Conservation & Restoration Task Force, The 2000 Evaluation Report to the U.S. Congress on the Effectiveness of Louisiana Coastal Wetland Restoration Projects 11 (2001).
137. *Id.*
138. *Id.*
139. Heberger et al., *supra* note 71, at 3.
140. Dan Cayan et al., Cal. Climate Change Ctr., CEC-500-2005-186-SF, Scenarios of Climate Change in California: An Overview 39 (2006), *available at* http://www.energy.ca.gov/2005publications/CEC-500-2005-186/CEC-500-2005-186-SF.PDF.
141. *Id.*
142. Heberger et al., *supra* note 71, at 28–29.
143. *Id.* at 30–31.
144. *See id.* at 32–33.
145. George W. Kling et al., Union of Concerned Scientists & Ecological Soc'y of Am., Confronting Climate Change in the Great Lakes Region: Impacts on Our Communities and Ecosystems 28 (2003), *available at* http://ucsusa.org/assets/documents/global_warming/greatlakes_final.pdf.
146. *Id.* at 30–31.
147. *See* Kling et al., *supra* note 145, at 31.
148. *See Water Research: Water and Climate*, U.S. Envtl. Prot. Agency, http://www.epa.gov/research/waterscience/water-climate.htm (last updated Oct. 19, 2012); *see also* Ruhl et al., *Implementing the New Ecosystem Services Mandate*, *supra* note 17, at 269–71.

we should not ignore and how we might begin to approach a more detailed assessment of that risk to guide our decisions.[149] This Part addresses the second question: whether and how the section 404 program and no net loss approach can contribute to an effective response to the risk. It begins by first discussing limitations of the section 404 program with respect to protecting wetlands from degradation associated with climate change, followed by an analysis of how climate change impacts can and should be addressed under the existing regulatory framework. Finally, we present several priorities for strengthening section 404 to better serve us in an era of climate change.

A. *Section 404's Limitations and Opportunities as a Response to Climate Change*

The section 404 program implements permitting requirements for the discharge of dredged or fill material into water and wetlands.[150] Two attributes of section 404 highlight its limitations in addressing the likely impacts to wetlands that may result from climate change. First, human activities that do not involve regulated discharges into jurisdictional wetlands are outside section 404's scope.[151] Thus, section 404 does not directly address wetlands loss or degradation caused by sea level rise or changes to hydrology from a changed climate.[152] It seems virtually certain that climate change will degrade and destroy some wetlands (along with the function and values associated with them) without triggering any action under section 404.[153] These impacts are beyond the scope of section 404's direct reach.

Second, section 404 seeks to preserve wetlands where they exist today.[154] Yet, we know that hydrology changes and sea level rise may make such efforts futile in certain areas.[155] This is not a new challenge for section 404,[156] but climate change presents the dilemma in a more extreme form. It is a new twist on the familiar tension between section 404's most successful mode of protection—allowing the wetland to remain where it is by denying authority to alter it—and the inherently dynamic wetlands, with their cycles of sedimentation, soil development, peat growth, and surface and ground water flow that contribute to their changing and often transient character.[157] Climate change will exacerbate this tension by creating a new and accelerated rate of change in wetlands.[158] This will inevitably hinder the success of a static strategy that seeks to preserve wetlands where they currently exist.[159] An added challenge is the uncertainty associated with climate predictions and its impact on agencies' ability to plan.

A natural response to this paralyzing combination of bad news and uncertainty would be to throw up our hands and simply admit defeat—accept that we don't know precisely what will happen, but that the net result will be a loss of wetlands that perform valuable services for humans and the ecosystems on which we depend. Because section 404 standing alone is unable to stop these global changes, one could easily decide that section 404 will become less important in an era of climate change and that our focus should be on creating some alternative method for dealing with the challenges.

