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Martin W. Doyle

Todd BenDor

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# EVOLVING LAW AND POLICY FOR FRESHWATER ECOSYSTEM SERVICE MARKETS

MARTIN W. DOYLE\* & TODD BENDOR\*\*†

## INTRODUCTION

Humans have altered freshwater ecosystems worldwide.<sup>1</sup> With the dramatic increase in irrigation, water storage projects, and land utilization through the twentieth century, the scale of environmental conversion has grown to influence fundamental biophysical processes including fundamental changes to the water cycle, cycling of elements (e.g., carbon, nitrogen, and phosphorus), species composition, and climate.<sup>2</sup> These transformations have raised questions about the possibility of conserving and possibly restoring damaged freshwater ecosystems.<sup>3</sup> While environmental conservation and restoration efforts have historically focused on recovering important organisms (flora and fauna), recent scientific and policy endeavors have centered on sustaining the services produced by ecosystems and their components.<sup>4</sup> One way of accomplishing this is through the creation and use of ecosystem service markets.

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\* Duke University, Nicholas School of the Environment.

\*\* Department of City and Regional Planning, University of North Carolina, Chapel Hill.

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<sup>1</sup> See MILLENNIUM ECOSYSTEM ASSESSMENT, ECOSYSTEMS AND HUMAN WELL-BEING: SYNTHESIS 26 (2005), available at <http://www.millenniumassessment.org/documents/document.356.aspx.pdf> [hereinafter MEA] (stating that the “ecosystems and biomes that have been most significantly altered globally by human activity include marine and freshwater ecosystems . . .”). See generally HEINZ CTR. FOR SCI., ECON. AND THE ENV'T, THE STATE OF THE NATION'S ECOSYSTEMS 133–54 (2002) [hereinafter HEINZ] (examining the state of fresh water ecosystems).

<sup>2</sup> Peter M. Vitousek et al., *Human Domination of Earth's Ecosystems*, 277 SCIENCE 494, 494–99 (1997), available at <http://www.sciencemag.org/content/277/5325/494.full>.

<sup>3</sup> Margaret Palmer et al., *Ecology for a Crowded Planet*, 304 SCIENCE 1251, 1251–52 (2004).

<sup>4</sup> See Elizabeth M. Strange et al., *Sustaining Ecosystem Services in Human-Dominated Watersheds: Biohydrology and Ecosystem Processes in the South Platte River Basin*, 24

Ecosystems are often defined as the complex of (1) organisms appearing together in a given area and (2) their associated abiotic environment, which interact through energy fluxes in order to construct biotic structures and material cycles.<sup>5</sup> The study of ecosystems is somewhat distinct from that of the field of ecology in that ecosystem ecologists generally study material or energy fluxes, while other ecologists commonly focus on the behavior or patterns of particular organisms or groups of organisms.<sup>6</sup> Additionally, ecosystem ecologists generally consider ecosystems to be landscape features (physical features in the natural environment) that have the ability to produce various functions.<sup>7</sup> Here, ecosystem functions are the ability of a particular ecosystem (i.e., area) to change the flux or storage of material or energy through time.<sup>8</sup> These functions include photosynthesis (carbon sequestration), nutrient uptake or retention, metabolism, or any other process characterized by the entirety of the ecosystem feature (physical expression of ecosystem) rather than the process of any particular individual organism or species.<sup>9</sup>

“Ecosystem services” are derived from the beneficial outcomes of ecosystem functions. These services provide the benefits that produce ecological value.<sup>10</sup> For example, streams and wetlands naturally function as retainers of nitrogen;<sup>11</sup> in watersheds in which there are nitrogen-driven water quality problems (e.g., hypoxia of estuaries),<sup>12</sup> nitrogen retention would be considered a valuable ecosystem service. The Millennium

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ENVTL. MGMT. 39, 50 (1999) (acknowledging that “there is increasing concern that substantial changes will be required to ensure sustainability of essential ecosystem services”).

<sup>5</sup> See HEINZ, *supra* note 1, at 16 n.7.

<sup>6</sup> TIMOTHY F.H. ALLEN & THOMAS W. HOEKSTRA, TOWARD A UNIFIED ECOLOGY 90–92 (1993).

