IMPLEMENTING THE NEW ECOSYSTEM SERVICES MANDATE OF THE SECTION 404 COMPENSATORY MITIGATION PROGRAM—A CATALYST FOR ADVANCING SCIENCE AND POLICY*

J.B. Ruhl**
James Salzman***
Iris Goodman****

I. INTRODUCTION

On April 10, 2008, the U.S. Army Corps of Engineers (Corps) and the Environmental Protection Agency (EPA) jointly published final regulations defining standards and procedures for authorizing compensatory mitigation of impacts to aquatic resources that the Corps permits under Section 404 of the Clean Water Act (CWA).[1] Prior to these final regulations, Section 404's compensa-

* © 2009, J.B. Ruhl, James Salzman & Iris Goodman. All rights reserved.

** Matthews & Hawkins Professor of Property, Florida State University College of Law.

*** Samuel F. Mordecai Professor of Law, Nicholas Institute Professor of Environmental Policy, Duke University.

**** National Center for Environmental Research, Office of Research and Development, U.S. Environmental Protection Agency. This Article is an expanded and referenced version of our previously published essay, *Bank Failure*, 26 Envtl. F. 22 (Jan./Feb. 2009). The Article has not been subjected to the EPA's peer and policy review process and, therefore, does not necessarily reflect the view of the agency, and no official endorsement should be inferred. Special thanks are due to Keith Ihlanfedlt, Florida State University Eminent Scholar in Economics; to participants in workshops at the University of Minnesota, Georgetown University, and Florida State University law schools; and to Kirl Kim and Tom Chapman of the Florida State University Geography Department for input and support provided on work conducted early in the stages of this research. We are also thankful for the research assistance we received from Nino Chiarello, Vicki Shiah, and Ali Stevens, and to the Florida State University and Duke University law schools for research and other support during the preparation of the Article. All positions taken and mistakes made in the Article are, of course, our own. Please direct any questions or comments to jruhl@law.fsu.edu, salzman@law.duke.edu, or Goodman.iris@epa.gov.

1. 33 C.F.R. §§ 325, 332 (2008); 40 C.F.R. § 230 (2008); *see also* 73 Fed. Reg. 19594

Electronic copy available at: http://ssrn.com/abstract=1281048

File: Ruhl.382.GALLEY(c).doc Created on: 5/4/2009 2:10:00 PM Last Printed: 5/14/2009 8:31:00 AM

tory mitigation program was administered under a mish-mash of guidances, inter-agency memoranda, and other policy documents issued over the span of seventeen years.[2] Although motivated primarily by the need to bring the program under one comprehensive regulatory framework, the final regulations also introduce ecosystem services into the mitigation decisionmaking standards for the first time by requiring that "compensatory mitigation should be located . . . where it is most likely to successfully replace lost functions and services."[3] Easily overlooked in the lengthy *Federal Register* document, this is a potentially significant development, but it is unlikely to gain policy traction without substantial research into the development of efficient and reliable wetland ecosystem service assessment methods. To help orient such research efforts, this Article provides the following:

(1) background on the compensatory mitigation program and ecosystem services prior to promulgation of the final regulations;

(2) an overview of how the final regulations integrate ecosystem service analysis into compensatory mitigation decisions; and

(3) suggestions for a research agenda to support implementation of that feature of the rule.

II. BACKGROUND

Section 404(a) of the CWA authorizes the Secretary of the Army, through the Corps, to "issue permits . . . for the discharge of dredged or fill material into the navigable waters at specified disposal sites."[4] Although the Corps is the front-line regulatory agency for administering this permit program, pursuant to Section 404(b)(1) of the CWA the EPA must promulgate substantive

(Apr. 10, 2008) (providing supplementary information).

2. *See generally* Palmer Hough & Morgan Robertson, *Mitigation under Section 404 of the Clean Water Act: Where It Comes From, What It Means*, 17 Wetlands Ecology and Mgt. 15 (Feb. 2009) (describing this collection of policies).

3. 33 C.F.R. at § 332.3(b)(1).

4. 33 U.S.C. § 1344(a) (2000).

Electronic copy available at: http://ssrn.com/abstract=1281048

permitting standards focused on environmental factors, known as the "404(b)(1) Guidelines." The Corps must follow these guidelines when issuing permits for disposal of dredged or fill material.[5] Under Section 404(c), the EPA may also deny (or "veto") any disposal site if 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."[6] Thus, under Section 404, and subject to specified exceptions, wetlands subject to federal jurisdiction may be filled only if the Corps grants a permit in accordance with the EPA's 404(b)(1) Guidelines.[7] These permits—known ubiquitously as "404 permits," "wetland permits," or "Corps permits"—are the cornerstone for federal protection of wetland resources, and many states implement similar programs to cover wetland resources not within the scope of the federal program.[8]

When a land development project involves filling of wetland areas regulated under Section 404 of the CWA, the Corps usually requires compensatory mitigation for the loss of wetland functions as a condition of approval.[9] Permittees traditionally accomplish compensatory mitigation themselves directly through creation or enhancement of wetlands on the development site (onsite mitigation) or on an offsite location (offsite mitigation), or by paying a fee to fund wetland mitigation by a third-party conservation entity in lieu of providing direct mitigation (in-lieu fee mitigation).[10] Wetland mitigation banking, which arose in the mid-1990s, provides a third-party variation on offsite mitigation by allowing the developer to compensate for the resource loss by purchasing "cred-

5. *Id.* at § 1344(b).

6. *Id.* at § 1344(c).

7. *Id.* at § 1344(b)–(c).