But giving up on section 404 would be a very shortsighted view. Climate change undoubtedly presents what Professor William Buzbee has termed "regulatory commons" barriers: it is a problem that numerous agencies can and must deal with, but under-regulation may result because each agency has various incentives not to regulate efficiently. [160] As Professors J.B. Ruhl and James Salzman have noted, however, agencies need to whittle away at complex problems such as the problem posed by the interaction of various problems and by climate change in particular.[161]

A better question to ask is not whether section 404 is ideally designed to address the challenge of protecting wetlands in an era of climate change, but whether section 404 nevertheless offers opportunities to help us whittle away at the problem.[162] Looked at from that lens, section 404 offers promise both in helping us to assess the threats we face and to develop a response that reflects our values and priorities.

As discussed above, assessing the risks climate change poses to wetlands present a huge informational challenge. Detailed data on wetlands values and functions, as well as analysis of the threats to specific wetlands posed by climate change, are critical to our ability to assess the threats we face and therefore critical to developing sound responses. If we decide that the costs associated with the loss of particular types of wetlands or wetlands in particular locations warrant our attention, then we have the opportunity to develop a strategy that will enable us to protect those critical wetlands, if that is possible, or to adapt by taking steps to offset unavoidable, but costly, losses. Good data on the values associated with wetlands in specific locations will likely be critical, as well as ongoing monitoring and adaptive planning to account for the impacts of a changing climate.[163]

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149. *See supra* Parts I–II.
150. *See* CWA § 404, 33 U.S.C. § 1344 (2006).
151. *See* Alyson C. Flournoy, *Section 404 at Thirty-Something: A Program in Search of a Policy*, 55 Ala. L. Rev. 607, 618 (2004) [hereinafter Flournoy, *Section 404 at Thirty-Something*]; Babcock, *supra* note 9, at 322.
152. *See* Babcock, *supra* note 9, at 322.
153. *See* CWA § 404, 33 U.S.C. § 1344 (establishing permitting program for dredged or discharged material); Burkett & Kusler, *supra* note 3, at 315 (stating that temperature increase, sea level rise, and precipitation caused by climate change will impact wetlands).
154. *See* Babcock, *supra* note 9, at 320 (stating that section 404 was intended to protect wetlands).
155. *See* Burkett & Kusler, *supra* note 3, at 315 (discussing that increased precipitation will change the size of many wetlands and convert some wetlands to dry lands).
156. *See* Babcock, *supra* note 9, at 322.
157. Maltby, *supra* note 55, at 4.
158. *See* Reed & Wilson, *supra* note 76, at 10.
159. Maltby, *supra* note 55, at 36–37.
160. *See* William W. Buzbee, *Recognizing the Regulatory Commons: A Theory of Regulatory Gaps*, 89 Iowa L. Rev. 1, 6, 11–15 (2003).
161. Ruhl & Salzman, *Climate Change, Dead Zones, and Massive Problems, supra* note 11, at 90.
162. Ruhl and Salzman evaluate dynamic federalism, new governance theory, and loose transgovernmental networks as approaches for addressing various types of massive problems. *Id.* They propose the particular value of loose agency networks as an approach for dealing with massive problems characterized by cumulative effects. *Id.* at 103–09, 116–20.
163. *See National Wetlands Inventory: Wetlands Mapper*, U.S. Fish & Wildlife Serv., http://www.fws.gov/wetlands/Data/Mapper.html (last updated Oct. 25, 2012). FWS is the primary Federal agency providing information on the status of the wetlands in the United States and this online tool provides current map

Section 404 provides one setting in which the type of assessment described above could prove extremely useful, helping regulators to identify wetlands that warrant protection and informing the design of mitigation measures intended to offset losses of wetlands for which permits are granted.[164] The types of information and assessment described in Part II.B would help us to identify now those wetlands that are most likely to persist notwithstanding climate change—wetlands that may prove in the future to be of greater value than ever. The discretion that regulators possess to permit draining and filling of wetlands under section 404 can be better informed and ensure that we do not inadvertently allow these key wetlands to be lost.

In addition, decisions on where and what types of mitigation to accept can be informed by this information, providing protection for key areas through easements and anticipating where the establishment of wetlands may be possible if anticipated change occurs. It may also be possible to identify opportunities for wetland gains presented by climate change—namely, upland areas likely to develop favorable hydrology. Instead of standing by and viewing the transformation of the hydrology of these uplands solely as a loss of upland, these areas could be incorporated into mitigation plans under section 404 and conserved as buffers against climate change losses of wetlands.