<sup>7</sup> See, e.g., Wolfgang Haber, *Landscape Ecology as a Bridge from Ecosystems to Human Ecology*, 19 ECOLOGICAL RESEARCH 99, 104–05 (2004); Monica G. Turner, *Landscape Ecology: The Effect of Pattern on Process*, 20 ANNUAL REVIEW OF ECOLOGY AND SYSTEMATICS 171, 173 (1989).

<sup>8</sup> Turner, *supra* note 7, at 173.

<sup>9</sup> Rudolf S. de Groot et al., *A Typology for the Classification, Description, and Valuation of Ecosystem Functions, Goods and Services*, 41 ECOLOGICAL ECON. 393, 394–95 (2002), available at [http://www.afordablefutures.net/uploads/3/5/8/5/3585210/degroot\\_et\\_al.pdf](http://www.afordablefutures.net/uploads/3/5/8/5/3585210/degroot_et_al.pdf).

<sup>10</sup> See Gretchen C. Daily et al., *Ecosystem Services: Benefits Supplied to Human Societies by Natural Ecosystems*, 2 ISSUES IN ECOLOGY 1, 1 (1997); Dennis M. King & Luke W. Herbert, *The Fungibility of Wetlands*, NAT'L WETLANDS NEWSL., Sept. 1997, at 10–13 [hereinafter King & Herbert].

<sup>11</sup> See Mats Jansson et al., *Wetlands and Lakes as Nitrogen Traps*, 23 AMBIO 320, 320 (1994).

<sup>12</sup> ECOLOGICAL SOCIETY OF AMERICA, HYPOXIA, available at <http://www.esa.org/education/edupdfs/hypoxia.pdf>.

Ecosystem Assessment (“MEA”)<sup>13</sup> groups ecosystem services into four categories: provisioning services (e.g., providing food and water); regulating services (e.g., disease regulation); cultural services (e.g., recreation opportunities); and supporting services (e.g., services necessary for the production of other service types).<sup>14</sup> The lists of potential ecosystem services appear to increase with time, and Ruhl et al.’s *The Law and Policy of Ecosystem Services*<sup>15</sup> provides a useful review and synthesis.

Markets for these services are as difficult to define as functions and services themselves.<sup>16</sup> Perhaps the most reasonable definition is given by Robertson, who defines ecosystem service markets as those markets that trade commodities based on ecological assessment criteria, such as wetlands, rather than units of weight or volume, as is the case for the acid rain program.<sup>17</sup> However, the clarity of this definition begins to break down as ecosystem service markets begin to interact, as in the case when there are both wetland and water quality markets. As we will discuss in Part III.C *infra*, there are instances in which markets attempt to trade in weight or volume units whose values are estimated using ecological assessment criteria (we describe this using the example of point-source to non-point-source water quality trading).<sup>18</sup> Given these complicating factors, it is imperative in any discussion of ecosystem markets to understand a range of different resource markets and trading structures. Substantial differences in commodity units and methods of assessment introduce problems that confront researchers and practitioners who study and implement different types of markets.<sup>19</sup>

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<sup>13</sup> See MEA, *supra* note 1.

<sup>14</sup> *Id.* at vi.

<sup>15</sup> See generally J.B. RUHL ET AL., *THE LAW AND POLICY OF ECOSYSTEM SERVICES* (2007).

<sup>16</sup> See Pac. Nw. Research Station, *Counting All That Matters: Recognizing the Value of Ecosystem Services*, 16 SCIENCE UPDATE 1, 1–4 (2008), available at <http://www.fs.fed.us/pnw/pubs/science-update-16.pdf> (describing the infancy of the concept of ecosystem services).

<sup>17</sup> Morgan M. Robertson, *Emerging Markets in Ecosystem Services: Trends in a Decade of Entrepreneurial Wetland Banking*, 4 FRONTIERS IN ECOLOGY AND THE ENV’T 297, 297 (2006) [hereinafter Robertson 2006].