8. For background on the scope of federal wetlands regulations, see Douglas R. Williams & Kim Diana Connolly, *Federal Wetlands Regulation: An Overview*, in Kim Diana Connolly, Stephen M. Johnson & Douglas R. Williams, *Wetlands Law and Policy: Understanding Section 404* 1–26 (ABA 2005).

9. Hough & Robertson, *supra* n. 2, ___; *see generally* Jessica Wilkinson & Jared Thompson, *2005 Status Report on Compensatory Mitigation in the United States* (Envtl. L. Inst., 2006) (discussing relevant background information on the compensatory mitigation programs).

10. For detailed explanations of each type of compensatory mitigation, see Royal C. Gardner, *Mitigation*, in Connolly, Johnson & Williams, *supra* n. 8, at 253–282; Wilkinson & Thompson, *supra* n. 9; Envtl. L. Inst., *Banks and Fees: The Status of Off-Site Mitigation in the United States* (Envtl. L. Inst. 2002).

Electronic copy available at: http://ssrn.com/abstract=1281048

its" from another landowner—the wetland banker—who has created or enhanced wetland resources elsewhere.[11]

Although wetland mitigation banking began mainly as a means for state highway and public works departments to satisfy their regulatory wetland mitigation needs by establishing their own banks,[12] several hundred entrepreneurial banks now operate in the nation, selling credits within defined "service area" boundaries to private and public land developers who need to satisfy regulatory wetland mitigation requirements.[13] Numerous retrospective studies show that individual project compensatory mitigation usually was poorly designed, inadequately implemented, and infrequently monitored.[14] Conceived and endorsed by the agencies in the mid-1990s, mitigation banking has been praised as ecologically and administratively superior to permittee-provided mitigation.[15] Although wetland mitigation banking is

11. *See* Michael Bean, Rebecca Kihslinger & Jessica Wilkinson, *Design of U.S. Habitat Banking Systems to Support the Conservation of Wildlife Habitat and At-Risk Species* 29–120 (Envtl. L. Inst. 2008) (including a survey of state practices and comprehensive bibliographies); *see generally* Envtl. L. Inst., *Wetland Mitigation Banking* (Envtl. L. Inst. 1993) (discussing the early development and use of wetland mitigation banking in the United States); Royal C. Gardner, *Banking on Entrepreneurs: Wetlands, Mitigation Banking and Takings*, 81 Iowa L. Rev. 527, 534–576 (1993) (outlining the history and development of mitigation banking).

12. Dennis Durbin, *Wetlands and the Federal Highway Program*, 27 Natl. Wetlands Newsltr. 7–8 (Sept./Oct. 2005); *see also* Lawrence R. Liebesman & David M. Plott, *The Emergence of Private Wetlands Mitigation Banking*, 13 Nat. Res. & Env. 341, 341 (1998) (reporting that before the mid-1990s, seventy-five percent of all banks were public agency, single-user banks linked to public works projects).

13. Durbin, *supra* n. 12, at 8.

14. Natl. Research Council, *Compensating for Wetland Losses under the Clean Water Act* 6–8 (Natl. Acad. Press 2001). Mitigation provided directly by permittees has been described as resulting in the proliferation of small-scale mitigation sites, making it difficult for the Corps and the EPA to monitor the permittees' performance. *See* R. Eugene Turner, Ann M. Redmond & Joy B. Zedler, *Count It by Acre or Function—Mitigation Adds Up to Net Loss of Wetlands*, 23 Natl. Wetlands Newsltr. 5, 5 (Nov./Dec. 2001) (explaining the failings in the implementation and compliance of individual project compensatory mitigation); Joy Zedler & Leonard Shabman, *Compensatory Mitigation Needs Improvement, Panel Says*, 23 Natl. Wetlands Newsltr. 1, 1 (July/Aug. 2001) (discussing the failure to meet the goal of no net loss of wetlands and offering recommendations for improvements).

15. Federal Guidance for the Establishment, Use, and Operation of Mitigation Banks, 60 Fed. Reg. 58605, 58607 (Nov. 28, 1995). Recently compiled evidence suggests that agencies have greater success monitoring wetland mitigation banks than first-party on-site and off-site mitigation provided directly by the project permittee. *See* U.S. Govt. Accountability Off., GAO-05-898 *Wetlands Protection: Corps of Engineers Does Not Have an Effective Oversight Approach to Ensure That Compensatory Mitigation Is Occurring*, 19–20 (Sept. 2005) (explaining that although oversight was still limited, the Corps districts monitored

not universally regarded as an ecological success story,[16] today it reportedly accounts for over thirty percent of all regulatory mitigation carried out under Section 404 nationwide.[17]

For many years, policy discourse on compensatory mitigation was primarily biocentric in focus—e.g., how did the different methods compare ecologically; were the agencies adequately ensuring replacement of lost wetland functions; what assessment methods best captured habitat function?[18] But wetlands provide economically important services to human populations as well, such as flood mitigation, groundwater recharge, water filtration, and sediment capture.[19] These benefits, while unquestionably of economic value if measured in terms of the adverse impacts that would result if they were removed or the cost to replace the benefits with technological substitutes, usually are not valued in the marketplace.[20] The real estate value of coastal wetlands, for example, rarely includes the benefits of storm surge buffering. That was made all too clear in the aftermath of Hurricane Katrina.[21] Landowners cannot easily charge for the offsite flood or pollutant mitigation benefits flowing from wetlands they own, making the

---

third-party mitigation more than first-party mitigation). Some studies show, however, that the administrative advantages are not necessarily as great as claimed. Minn. Dept. Nat. Res. et al., *Minnesota Wetland Mitigation Banking Study* 13 (Mar. 1998) [hereinafter Minnesota Banking Study].