The National Wetlands Inventory conducted by FWS and the coastal wetlands reports developed by the National Oceanic and Atmospheric Administration ("NOAA") and FWS will continue to play a critically important role in providing the national overview of the status of our wetlands. EPA's National Wetland Condition Assessment initiative is underway to better assess the quality of our extant wetlands.[165] This initiative could prove extremely valuable in assessing wetlands' resilience and values in the section 404 permitting context.

Information sharing and coordination among federal, state, and local governments would ensure that state and local decision making and planning could benefit from this information and that information gathered at the local level could be incorporated into the national database. As is currently true of wetlands conservation, section 404 will not be the only tool we need. The agricultural subsidy programs, including the conservation reserve and wetlands reserve programs, have played, and will continue to play, an important role in conserving wetlands,[166] as will habitat conservation planning under the Endangered Species Act.[167]

B. *Incorporating Climate Change Considerations Into the Regulatory Framework*

A key question is whether the considerations described above—that is, an assessment of wetland values and functions, identification of wetlands likely to persist notwithstanding climate change, and areas to target for potential future wetlands—can be incorporated into the existing regulatory framework under section 404. Based on a review of both the broad goals of the CWA[168] and section 404 and the implementing regulations,[169] these considerations seem entirely compatible. The remainder of this section examines how these considerations mesh with various aspects of existing regulations, including the public interest review conducted by the U.S. Army Corps of Engineers ("Corps"),[170] EPA's section 404(b)(1) guidelines,[171] section 404 mitigation planning,[172] and Council on Environmental Quality ("CEQ") guidance.[173]

1. CWA and Section 404 Goals

A first step in determining whether the existing wetlands regulatory regime can account for climate change impacts is to examine the goals that the statute and regulations are intended to achieve. Protecting the integrity of national waters—the broad goal of the CWA[174]—encompasses protections against threats to the chemical, physical, and biological integrity of wetlands.[175] Climate change presents such threats.[176] For example, sea level rise threatens, at a minimum, the physical integrity of coastal wetlands.[177] Similarly, saltwater intrusion and precipitation shifts could threaten wetlands' biological integrity.[178]

An examination of sections 404(b) and 404(c) of the CWA suggests that the purpose of the section 404 program is to preclude unacceptable degradation of wetlands values and functions.[179] Section 404(b) mandates that the Corps issue

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views of America's wetland resources in a digital format. Div. of Habitat & Res. Conservation, U.S. Fish & Wildlife Serv., Wetlands Mapper Documentation and Instructions Manual 3 (2010), *available at* http://www.fws.gov/wetlands/Documents/Wetlands-Mapper-Instructions-Manual.pdf.

164. *See* Office of Water, U.S. Envtl. Prot. Agency, EPA843-F-04-001, Wetland Regulatory Authority 1–2 (2010), *available at* http://www.epa.gov/owow/wetlands/pdf/reg_authority_pr.pdf (providing an overview of section 404 and the promotion efforts of the EPA and the U.S. Army Corps of Engineers to implement the permitting program).
165. Dahl, Status and Trends 2004 to 2009, *supra* note 10, at 81–85.
166. *See* Jerry Ferris & Juha Siikamäki, Res. for the Future, Conservation Reserve Program and Wetland Reserve Program: Primary Land Retirement Programs for Promoting Farmland Conservation 1 (2009), *available at* http://www.rff.org/RFF/Documents/RFF-BCK-ORRG_CRP_and_WRP.pdf.
167. *See* Endangered Species Act of 1973, 16 U.S.C. § 1531 (2006).
168. CWA § 101, 33 U.S.C. § 1251 (2006) (providing that the broad goal of the statute is to protect the integrity of the nation's waters).
169. *See supra* pp. 75–76.
170. General Policies for Evaluating Permit Applications, 33 C.F.R. § 320.4 (2013).
171. 33 U.S.C. § 1344(b); Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, 40 C.F.R. § 230.1–.98 (2013).
172. Compensatory Mitigation for Losses of Aquatic Resources, 73 Fed. Reg. 19594, 19594 (Apr. 10, 2008) (to be codified at 33 C.F.R. pts. 325, 332; 40 C.F.R. pt. 240).
173. Instructions for Implementing Climate Change Adaptation Planning in Accordance with Executive Order 13514, 76 Fed. Reg. 12,945, 12,945 (Mar. 9, 2011); Council on Envtl. Quality, Instructions for Implementing Climate Change Adaptation Planning in Accordance with Executive Order 13514, at 1 (2011) [hereinafter Council on Envtl. Quality, Implementing Instructions], *available at* http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_final_implementing_instructions_3_3.pdf.
174. CWA § 101(a), 33 U.S.C. § 1251(a).
175. *See* Rapanos v. United States, 547 U.S. 715, 722–29 (2006); Solid Waste Agency of N. Cook Cnty. v. U.S. Army Corps of Eng'rs, 531 U.S. 159, 166–67 (2001); United States v. Riverside Bayview Homes, Inc., 474 U.S. 121, 132–33 (1985).
176. Burkett & Kusler, *supra* note 3, at 315.
177. Titus, *supra* note 58, at 11.
178. *Id.* at 18.
179. *See* Alyson C. Flournoy, *Supply, Demand, and Consequences: The Impact of Information Flow on Individual Permitting Decisions Under Section 404 of the*