<sup>18</sup> See generally CYNDI KAROLY, N.C. DIV. OF COASTAL MGMT., NC WETLAND ASSESSMENT METHOD (NCWAM) (2009), available at <http://www.nccoastaltraining.net/uploads/Documents/DWQ%20NCWAM%20PPT.pdf> (providing an overview of the North Carolina Wetlands Assessment Method); PAUL ADAMUS, HYDROGEOMORPHIC (HGM) ASSESSMENT GUIDEBOOK FOR TIDAL WETLANDS OF THE OREGON COAST—PART 1: RAPID ASSESSMENT METHOD (2006), available at [http://www.oregon.gov/DSL/WETLAND/docs/tidal\\_HGM\\_pt1.pdf?ga=t](http://www.oregon.gov/DSL/WETLAND/docs/tidal_HGM_pt1.pdf?ga=t) (providing overview of the Oregon Rapid Assessment Method).

<sup>19</sup> Morgan M. Robertson, *Discovering Price in All the Wrong Places: Commodity Definition*

There is rapidly growing interest and advocacy for using market forces for regulating environmental quality, and this is perhaps most visibly shown by the formation of the USDA Office of Ecosystem Services and Markets.<sup>20</sup> This enthusiasm needs to be more critically informed by carefully examining markets that have existed, and evolved, over the past few decades. Wetlands and streams comprise the oldest ecosystem markets, and continue to be the most active at the national scale.<sup>21</sup> Ecosystem service markets for wetlands and streams thus form one of the few empirical bases for understanding the policies, guidelines, and operations of ecosystem service markets.

Nearly ten years ago, several studies began to explore the implications of different market structures as a means of protecting wetlands and streams and enhancing ecosystem services.<sup>22</sup> In the intervening decade, a number of analyses have collected data on the actual geographic,<sup>23</sup> economic,<sup>24</sup> and social<sup>25</sup> operation of these markets, in addition to an emerging body of scientific work conducted at these sites.<sup>26</sup> This

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*and Price Under Neoliberal Environmental Policy*, 39 *ANTIPODE* 500, 506–07 (2007) [hereinafter Robertson 2007].

<sup>20</sup> See generally U.S. DEPT OF AGRIC., OFFICE OF ENVTL. MKTS., <http://www.fs.fed.us/ecosystems/services/OEM/> (last visited Nov. 7, 2011).

<sup>21</sup> See BECCA MADSEN ET AL., STATE OF BIODIVERSITY MARKETS REPORT: OFFSET AND COMPENSATION PROGRAMS WORLDWIDE vii, 8–9, 11–14 (2010), available at <http://www.ecosystemmarketplace.com/documents/acrobat/sbdmr.pdf>.

<sup>22</sup> See GRETCHEN C. DAILY & KATHERINE ELLISON, THE NEW ECONOMY OF NATURE: THE QUEST TO MAKE CONSERVATION PROFITABLE 16 (2002); Gretchen C. Daily et al., *The Value of Nature and the Nature of Value*, 289 *SCIENCE* 395, 395 (2000); James Salzman & J.B. Ruhl, *Currencies and the Commodification of Environmental Law*, 53 *STAN. L. REV.* 607, 607–09 (2000).

<sup>23</sup> See Todd K. BenDor et al., *Landscape Characteristics of a Stream and Wetland Mitigation Banking Program*, 19 *ECOLOGICAL APPLICATIONS* 2078, 2089 (2009), available at <http://dx.doi.org/10.1890/08-1803.1>; P. Womble & M. Doyle, *Setting Geographic Service Areas for Compensatory Mitigation Banking*, *NAT'L WETLANDS NEWSL.*, Sept./Oct. 2010, at 18.

<sup>24</sup> See generally Robertson 2006, *supra* note 17; Morgan M. Robertson, *Discovering Price in All the Wrong Places: Commodity Definition and Price Under Neoliberal Environmental Policy*, 39 *ANTIPODE* 500, 500–26 (2007) [hereinafter Robertson 2007].

<sup>25</sup> See Todd K. BenDor & Martin Doyle, *Planning for Ecosystem Service Markets*, 76 *J. OF THE AM. PLANNING ASS'N* 59, 60–61, 69–70 (2010); Salzman & Ruhl, *supra* note 22, at 612–13 (noting that there is “universal accord over the contributions of clean water and flood control to social welfare . . .”).