16. The debate over the relative merits of "first-party" permittee mitigation versus wetland mitigation banking continues in often heated dialogue. *Compare* Society of Wetland Scientists, *Wetland Mitigation Banking: Clarifying Intent*, 27 Natl. Wetlands Newsltr. 5, 5 (Sept./Oct. 2005) (responding to criticism by National Wildlife Federation that Society's prior report on wetland mitigation banking overstated its proven merits) *with* Julie Sibbing, *Mitigation Banking: Will the Myth Ever Die?*, 27 Natl. Wetlands Newsltr. 5, 5 (Nov./Dec. 2005) (replying to the response from the Society of Wetland Scientists).

17. Wilkinson & Thompson, *supra* n. 9, at 27.

18. *See* Rebecca L. Kihslinger, *Success of Wetland Mitigation Projects*, 30 Natl. Wetlands Newsltr. 14, 14–16 (Mar./Apr. 2008) (surveying and summarizing literature on the success of federal and state wetland programs).

19. Sandra Postel & Stephen Carpenter, *Freshwater Ecosystem Services*, in *Nature's Services: Societal Dependence on Natural Ecosystems* 1, 195–206 (Gretchen C. Daily ed., Island Press 1997).

20. *See* Geoffrey Heal, *Nature and the Marketplace: Capturing the Value of Ecosystem Services* 123 (Island Press 2000) (explaining that although economists would like to value ecosystem services by using market value, this cannot always be done).

21. Some wetland types can absorb over 1.5 million gallons of flood water per acre. Not surprisingly, the most economically destructive flooding in New Orleans was on prior coastal wetland areas that had been drained and developed. *Nature Destroys, but It Can Also Protect*, Envtl. F. 18 (Sept./Oct. 2005).

services a positive externality that appears free for the taking to other landowners who benefit from them.[22] Even if landowners could charge for the services provided, pricing would be difficult because of the complex ecological and geographic attributes of ecosystem services.[23] Consequently, and understandably, a landowner's decision about whether to convert wetlands to other uses is unlikely to take into account their service value to others. This opens the door to the question of whether, if land markets do not adequately take ecosystem service values into account, regulatory programs such as wetland mitigation banking should attempt to fill the gap.

Focusing on mitigation banking in particular, a series of research articles starting in the late 1990s took up that question, widening the policy debate on compensatory mitigation to include the distribution of ecosystem services to individuals.[24] The concern driving the research was that the economics of compensatory mitigation inherently shift wetlands on landscape scales[25] from urban to rural areas, because developers seek high-value land in urban areas whereas mitigation bankers seek less expensive properties in rural areas where opportunities exist to restore aquatic resources.[26] Although the compensatory rural wetlands may provide as many or more ecological functions as the impacted urban wetlands they replace, the translocation of those functions raises the possibility that the ecosystem services associated with them are also moving from urban to rural populations. Because urban wetlands can provide important services to local populations, such as "air filtration, micro climate regulation, noise reduction, rainwater drainage, sewage treatment, and recreational and cultural values,"[27] the researchers asked whether Section

22. *Id.*

23. James Salzman, Barton H. Thomson, Jr. & Gretchen C. Daily, *Protecting Ecosystem Services: Science, Economics, and Law*, 20 Stan. Envtl. L.J. 309, 311–312 (2001).

24. For a summary of the major research articles, see *infra* notes 28–38 and accompanying text.

25. Landscape scales are regional systems of interconnected properties directed to achieve specific ecological and conservation objectives. James N. Levitt, *Landscape-Scale Conservation: Grappling with the Green Matrix*, 16-1 Land Lines 1, 2 (2004).

26. *See* Minnesota Banking Study, *supra* n. 15, at 12 (finding that the location of wetland banks is almost entirely dictated by the presence of willing landowners and seldom on ecological or hydrological needs).

27. Per Bolund & Sven Hunhammar, *Ecosystem Services in Urban Areas*, 29 Ecological Econ. 293, 293 (1999).

404's compensatory mitigation program was adequately taking this effect into account. A chronological summary of the major installments in the series of articles follows:

- In 1997, King and Herbert showed that the aggregate effects of mitigation and permitting decisions in Florida led to a "migration" of wetlands and their services across the urban-rural divide.[28]

- One year later, Brown and Lant extended that theme and argued that if the wetlands move, most of their ecosystem service benefits go with them, meaning they must either be replaced through some means at the impact site area or their benefits will no longer be enjoyed by that human population.[29]

- Then in 1999, Jennings, Hoagland, and Rudolph found the same effects as King and Herbert in a study of wetlands mitigation in Virginia.[30]

- Salzman and Ruhl, in 2000, examined laws and regulations employing habitat trading programs in general and used mitigation banking as a case study, arguing that the program does not adequately account for services.[31]

- Ruhl and Gregg argued, in 2001, that the 404(b)(1) Guidelines provide clear regulatory authority to consider ecosystem service values, such as those derived from the water purification function that wetlands provide, though none of the mitigation policies in place at the time specifically mentioned the full scope of ecosystem service benefits supplied by wetlands or integrated them into the mitigation process.[32]

---

28. Dennis M. King & Luke W. Herbert, *The Fungibility of Wetlands*, 19 Natl. Wetlands Newsltr. 10–11 (Sept./Oct. 1997) (suggesting this urban-to-rural shift effect).

29. Phillip H. Brown & Christopher L. Lant, *The Effect of Wetland Mitigation Banking on the Achievement of No-Net-Loss*, 23 Envtl. Mgt. 333, 339 (1999).

30. Ann Jennings, Roy Hoagland & Eric Rudolph, *Down Sides to Virginia Mitigation Banking*, 21 Natl. Wetlands Newsltr. 9–10 (Jan./Feb. 1999).