permits pursuant to "guidelines developed by the Administrator, in conjunction with the Secretary, which guidelines shall be based upon criteria comparable to the criteria applicable to the territorial seas, the contiguous zone, and the ocean under section [403(c)]."[180] Thus, permit decisions must be based on guidelines for determining the degradation of jurisdictional waters, including wetlands.[181] And under section 403(c), the guidelines must specify criteria for the effects of proposed discharges on a variety of values and services provided by a wetland, including human health and welfare, marine life, and esthetic, recreation, and economic values, among other criteria.[182]

In addition, the EPA veto provision in section 404(c), which authorizes the EPA Administrator to veto a permit upon a determination that "the discharge . . . will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas,"[183] reflects a concern for the protection of the values and functions of jurisdictional waters, including wetlands. Thus, the guiding principles and policies of the CWA and section 404 seem to permit, if not require, that the Corps and EPA consider how to protect the values and services associated with wetlands notwithstanding climate change.

2. The Corps's Public Interest Review

The most direct and obvious route for considering information on wetland values, functions, and resilience and the impacts anticipated from climate change is under the Corps's guidelines for public interest review of section 404 permit applications.[184] Title 33, section 320.4 of the Code of Federal Regulations sets forth the Corps's policies for evaluating section 404 permit applications, including public interest review.[185] The public interest review provision begins:

> The decision whether to issue a permit will be based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interest. Evaluation of the probable impact which the proposed activity may have on the public interest requires a careful weighing of all those factors which become relevant in each particular case. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments.[186]

In envisioning a weighing of various factors that affect the public interest, this broad, open-ended balancing test "reflect[s] the national concern for both protection and utilization of important resources."[187] The regulations go on to enumerate all factors relevant to the public interest determination, including:

> conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people.[188]

The regulations also explicitly require consideration of cumulative effects, which could include the anticipated loss of wetlands due not only to human activity but to climate change as well.[189] Based on these factors, which exhibit a broad range of specificity and amenability to quantification, the Corps determines whether the proposed activity "would be contrary to the public interest."[190] A permit will be granted unless the Corps makes such a determination.[191] For a proposed activity found to be contrary to the public interest, the Corps can only grant a permit if "the benefits of the proposed alteration outweigh the damage to the wetlands resource."[192]

Not only does public interest review explicitly demand consideration of cumulative impacts—a fact critical to effective consideration of the broad impacts of climate change to wetlands—but it also requires consideration of a broad array of human values,[193] exactly those values we identify above as at risk from climate change impacts to wetlands in some areas.