<sup>26</sup> See special issue of the journal *ECOLOGICAL APPLICATIONS* focusing on stream and river restoration quality; many sites were mitigation (i.e., ecosystem service market) sites. *Evaluating River Restoration*, 21 *ECOLOGICAL APPLICATIONS* 1925–2015 (2011).

paper seeks to explore these operational issues in markets for freshwater ecosystems, which unlike many proposed, and still theoretical, markets (e.g., markets for carbon, impervious surface,<sup>27</sup> and trees<sup>28</sup>) are operational at a wide scale.

In discussing wetlands and streams, we will focus our discussion and examples on markets in North Carolina, since they have been active for over a decade and have been the focus of several recent studies as well as recent federal and state regulation revisions.<sup>29</sup> Although the experience of designing and implementing these markets meant successfully navigating certain policy and scientific problems, many others have been exposed and are still in need of further study and remedy.<sup>30</sup> In addition to freshwater ecosystem markets, we also look at habitat conservation banking, an emerging market that presents a new set of opportunities and challenges which will likely interact with these existing markets in the future.<sup>31</sup> We will describe the policies that created these markets, including those crafted at the federal, state, and local level. We will also present a series of summary statistics that provide a sense of scale of these markets. Finally, we use these examples to point toward some of the potential limitations or problems of these markets that merit considerable thought and research attention as comparable markets proliferate.

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<sup>27</sup> See CLAIRE WELTY ET AL., FINAL REPORT: USING AN “IMPERVIOUS PERMIT” ALLOWANCE SYSTEM TO REDUCE IMPERVIOUS SURFACE COVERAGE FOR ENVIRONMENTAL SUSTAINABILITY (2005), available at [http://cfpub.epa.gov/ncer\\_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/7148/report/F](http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/7148/report/F) (last visited Nov. 7, 2011).

<sup>28</sup> See generally INT’L SOC’Y OF ARBORICULTURE, GUIDELINES FOR DEVELOPING AND EVALUATING TREE ORDINANCES (2001), [http://www.isa-arbor.com/education/resources/educ\\_TreeOrdinanceGuidelines.pdf](http://www.isa-arbor.com/education/resources/educ_TreeOrdinanceGuidelines.pdf) (search “mitigation”) (discussing how “tree ordinance development can be integrated with an overall community tree program”).

<sup>29</sup> See BenDor & Doyle, *supra* note 25 (“present[ing] a case study of the unique institutional structure that oversees and regulates land development, highway construction, and environmental restoration in North Carolina”); ECOSYSTEM ENHANCEMENT PROGRAM (EEP), 2003 MEMORANDUM OF AGREEMENT, available at <http://www.nceep.net/images/Final%20MOA.pdf> [hereinafter EEP MOA] (establishing the EEP and “the procedures for providing compensatory mitigation through the [North Carolina Department of Environment and Natural Resources] Ecosystem Enhancement Program (EEP) to offset impacts to waters and wetlands due to activities authorized by Clean Water Act permits”).

<sup>30</sup> See Dan Kane, *EBX is Paid Twice for Wetlands Work*, RALEIGH NEWS & OBSERVER, Dec. 8, 2009, at A1 (explaining the “double-dipping” controversy of taxpayers apparently paying twice for environmental clean-up in North Carolina).

<sup>31</sup> See J.B. Ruhl et al., *A Practical Guide to Habitat Conservation Banking Law and Policy*, 20 NATURAL RES. & ENV’T 26, 26–27 (2005), available at <http://www.law.fsu.edu/faculty/profiles/ruhl/2005-HabitatBanking20NRESummer.pdf> [hereinafter *A Practical Guide to Habitat Conservation Banking Law and Policy*].