31. James Salzman & J.B. Ruhl, *Currencies and the Commodification of Environmental Law*, 53 Stan. L. Rev. 607, 657–668 (2000).

32. J.B. Ruhl & R. Juge Gregg, *Integrating Ecosystem Services into Environmental*

- In 2002, Boyd, King, and Wainger argued that the debate over the *ecological* impacts of compensatory mitigation had thus far left out the potential *economic* impact as a relevant policy concern.[33]

- In 2006, Ruhl and Salzman presented the results of a detailed geographic study of all the mitigation banks in Florida and the impact sites that purchased credits from them. The results showed that the effect King and Herbert identified was not abated; indeed, it appeared to be endemic, with mitigation sites on average over fifteen miles from impact sites and in markedly more rural locations.[34]

- Ruhl, Kraft, and Lant examined all state wetland program regulations in 2007 and found essentially the same pattern of attention to functions, but not services, as was present in the Corps program.[35]

- BenDor and Brozović (2007),[36] BenDor, Brozović, and Pallathucheril (2007),[37] and Robertson and Hayden (2008),[38] in studies of the Chicago area, also found considerable distances between impact sites and mitigation sites and an urban-to-rural redistribution effect associated with mitigation banking, which they identified as

---

Law: A Case Study of Wetlands Mitigation Banking, 20 Stan. Envtl. L.J. 365, 365–367 (2001).

33. James Boyd, Dennis King & Lisa A Wainger, *Compensation for Lost Ecosystem Services: The Need for Benefit-Based Transfer Ratios and Restoration Criteria*, 20 Stan. Envtl. L.J. 393, 396 (2001).

34. J.B. Ruhl & James Salzman, *The Effects of Wetland Mitigation Banking on People*, 28 Natl. Wetlands Newsltr. 1, 8–13 (Mar./Apr. 2006).

35. *See* J.B. Ruhl, Steven E. Kraft & Christopher L. Lant, *The Law and Policy of Ecosystem Services* 138–143 (Island Press 2007).

36. Todd K. BenDor & Nicholas Brozović, *Determinants of Spatial and Temporal Patterns in Compensatory Wetland Mitigation*, 40 Envtl. Mgt. 349, 349 (2007).

37. Todd BenDor, Nicholas Brozović & Varkki George Pallathucheril, *The Social Impacts of Wetland Mitigation Policies in the United States*, 22 J. Planning Lit. 341, 342 (2008); Todd BenDor, Nicholas Brozović & Varkki George Pallathucheril, *Assessing the Socioeconomic Impacts of Wetland Mitigation in the Chicago Region*, 73 J. Am. Planning Assn. 263, 263 (2007).

38. Morgan Robertson & Nicholas Hayden, *Evaluation of a Market in Wetland Credits: Entrepreneurial Wetland Banking in Chicago*, 22 Conserv. Biology 636, 636 (2008).

being the mitigation option of choice for projects with relatively small wetland resource impacts.

Some representatives of the wetland mitigation banking industry defended the practice in the face of these studies but with little or no empirical backup.[39] One argument, for example, was that urban wetlands are ecologically stressed, isolated, and of little value to wildlife.[40] That argument, however, too narrowly defines the array of benefits wetlands provide, neglecting the potential economic values delivered through ecosystem services.[41] What services were being lost at urban impact sites is as relevant a question as what value they provide to wildlife. Biomass productivity and habitat quality may or may not be proxies for services such as storm water mitigation, groundwater recharge, and thermal regulation.[42]

Another argument was that the federal compensatory mitigation program need not be concerned with ecosystem services, because state and local regulations are there to ensure the replacement of vital services, such as storm water retention, while the Corps is concerned about replacing ecological values at mitigation sites.[43] In essence, this objection assumes that state and local authorities ensure that all the services lost to urban communities as a result of wetland mitigation "migration" are being replaced in one way or another under state and local authority. The issue then is whether state and local governments inventory ecosystem services to ensure that *all* those supplied by urban wetlands are replaced. Storm water retention is a major focus of state and local regulation, but that is only one of the services in the stream of benefits wetlands provide.[44] Moreover, this objection assumes

39. George I. Platt, *Wetland Mitigation Bankers Are People Too*, 28 Natl. Wetlands Newsltr. 5 (Nov./Dec. 2006).

40. *Id*.

41. J.B. Ruhl & James Salzman, *The Authors Respond*, 28 Natl. Wetlands Newsltr. 5, 5 (Nov./Dec. 2006).

42. *See National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution*, EPA-841-B-05-003 Envtl. Protec. Agency Off. of Water 15 (EPA July 2005) [hereinafter *National Management Measures*] (discussing constructed wetlands and the uncertainty as to whether they are designed to provide flood storage, ground water exchange, or the other functions associated with natural wetlands).

43. Ruhl & Salzman, *supra* n. 41, at 5.

44. *See National Management Measures*, *supra* n. 42, at 21 (discussing the numerous

that the different services a wetland provides are independent of each other and geographically fungible, so that they can be "parsed" or "unbundled" and then redistributed in separate "parts" around the landscape. Do small storm water retention ponds tucked in the corner of an urban development really provide thermal regulation, groundwater recharge, sediment capture, water filtration, and other services in the same manner and degree as did the wetlands they replace? Although "parsing" or "unbundling" of wetland functions has been and remains a central premise of compensatory mitigation, it may be, as Robertson and Mikota observe, that "a wetland's component functions do not unstack and restack like so many legos . . . ."[45]

A final major argument was that it is economically inefficient to preserve urban wetlands, notwithstanding any net loss of services, given the valuable alternative uses to which the land can be converted. As noted above, however, the public may not be aware of all that is gained and lost in that land-use conversion. If the effect on urban wetland services were made clear at the landscape scale, public perception might be influenced and, at the very least, decisions would be more fully informed. Of course, it is difficult to determine whether the effect of redistributing wetland ecosystem services is to increase or decrease overall social welfare.