3. EPA's Section 404(b)(1) Guidelines

Although the EPA section 404(b)(1) water quality guidelines do not provide as easy a fit for addressing climate impacts, section 404(b)(1) requires the consideration of the criteria enumerated in section 403(c), which are broad value-based criteria.[194] This is consistent with the approach described above in that it focuses on the values affected by the potential loss of the relevant wetlands.[195] EPA's section 404(b)(1) guidelines include a requirement for consideration of cumulative effects and create a presumption against granting a

Clean Water Act, 83 Ind. L.J. 537, 544 (2008) [hereinafter Flournoy, *Supply, Demand, and Consequences*]. This section draws on that Article as well as a framework one of us developed on the 30th anniversary of the CWA to describe the conflicts surrounding the development and implementation of the section 404 permitting program and its inadequacies as a national policy for wetlands protection. *See* Flournoy, *Section 404 at Thirty-Something*, *supra* note 151, at 618–20.

180. CWA § 404(b), 33 U.S.C. § 1344(b) (2006).
181. *See* Envtl. Lab., Waterways Experiment Station, U.S. Army Corps of Eng'rs, Technical Report Y-87-1, Corps of Engineers Wetlands Delineation Manual vii (1987), *available at* http://el.erdc.usace.army.mil/elpubs/pdf/wlman87.pdf (describing the mandatory nature of the Army Corps of Engineers' work to delineate wetlands as required by CWA section 404).
182. CWA § 403(c)(1)(A)–(C), 33 U.S.C. § 1343(c)(1)(A)–(C) (2006).
183. *Id.* § 1344(c).
184. General Policies for Evaluating Permit Applications, 33 C.F.R. § 320.4 (2013).
185. *Id.*
186. *Id.* § 320.4(a).
187. *Id.*
188. *Id.*
189. *Id.* § 320.4(b)(3).
190. *Id.* § 320.4(a)(1).
191. *Id.*
192. *Id.* § 320.4(b)(4).
193. *See id.* § 320.4(a).
194. CWA §§ 403(c), 404(b), 33 U.S.C. §§ 1343(c), 1344(b) (2006); Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, 40 C.F.R. § 230.1–.98 (2013) (providing the section 404(b)(1) guidelines).
195. *See* CWA § 403(c), 33 U.S.C. § 1343(c).

permit unless it can be proven that there will not be an unacceptable adverse impact.[196]

This presumption is also consistent with section 403(c)(2), which provides that where insufficient information exists on a proposed discharge, no permit shall be issued.[197] Thus, both the statute and the section 404(b)(1) water quality guidelines suggest a precautionary approach.[198] With the uncertainty surrounding climate change, the Corps should adopt this precautionary approach as it seeks to address the potential loss of wetlands.

In addition to this general guidance, the section 404(b)(1) guidelines explicitly require denial of a permit for a discharge that will result in significant degradation of the aquatic ecosystem.[199] Loss of key values and services, whether related to water quality, habitat, or water storage, are facts relevant to this inquiry.[200] Thus, under the water quality guidelines, it seems clear that the Corps could consider the likelihood of losses of key values and services based on the cumulative impact of discharges, taking account of climate change impacts.

4. Section 404 Mitigation Planning

The section 404(b)(1) guidelines' requirement of compensatory mitigation to offset unavoidable adverse impacts to wetlands represents an opportunity to integrate climate change adaptation strategies into the section 404 program.[201] Compensatory mitigation can be accomplished through restoration, enhancement, establishment, or preservation of a wetland.[202] If we can identify the locations of (1) wetlands that provide the greatest amount of high-value functions and services and (2) upland areas likely to become wetlands in the future as a result of climate change, we can establish these areas as targets for compensatory restoration, enhancement, establishment, or restoration—perhaps through incentives. The Corps's and EPA's 2008 final regulations defining standards and procedures regarding compensatory mitigation support the notion of using valuation techniques to determine the mitigation requirements associated with a section 404 permit.[203] The regulations require that "compensatory mitigation should be located . . . where it is most likely to successfully replace lost functions and services."[204] At a minimum, the valuation process should include an assessment of the effects of climate change on particular wetlands that may form part of a mitigation plan.[205]

Of course, identifying target locations for compensatory mitigation is no small task. It demands that regulators plan for change in the face of considerable uncertainty. As discussed above, problems persist with mitigation efforts.[206] However, it may be worthwhile as part of mitigation planning both to identify and take steps to protect those wetlands that we can least afford to lose and to identify areas where hydrology is likely to become favorable for wetlands and seek to allow or promote wetland establishment in those areas.