## I. ECOSYSTEM SERVICE MARKETS: DESCRIPTION AND REGULATION

A. *The Origin of Wetland Markets*

Ecosystem service markets are almost all in some way based on, or similar to, wetland markets.<sup>32</sup> Wetland regulation in the United States is rooted in the U.S. Federal Water Pollution Control Act of 1972,<sup>33</sup> and the Clean Water Act amendments of 1977,<sup>34</sup> which provide for the protection of “waters of the United States” under the Interstate Commerce Clause of the U.S. Constitution.<sup>35</sup> Congress designated the Army Corps of Engineers (“Corps”) to administer § 404 for waters of the United States with oversight from the U.S. Environmental Protection Agency (“EPA”).<sup>36</sup> Through judicial interpretation, “waters of the United States” includes wetlands.<sup>37</sup> Most development activities that affect waters of the United States fall under § 404 of the Clean Water Act, and thus require a permit from the Corps.<sup>38</sup> As part of the 404 program, the permittee must mitigate wetland damage, a process through which they (a) avoid all possible impacts, (b) minimize unavoidable impacts, and (c) provide compensatory mitigation of unavoidable impacts, i.e., create, restore, or preserve wetlands such that there is no net loss of cumulative wetland ecosystem function.<sup>39</sup>

In the early years of this regulation (until the mid-1990s), compensatory mitigation was usually performed on-site by the permittee (also often called the “developer” or “impactor”), resulting in the creation or restoration of numerous, small mitigation sites with limited ecological

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<sup>32</sup> See Deborah L. Mead, *History and Theory: The Origin and Evolution of Conservation Banking*, in CONSERVATION AND BIODIVERSITY BANKING 9, 9–11 (N. Carroll et al. eds., 2008).

<sup>33</sup> Federal Water Pollution Control Act of 1972, Pub. L. No. 92-500, 86 Stat. 816 (1972), codified as 33 U.S.C. §§ 1251–1263, 1265, 1281–1292, 1311–1326, 1328, 1341–1345, 1361–1376 (2006).

<sup>34</sup> Clean Water Act of 1977, Pub. L. No. 95-217, 91 Stat. 1566 (1977), codified as 33 U.S.C. §§ 1281a, 1294–1297 (2006).

<sup>35</sup> U.S. CONST. art. I, § 8.

<sup>36</sup> 33 U.S.C. § 1344 (2006); Palmer Hough & Morgan M. Robertson, *Mitigation under Section 404 of the Clean Water Act: Where it Comes From, What it Means*, 17 WETLANDS ECOLOGY & MGMT. 15, 15–16 (2007), available at <http://www.springerlink.com/content/ag615v755494325v/fulltext.pdf> (describing how the Corps came to regulate wetlands and streams).

<sup>37</sup> Donn M. Downing et al., *Navigating Through Clean Water Act Jurisdiction: A Legal Review*, 23 WETLANDS, 475, 476, 484 (2003).

<sup>38</sup> 33 U.S.C. § 1344 (2006).

<sup>39</sup> See Hough & Robertson, *supra* note 36, at 15–16 (explaining the “history of three forms of [wetland] mitigation: avoidance, minimization, and compensation”).

value in comparison to existing reference, less disturbed wetlands.<sup>40</sup> During this period, regulations also began promoting off-site compensatory mitigation by permittees.<sup>41</sup> Although this was thought to promote better mitigation, the ecological values of these compensation sites were also often extremely low, and the permittee, often a private land developer or a state department of transportation, did not want to be in the business of ecological restoration.<sup>42</sup>

In response to slow § 404 permitting and high permittee-responsible mitigation costs throughout the early 1990s, entrepreneurs and regulators proposed creating large, consolidated areas of constructed wetlands, known as “mitigation banks,” as pre-impact or advance mitigation.<sup>43</sup> In conjunction with entrepreneurial mitigation bankers, developers, and EPA staff, Corps districts developed the regulatory guidance necessary to define, create, and maintain markets for mitigation of wetlands by overseeing the banks and the trades that occurred.<sup>44</sup>

Wetland mitigation banking allows private, third-party companies to speculatively restore wetlands, which can then be sold as credits to developers who do not wish to perform their own compensatory mitigation (Figure 1).<sup>45</sup> In order for a mitigation bank to be created, and credits from that bank sold, the mitigation banker must have the site approved by an Interagency Review Team (“IRT”) which is made up of personnel from the Corps, EPA, and other local or federal natural resource agencies (e.g., U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service, and state departments of environmental conservation).<sup>46</sup>

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<sup>40</sup> R. Eugene Turner et al., *Count it By Acre or Function: Mitigation Adds Up to Net Loss of Wetlands*, 23 NAT'L WETLANDS NEWSL., Nov./Dec. 2001, at 5, 6, 14.