Ecosystem services are just one of the values associated with wetlands and land development, so it could be that the loss of wetland ecosystem service values to a particular community is offset by other considerations such as the economic impact of urban development facilitated by the mitigation program. Neither of those quantifications is likely to remain static. It is certainly possible, for example, that over time the population around wetland banks could grow, meaning that larger populations would enjoy their associated ecosystem services and that the economic development in urban areas losing wetlands far outstrips the costs associated with the lost services.

---

important functions provided by wetlands and riparian areas such as supplying a source of food, nesting material, habitat, and nursery areas for wildlife as well as other functions like floodwater storage, erosion control, ground water recharge, and maintenance of biological diversity).

45. Morgan Robertson & Michael Mikota, *Water Quality Trading & Wetland Mitigation Banking: Different Problems, Different Paths?* 29 Natl. Wetlands Newsltr. 1, 14 (Mar./Apr. 2007).

The problem is that we cannot reliably assess any of these arguments in the absence of data regarding the scope and magnitude of the distributional effects on ecosystem services associated with compensatory mitigation. Neither reliable empirical studies nor relevant data are generally available to address these questions.[46] Although ecological assessments of wetland impact and mitigation sites have long been required as part of the Corps permitting process, ecosystem service assessments were not, and the former is not necessarily a proxy for the latter.[47] Wildlife may be able to adjust to moving wetlands fifteen or more miles, but vastly different human populations might surround impact sites and their associated mitigation banks when such distances between them are the norm. Some of the ecosystem services flowing from wetlands are primarily local in terms of who benefits from them or are at least more pronounced the closer to the wetland one is located. For example, research on the effects of the 2004 tsunami in Asia shows that the presence of coastal wetlands significantly mitigated the nearby inland damage caused by the wave forces.[48] Similarly, research from Florida shows that wetlands help regulate local moisture and temperature.[49] Even small wetlands in urban areas, it has been demonstrated, provide important pollutant control services to the local urban population.[50] Hence, moving wetland resources, even within a bank's defined

46. *See* Morgan M. Robertson, *Emerging Ecosystem Service Markets: Trends in a Decade of Entrepreneurial Wetland Banking*, 4 Frontiers in Ecology and the Env. 297, 297 (2006) (stating that "little empirical data currently informs policy development around [ ] markets" in ecosystem services); Zedler & Shabman, *supra* n. 14, at 1, 12.

47. *Id.*

48. *See* Finn Danielson et al., *The Asian Tsunami: A Protective Role for Coastal Vegetation*, 310 Science 643, 643 (2005) (finding that the areas protected by mangroves and tree shelterbelts that were hit by the tsunami were significantly less damaged than other areas of the coast that were not behind those mangroves).

49. *See* Curtis H. Marshall, Roger A. Pielke, Sr. & Louis T. Steyaert, *Crop Freezes and Land-Use Change in Florida*, 426 Nature 29, 29 (2003) (demonstrating that agricultural damage caused by freezes in South Florida may have been worse than if the natural wetlands were still present in those areas).

50. *See* Brant Keller, *What We Always Knew: Wetlands Win Hands Down at Pollution Mitigation*, 27 Natl. Wetlands Newsltr. 12, 14 (Sept./Oct. 2005) (finding that city planners should consider constructed wetlands as a means to reduce pollution to meet water quality standards or achieve other environmental goals); *National Management Measures*, *supra* n. 42, at 12–13 (showing that wetland areas play a critical role in pollutant control by intercepting surface runoff, subsurface flow, and certain ground water flows as well as maintaining water quality).

service area and watershed, is likely to alter who benefits from the associated ecosystem services, and, more likely, urban populations will lose net services and smaller rural populations will gain them.

Of course, urbanites might not care about this possible loss of services—that is, urban dwellers might prefer a shopping center to a wetland and might not mind losing the services associated with the wetland. But if they do not know what and where those services are and the values conferred, they cannot make fully informed decisions. Indeed, the more pernicious problem is the cumulative effect—the loss of urban wetland networks mounts over time as each site-specific loss seems inconsequential. Geospatial tracking of wetland impact and mitigation sites has not been a part of the Corps' program until recently,[51] and thus, very little is known about these landscape effects of compensatory mitigation on ecosystem services from the last several decades. In short, although wetlands provide valuable ecosystem services, and evidence demonstrates the compensatory mitigation program has "migrated" wetland services, the Corps' regulatory program has had no mechanisms for monitoring this effect and taking ecosystem services into account.

---

51. The Corps and the EPA have begun a pilot study in three Corps regional offices of a tracking system, known as Regional Internet Bank Information Tracking System (RIBITS), designed to allow the agency and mitigation banks to monitor bank transactions and ecological performance through an online system. U.S. Army Corps of Engineers, *Regional Internet Bank Information Tracking System (RIBITS)*, Engineer Research and Development Center (May 2008) (available at http://www.erdc.usace.army.mil/pls/erdcpub/!www_fact_sheet.PRODUCT_PAGE?ps_product_numb=114145&tmp_Main_Topic=&page=All). But RIBITS is a restricted access format that limits public access to the information, and it does not track demographic information for a bank or its projects. *See* Envtl. Law Inst., *Fifth Stakeholder Forum on Federal Wetlands Mitigation* 36 (May 11–12, 2006) (stating that the Corps is currently working to determine which data will be made publicly available). The Corps and the EPA are also planning to integrate RIBITS with the Corps' GIS-enabled permit tracking data management system, currently under development, called G-ORM. *Id.* If successful, G-ORM/RIBITS will track spatial information associated with all authorized impacts and required compensatory mitigation, including mitigation banks, which will make it much easier to illustrate any spatial redistribution of ecological functions taking place under the 404 permit program. *See id.* at 37 (indicating that the G-ORM/RIBITS will generate permitting information on impacts and mitigation).