5. CEQ's Guidance

In 2009, President Obama signed an Executive Order requiring federal agencies to "evaluate agency climate-change risks and vulnerabilities to manage the effects of climate change on the agency's operations and mission in both the short and long term"[207] and to participate in the interagency Climate Change Adaptation Task Force to develop strategies regarding climate change adaptation.[208] In 2011, the CEQ issued instructions to aid agencies in implementing the president's order to participate in climate change adaptation planning.[209] The instructions state that the head of each agency shall establish an agency climate change adaptation policy,[210] increase agency understanding of how the climate is changing,[211] apply that understanding to the agency's mission and operations,[212] identify and submit to the CEQ Chair three to five priority climate change adaptation actions the agency will implement in fiscal year 2012,[213] and submit a climate change adaptation plan for implementation in fiscal year 2013,[214] among other tasks. A support document CEQ issued alongside the implementing instructions identifies wetlands as an ecosystem "particularly vulnerable to the impacts of

196. The guidelines state:

> (c) Fundamental to these Guidelines is the precept that dredged or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern.
>
> (d) From a national perspective, the degradation or destruction of special aquatic sites, such as filling operations in wetlands, is considered to be among the most severe environmental impacts covered by these Guidelines. The guiding principle should be that degradation or destruction of special sites may represent an irreversible loss of valuable aquatic resources.

40 C.F.R. § 230.1(c)–(d).

197. *See* CWA § 403(c)(2), 33 U.S.C. § 1343(c)(2).

198. *See* Flournoy, *Supply, Demand, and Consequences*, *supra* note 179, at 569–71.

199. *See* 40 C.F.R. § 230.12(a)(3)(ii) (2013).

200. *See id.* § 230.1.

201. General Policies for Evaluating Permit Applications, 33 C.F.R. § 320.4(r) (2013).

202. Compensatory Mitigation for Losses of Aquatic Resources, 73 Fed. Reg. 19594, 19594 (Apr. 10, 2008) (to be codified at 33 C.F.R. pts. 325, 332; 40 C.F.R. pt. 240).

203. *Id.* at 19,673 (to be codified at 33 C.F.R. pt. 332.3(b)(1)); Ruhl et al., *Implementing the New Ecosystem Services Mandate, supra* note 17, at 252, 255, 262–65.

204. Compensatory Mitigation for Losses of Aquatic Resources, 73 Fed. Reg. at 19,673.

205. *See* Ruhl et al., *Implementing the New Ecosystem Services Mandate, supra* note 17, at 269 (describing EPA research on effects of various phenomena, including climate change, on wetland ecosystem services that might aid in assessing wetland ecosystem services).

206. *See supra* text accompanying notes 13–17.

207. Federal Leadership in Environmental, Energy, and Economic Performance, Exec. Order No. 13514, 74 Fed. Reg. 52117, 52122 (Oct. 5, 2009).

208. *Id.* at 52,125.

209. Instructions for Implementing Climate Change Adaptation Planning in Accordance with Executive Order 13514, 76 Fed. Reg. 12,945, 12,945 (Mar. 9, 2011); Council on Envtl. Quality, Implementing Instructions, *supra* note 173, at 1.

210. Council on Envtl. Quality, Implementing Instructions, *supra* note 173, § A.

211. *Id.* § B.

212. *Id.* § C.

213. *Id.* § D(1).

214. *Id.* § D(2).

climate change" and notes that "[i]mpacts of climate change on ecosystem services . . . are a major concern."[215]

The Corps is undertaking various efforts to comply with the Executive Order. In accordance with the CEQ implementing instructions, the Corps is updating guidance on how agency projects and programs can respond to sea level rise.[216] The Corps plans to incorporate sea level and climate change considerations "into existing and new civil works infrastructure and ecosystem restoration projects in coastal areas to improve safety and resilience."[217] In addition, the Corps is working with other agencies, including the Department of the Interior's ("DOI") Bureau of Reclamation, to develop guidance documents on climate change data and tools needed to support water resources management planning and operations at the local, state, and federal levels.[218] A next step for the Corps might be to consider how its findings on climate change adaptation could apply to the section 404 program.