<sup>41</sup> NAT'L RESEARCH COUNCIL, COMPENSATING FOR WETLAND LOSSES UNDER THE CLEAN WATER ACT 67–69 (2001) [hereinafter NRC] (explaining that mitigation banks “provide off-site mitigation” for permittees “who anticipate having a number of future permit applications or by third parties who develop wetland credits for sale to permittees needing to provide compensatory mitigation”).

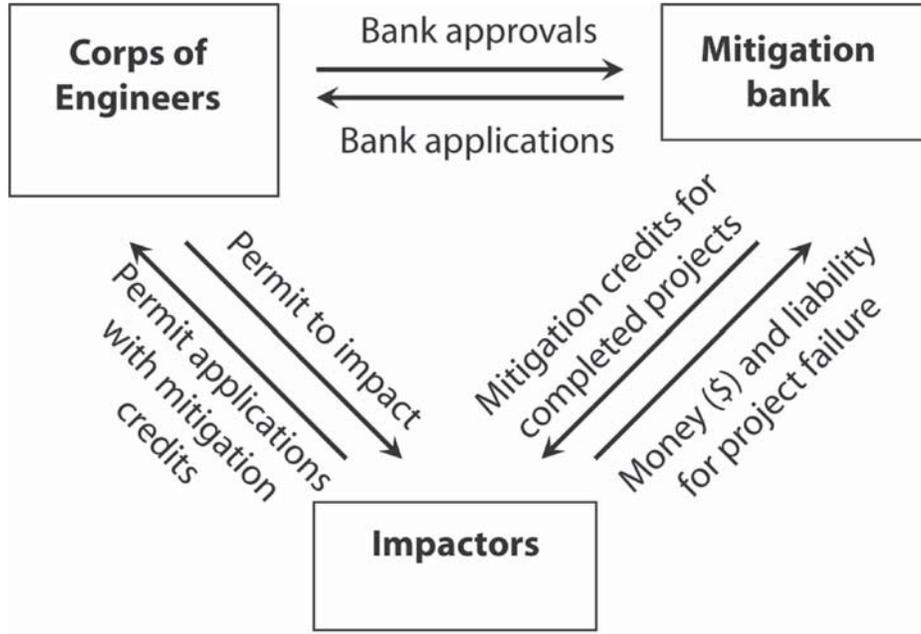
<sup>42</sup> Todd BenDor & Martin Doyle, *Markets for Freshwater Ecosystem Services*, in WATER MARKETS (D. Gardner & R. Simmons ed., forthcoming), available at <http://www.perc.org/files/Doyle%20BenDor%20fresh%20water%20markets.pdf> [hereinafter *Markets*].

<sup>43</sup> See Robertson 2006, *supra* note 17, at 297–98.

<sup>44</sup> See Federal Guidance for the Establishment, Use and Operation of Mitigation Banks, 60 Fed. Reg. 58,605–58,614 (Nov. 28, 1995) [hereinafter Corps 1995].

<sup>45</sup> *Id.* at 58,605.

<sup>46</sup> Compensatory Mitigation for Losses of Aquatic Resources: Final Rule, 73 Fed. Reg. 19,594–19,705 (2008), 33 C.F.R. § 332 (2008) [hereinafter 2008 Compensatory Mitigation Rule].



**Figure 1.** Relationships between agencies, impactors (developers), and mitigation bankers in the originally conceived structure of compensatory mitigation banking.<sup>47</sup> Note that once impactors have purchased compensatory mitigation credits, the liability for mitigation site failure is transferred from the impactor to the mitigation bank.<sup>48</sup>

A key requirement of mitigation banking is that wetlands should be restored in advance of impacts.<sup>49</sup> In less-developed regions of the United States, however, mitigation bankers are unlikely to speculatively invest in banks because it is doubtful that there will eventually be sufficient demand for the created credits.<sup>50</sup> Such markets are known as “thin” markets.<sup>51</sup> This lack of economic incentive to invest in mitigation banks has a feedback

<sup>47</sup> 2008 Compensatory Mitigation Rule, *supra* note 46.