III. THE 2008 REGULATION

The new compensatory mitigation regulation represents a significant turning point in the program's integration of ecosystem services into mitigation decisionmaking. It is the first major federal agency legislative rule to explicitly integrate ecosystem services as one of the decisionmaking factors in a regulatory permitting program. Although the rule is massive and comprehensively addresses compensatory mitigation, which itself is just a part of the larger Section 404 permit program, the focus of this Article is on the narrow topic of integration of ecosystem services as a new factor in the mitigation decision process.

Initially, the rule adopts the term "services" to mean "the benefits that human populations receive from functions that occur in ecosystems."[52] The rule mandates that "[i]n general, the required compensatory mitigation should be located within the same watershed as the impact site, and should be located where it is most likely to successfully replace lost functions *and services* . . . ."[53] Supporting that directive, the rule explains that

> the success of compensatory mitigation for impacted habitat functions . . . may lead to siting of such mitigation away from the project area. However, consideration should also be given to functions and services (e.g., water quality, flood control, shoreline protection) that will likely need to be addressed at or near the areas impacted by the permitted impacts.[54]

Accordingly, Corps district engineers, when making mitigation determinations, "may require on-site, off-site, or a combination of on-site and off-site compensatory mitigation to replace permitted losses of aquatic resource functions *and services*."[55] The EPA adopted an identical set of provisions in its part of the joint rule to implement the Section 404(b)(1) Guidelines.[56]

---

52. 33 C.F.R. at § 332.2.

53. *Id.* at § 332.3(b)(1) (emphasis added). For marine resources, the rule uses the term "marine ecological system" in place of watershed. *See e.g. id.* (discussing compensating for impacts to marine resources).

54. *Id.* at § 332.3(c)(2)(ii).

55. *Id.* at § 332.3(d)(2) (emphasis added).

56. 40 C.F.R. at § 230.92 (defining terms used in the regulations); *id.* at § 230.93(b)(1)

Although the impact to ecosystem services is just one of many factors the Corps must weigh in the compensatory mitigation decision under the new regulations,[57] the integration of that factor into the rule enables the EPA and the Corps to consider the issues arising from the migration of wetland services from urban to rural areas, as well as the question of how wetland ecosystem services generally should be factored into compensatory mitigation decisions. The Corps' permit rules and the EPA's 404(b)(1) Guidelines thus can be summarized as follows:

- The Corps may require on-site, off-site, or a combination of on-site and off-site compensatory mitigation to replace permitted losses of aquatic resource services.
- Compensatory mitigation should be located within the same watershed as the impact site and should be located where it is most likely to successfully replace lost ecosystem services.
- When off-site compensatory mitigation is used, specific consideration should be given to ecosystem services that will need to be addressed at or near the areas impacted by the permitted impacts.[58]

There is, however, no further detail in the rule to guide implementation of these requirements. In particular, the provision requiring permittees to develop mitigation plans does not require assessment of ecosystem services at the impact site as part of the

(replacing lost services); *id.* at § 230.93(c)(2)(ii) (addressing services at impact site); *id.* at § 230.93(d)(2) (replacing lost services). The focus in this Article is on the Corps' regulations for permitting wetland impacts under Section 404 of the CWA, as that is the stage at which wetland services assessments will most frequently take place. As the EPA 404(b)(1) rules are the same regarding services, the research agenda outlined herein would apply equally to the EPA's implementation of the Section 404(b)(1) Guidelines.

57. *See* 33 C.F.R. at § 332.3(b)(1) (stating that the Corps must also consider factors such as aquatic habitat diversity, habitat connectivity, relationships to hydrologic sources, trends in land use, ecological benefits, and compatibility with adjacent land use).

58. *See* 40 C.F.R. at § 230.93(e)(1)–(2) (2008) (allowing the district engineer authority to determine whether off-site compensatory mitigation will serve the aquatic resource needs of the watershed).

"baseline information" that the permittee must compile.[59] On this point, the agencies explained in the rule's preamble that

> [a]lthough the services provided by aquatic resource functions are important to consider when determining the type and location of compensatory mitigation projects[,] there are few methods available for assessing services. Therefore, in most cases consideration of services will be conducted through best professional judgment.[60]

Yet the rule offers no additional guidance on what will inform this "best professional judgment" or how the Corps will exercise it.

The sparse level of detail in the rule, however, by no means defines the limits of detail for the program as a whole or for the development and use of ecosystem service assessments. Just as the overall compensatory mitigation program evolved over time prior to the rule through a series of inter-agency and Corps guidances and policy memoranda outlining standards and practices, so too can the ecosystem services component of the new rule be further defined and implemented. Indeed, in the EPA's 404(b)(1) Guidelines portion of the new rule, the agency states that "[f]rom time to time guidance on interpreting and implementing this subpart may be prepared jointly by EPA and the Corps at the national or regional level."[61] In fairness, the rule probably goes as far as policy can take the ecosystem services concept at this time—the work ahead will require a research-based infusion of better understanding of the ecology, economics, and geography of wetland ecosystem services at local landscape scales.

IV. RESEARCH AGENDA

The agencies unquestionably are correct that there are few methods available for assessing services;[62] thus it would have

59. *See* 33 C.F.R. at § 332.4(c)(5) (discussing the baseline information the permittee must compile, such as descriptions of historic and existing plant communities, hydrology, soil conditions, a map of the locations of impact, and other site characteristics appropriate).