The efforts of other agencies to comply with the Executive Order could aid the Corps in its implementation of the section 404 program. For instance, DOI is formulating strategies to address sea level rise that "may require acquisition of upland habitat and creation of wetlands and other natural filters and barriers to protect against sea level rise and storm surges."[219] These efforts could prove useful to the Corps in mitigation planning. DOI is also working to quantify the amount of carbon stored in various wetlands,[220] which can be important in wetlands valuation. In accordance with the implementing instructions, NOAA is developing "programmatic guidance to consider climate change impacts in coastal habitat restoration, land acquisition, and facility development investments."[221] The guidance will help NOAA determine whether a wetland restoration effort may become submerged by rising sea levels[222]—a topic in which the Corps shares an interest.

C. *Priorities for Change: Helping Section 404 Meet the Challenge*

The existing regulations described above support incorporating climate change considerations into the section 404 permitting program. This section briefly outlines a plan to identify and prioritize these considerations. The Corps, FWS, EPA, and other cooperating agencies should seek to assess which wetlands are likely to persist in various climate change scenarios and ensure that these are prioritized for protection both under section 404 and in subsidy programs. Information on the values and functions of all wetlands is needed, including those that are likely to disappear or suffer degradation from climate change impacts. Based on this information, the Corps and other relevant agencies including FWS should develop an affirmative strategy to replace high value wetlands that we anticipate losing. In coastal and riparian areas where increased flooding is likely, mitigation planning under section 404 could include the establishment of rolling easements on private lands and acquisition and protection of areas that may be suitable for the establishment of wetlands in the future. Similar strategies could be developed for inland areas likely to see hydrologic changes under different climate change scenarios. Protecting these areas should become a new focus of mitigation planning under section 404 and of conservation and wetland reserve program payments.

IV. Conclusion

By 1972, unrestrained development and urban growth had led to widespread destruction of wetlands.[223] Congress enacted section 404 of the CWA in part as an answer to the primary challenge identified at the time: how to preserve the existing stock of wetlands. Over the past forty years, however, the challenges facing wetlands have changed. The section 404 program and no-net-loss goal have shifted the focus from preserving current wetlands to minimizing wetlands loss and replacing wetlands lost due to discharges of dredged and fill material.

But a focus on dredge and fill has never been adequate. Climate change now makes it imperative to look beyond its bounds if we value the services and functions of wetlands. With better data, we can prevent the loss of high-value or highly resilient wetlands. An intelligent response demands that we continue the critically important work of identifying the values and services wetlands provide in specific locations. Armed with this information, the Corps can assess how best to maintain these functions, whether through prioritizing preservation of other existing wetlands or, where loss is inevitable, through planning to allow migration or reestablishment of wetlands in non-wetlands areas that are likely to develop favorable hydrology. Section 404 can help us to plan and implement protections for the wetlands on which we depend even in the face of climate change.

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215. Council on Envtl. Quality, Implementing Climate Change Adaptation Planning in Accordance with Executive Order 13514, at 11 (2011) [hereinafter Council on Envtl. Quality, Support Document], *available at* http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_support_document_3_3.pdf.
216. Interagency Climate Change Adaptation Task Force, Federal Actions for a Climate Resilient Nation: Progress Report of the Interagency Climate Change Adaptation Task Force 6–7 (2011), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ceq/2011_adaptation_progress_report.pdf.
217. *Id.* at 6.
218. *See id.* at 13.
219. *Id.* at 34.
220. *See id.* at 35.
221. *Id.* at 13.
222. *Id.*
223. *See, e.g., Water Pollution Control Legislation—Ocean Dumping: Hearing on S. 75, S. 192, S. 280, S. 281, S. 523, S. 573, S 601, S. 679, S. 927, S. 1011, S. 1012, S. 1013, S. 1014, S. 1015, and S. 1017 Before the Subcomm. on Air & Water Pollution of the S. Comm. on Pub. Works*, 92d Cong. 2347 (1972) ("Filled wetlands in New York City constitute about one-fifth the area of Manhattan, Brooklyn, Queens and the Bronx. Except for small portions of Jamaica Bay, there is little left of the city's wetland areas.").