60. Compensatory Mitigation for Losses of Aquatic Resources, 73 Fed. Reg. 19594, 19659 (Apr. 10, 2008).

61. 40 C.F.R. at § 230.91(a)(2).

62. Boyd, King & Wainger, *supra* n. 33, at 397–398, 412 (2001) (stating that the valuation of benefits is often an ignored component of environmental trading and compensation

been imprudent for the agencies to demand more detailed and substantive wetland ecosystem service impact assessments before the science is available to do so. On the other hand, the science on ecosystem services left the agencies little choice but to acknowledge in the rule that compensatory mitigation does have an impact on the distribution and delivery of ecosystem services to discrete human populations.[63] Of course, this is by no means the first time policy and methodology have been caught in the "chicken and egg" dilemma in which each waits for the other to take a step forward before doing so itself. In the compensatory mitigation program, for example, early assessments of wetland impact and mitigation were usually based on acreage, with little attention on ecological functions.[64] Over time, however, the Corps, the EPA, and state agencies developed more refined functional assessment methods, allowing impact and mitigation evaluations to move closer to measuring true ecological losses and benefits.[65] Science pushes policy, and then policy pushes science, and so on.

This potential for co-evolution of policy and science defines an important step for implementing the wetlands compensatory mitigation rule—i.e., to develop a more robust base of research and knowledge from which to develop such methods for assessing services. The following sequence of three questions is a useful way of designing such a research agenda: (1) What questions must the Corps and the EPA address under the new ecosystem services provisions? (2) What information and methods will the Corps and EPA need to competently answer those questions? and (3) What research is needed to begin to compile the necessary information and develop the necessary methods? A discussion of each step follows.

---

schemes); Lisa A. Wainger et al., *Wetland Value Indicators for Scoring Mitigation Trades*, 20 Stan. Envtl. L.J. 413, 415 (2001) (indicating that there is not yet a way to determine with reasonable certainty whether trading existing wetlands for restored wetlands promotes social welfare).

63. *See* 40 C.F.R. at § 230.93(c)(2)(ii) (discussing the role that locational factors play in the success of compensatory mitigation).

64. *See* Envtl. Law Inst., *Banks and Fees*, *supra* n. 10; Turner, Redmond & Zedler, *supra* n. 14, at 5 (demonstrating that prior assessments of wetland impact and mitigation were based on acres).

65. *See* Ruhl & Gregg, *supra* n. 32, at 372–373 (discussing the different instruments that have been developed to integrate consideration of ecological functions into wetland mitigation banking decisionmaking).

A. Questions

First, consider the questions the Corps and the EPA must answer under the new set of provisions:

- What combination of on-site and/or off-site compensatory mitigation will best replace permitted losses of ecological resource services?
- At what locations will compensatory mitigation be most likely to successfully replace lost services?
- If off-site compensatory mitigation is used, what services at or near the areas impacted by the permitted impacts need to be addressed?[66]

B. Information Needs

Next, consider what information the Corps and the EPA should have at their disposal and what information must be generated, either by the agencies or by the permittee, to effectively answer these questions in site-specific decisions. Ideally, the following would be available:

- Qualitative information about the kinds of services associated with the particular wetland type in the particular region.
- Demographic information about human populations in the impact area and at mitigation sites.
- Geospatial models of the watershed area showing the transport pathways of services from the impact and mitigation sites to the relevant human populations.
- Quantitative assessments of the stocks and associated flows of such services within the watershed.

66. *See* 40 C.F.R. at § 230.93(b)(6) (stating that the district engineer must determine the likelihood of offsetting the permitted impacts).

- Economic valuations of the flows of services.
- Models for assessing the effects that cumulative losses and gains of wetland resources within watersheds have on the supply and pathways of ecosystem services.
- Projections of demographic and environmental change in the relevant areas of the watershed.

C. Research Design

With these information needs identified, research should be designed around the following:

- Classify types of wetlands and qualitatively describe the services associated with each under different environmental, biophysical, and regional conditions, as well as possible trade-offs in services from different management approaches.
- Develop geospatial databases and models that can readily display ecological and demographic attributes of the relevant impact and mitigation site areas, as well as cumulative impacts on aquatic resources and their associated services over time within watersheds.
- Establish an understanding of nonlinear temporal and spatial scale effects on ecosystem services flows, particularly as a consequence of cumulative losses or gains in aquatic resources within watersheds.
- Conduct pilot studies of wetland types in different regions, particularly in urban settings, to develop cost- and time-efficient methods for identifying service flow pathways, quantities, and beneficiaries.
- Develop economic models for valuing wetland services in local settings given information about the type of service, service flow pathways and quantities, and human population receiving the service.

In an example of research that anticipated emerging management issues related to ecosystem services, the EPA's Office of Research and Development in 2007 began planning such studies on wetlands as a major component of its Ecosystem Services Research Program (ESRP).[67] Initiated independently of the 2008 rule making, this research provides a foundation to enable the assessment of an array of core ecosystem services provided by freshwater and coastal wetlands.[68] The core wetland ecosystem services under study include biological integrity and wildlife habitat provided by wetlands, which have long been valued in their own right by society.[69] In addition, ESRP research is developing methods to quantitatively assess other wetland services, including flood control and storm surge protection; maintenance of water quality, including nutrient cycling; maintenance of water quantity, including recharge and baseflow; carbon storage and sequestration; support of fisheries; and other contributions to human well-being, such as recreational and cultural values associated with wetlands.[70] This research extends ESRP's previous work to develop ecological stressor-response models. In particular, ESRP's new wetlands research is designed to develop methods to assess the effects of pollution, infrastructure development, hydrologic modification, resource extraction, invasive species, climate change, and changing patterns of land cover and use on these core ecosystem services.[71]

ESRP will conduct studies at wetland sites across the contiguous U.S., including tidal and freshwater wetlands in portions

---

67. *See* Envtl. Protec. Agency, *Research to Value Ecosystem Services Identifying, Quantifying, and Assessing Nature's Benefits*, http://www.epa.gov/ord/npd/pdfs/erp-overview-fact-sheet-final.pdf (July 2007) (discussing the importance of ecosystem services in researching wetlands).

68. *See id.* (stating that this new wetland research will determine how the position of wetlands on the landscape alters the provision of ecosystem services).

69. *See* Envtl. Protec. Agency, *Ecosystem Services Research Focuses on Wetlands*, http://www.epa.gov/ORD/npd/pdfs/erp-place-based-research_wetlands-factsheet.pdf (Oct. 2007) [hereinafter *Research Focuses on Wetlands*] (discussing the range of benefits gained from wetland ecosystems that contribute to human well-being).

70. *See id.* (stating that ecosystem services include safe water supply, fish and fiber, wildlife habitat, flood regulation and recreation among others); Envtl. Protec. Agency, *Basic Information: Foundation for Research*, http://www.epa.gov/ord/esrp/basic-foundation.htm (last updated Mar. 25, 2009) (discussing the future research of the ESRP is designed to measure and assess these ecosystem services).

71. *See id.* (stating that this new wetland research will determine how the position of wetlands on the landscape alters the provision of ecosystem services).

of the Pacific Northwest, the coastal wetlands of the Great Lakes, the coastal wetlands of North and South Carolina, isolated wetlands in the Midwest, and urban wetlands in and near Tampa Bay, Florida.[72] These studies will be conducted in collaboration with local communities, state resource agencies, the EPA's Regional Offices, other federal agencies, and ESRP research partners in academia and the private sector.[73]

In order to enhance their comparability and extend their usefulness to resource managers, these studies will share common methods and products.[74] These include developing ecosystem service indicators for wetlands, predictive landscape models that incorporate landscape profiles and wetland functional surfaces, atlases that depict the spatial distribution of wetland services, and tools to assess trade-offs among wetland ecosystem services, as affected by various stressors to these systems.[75] A major objective of ESRP's wetlands research is to provide quantitative information on baseline services provided by wetlands, as well as methods for prospective scenarios of how these services may change in the future—at site, landscape, and sub-regional scales.[76] ESRP's goal is to provide information about wetland ecosystem services that will support innovation in resource management and private-sector investments in wetland stewardship and conservation.[77]

It will be important, of course, to build from the results of such research to develop wetland service assessment methods that the Corps can apply in permitting decisions efficiently and reliably, without undue time and expense. As these methods emerge and are refined over time, Corps district engineers exercising best professional judgment about impacts to services can

72. *Research Focuses on Wetlands*, *supra* n. 69.

73. *See id.* (indicating that these four studies will be a collaborative effort).

74. *Id.*

75. *See* Envtl. Protec. Agency, *Research Tests New Approach to Assessing Wetlands*, http://www.epa.gov/ord/npd/pdfs/wetlands-assessment-tool-fact-sheet-final.pdf (Oct. 2007) (discussing the research tests developed to assess wetland functions).

76. *See Research Focuses on Wetlands*, *supra* n. 69 (discussing the application and impact of the research to predict the effects of local and landscape manipulations on the provision of wetland ecosystem services).

77. *See* Envtl. Protec. Agency, *Ecosystem Services Research in Communities: Developing Tools to Support Sustainability and Good Stewardship*, http://epa.gov/ord/esrp/pdfs/ESRP-place-based-research_overview-factsheet.pdf (Dec. 2007) (stating that the research will be used to enable decisionmakers to consider the value of the ecosystem services and to improve stewardship of the land and its services).

move from basing decisions on generalized qualitative assessments to more site-specific quantitative, biophysically-based assessments. This shift will make their decisions more transparent and justifiable from site to landscape to sub-regional scales. Moreover, the Corps and EPA can begin to integrate information collected on ecosystem services into aggregate geospatial databases on wetland mitigation, allowing regional assessments of wetland ecosystem service distributions. Ultimately, manuals and other forms of guidance can be published to provide more uniform practice across the program. The same co-evolution of science and policy implementation occurred for wetland delineation methods and functional assessment methods[78]—there is no reason to believe it cannot also happen for wetland service assessment methods.

V. CONCLUSION

Prior to the rise of mitigation banking, the principal method for a land development project to satisfy regulatory wetland mitigation requirements was to compensate for resource losses through on-site creation, enhancement, or preservation of wetlands. The result of this practice, compounded over tens of thousands of land development projects, was an administrative nightmare for federal and state regulatory agencies administering wetland protection programs. Numerous retrospective studies show that individual project compensatory mitigation was poorly designed, inadequately implemented, and infrequently monitored. In mitigation banking, by contrast, the banker is more easily subjected to permitting standards and close monitoring and has an economic incentive to produce and sustain the wetland values needed to generate credits to sell. Yet, far from discounting these advantages or suggesting that mitigation banking is inherently inferior to on-site mitigation, it is precisely these features of mitigation banking that suggest ecosystem service values could appropriately be integrated into compensatory mitigation. The good should, and can, be made better, and the new rule is a significant

78. *See e.g.* Leah Stetson, *Wetland Assessment: Measuring the Quality of the Nation's Wetlands*, 18 Wetland News 3 (Feb. 2008) (available at http://www.aswm.org/propub/news/wetland_assessment_0208.pdf) (discussing the evolution of wetland functions).

move in that direction. From here, much will depend on follow through in research and, ultimately, in the Corps' commitment to implement a mandate that should have long been a part of the Section 404 program.