<sup>48</sup> 2008 Compensatory Mitigation Rule, *supra* note 46, at § 332.3.

<sup>49</sup> Corps 1995, *supra* note 44, at pt. B; 23 C.F.R. § 777.2 (2008).

<sup>50</sup> See Salzman & Ruhl, *supra* note 22, at 666–67 (“[D]evelopers want to develop wetlands where land is dear (urban) and wetland banks want to locate where land is cheap (rural).”).

<sup>51</sup> *Id.* at 645–46.

to development activities, as development activities become hindered or slowed by the lack of available mitigation banks in a region, since developers cannot easily obtain a § 404 permit.<sup>52</sup> Such lack of available advance credits created the impetus for in-lieu fee (“ILF”) programs.<sup>53</sup>

ILF programs are run by government or non-profit entities that collect fees from developers (in lieu of actual compensation) and then consolidate these fees over time to build the necessary capital to restore wetlands.<sup>54</sup> Similar to mitigation banks, the obligation and associated liability for providing compensatory mitigation under ILF programs is transferred from the developer to the third-party mitigator.<sup>55</sup> The primary difference between ILF programs and mitigation banks is the time at which mitigation occurs relative to impacts; in banking, restoration is performed prior to impacts, while ILF programs allow mitigation to be performed years after impacts are permitted.<sup>56</sup>

To summarize, compensatory mitigation of wetlands can now take place through three mechanisms: permittee-responsible mitigation, purchase of credits from a mitigation bank, or purchase of credits through an ILF. These and other rules for wetlands-related regulation under compensatory mitigation were most recently summarized and formalized by the Corps and EPA in 2008 through the published new regulations governing compensatory mitigation, *Compensatory Mitigation for Losses of Aquatic Resources*.<sup>57</sup>

### B. *Emerging Markets for Streams*

How, when, and which wetlands merit being considered waters of the United States (and thus subject to federal jurisdiction via the Corps) remains highly contested between land developers and regulatory agencies, and there has been a string of mixed Supreme Court decisions addressing

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<sup>52</sup> See David Sunding & David Zilberman, *The Economics of Environmental Regulation by Licensing: An Assessment of Recent Changes to the Wetland Permitting Process*, 42 NAT. RESOURCES J. 59, 73–76 (2002).

<sup>53</sup> ENVTL. LAW INST., *THE STATUS AND CHARACTER OF IN-LIEU FEE MITIGATION IN THE UNITED STATES* (2006) [hereinafter ELI 2006].

<sup>54</sup> *Id.* at 1–3; Jessica Wilkinson, *In-lieu Fee Mitigation: Coming into Compliance with the New Compensatory Mitigation Rule*, 17 WETLANDS ECOLOGY & MGMT. 53, 67 (2009), available at <http://www.springerlink.com/content/y5538766x2551382/fulltext.pdf>.

<sup>55</sup> See 2008 Compensatory Mitigation Rule, *supra* note 46, at 19,594.

<sup>56</sup> See ELI 2006, *supra* note 53, at 1–6.

<sup>57</sup> 2008 Compensatory Mitigation Rule, *supra* note 46, at 19,594–19,596.

this issue over the past twenty years.<sup>58</sup> The recent *Rapanos v. Carabell* case<sup>59</sup> again raised the question of which waters in the United States should be considered under the regulatory authority of the Corps, and the Corps in part answered this question through the 2008 Compensatory Mitigation Rule<sup>60</sup> discussed in Part I.A *supra*. In contrast to wetlands, streams, and rivers are more easily justified as “waters of the United States” that can be regulated by federal power over interstate commerce.<sup>61</sup> Although § 404 of the Clean Water Act is known generally as a “wetlands rule,” streams and rivers also fall under its jurisdiction, specifically as a category of a “difficult to replace” type of wetland.<sup>62</sup> In the past, impacts to streams were often either considered by the Corps to be impractical to compensate, or compensation was performed using wetlands credits.<sup>63</sup> Trading stream impacts for wetland credits is called “out of kind” compensation, since the resources traded are not of the same kind.<sup>64</sup>

More recently, the Corps has begun requiring in-kind compensation for streams, thus increasing the market for stream ecosystems and stream banking separate from wetland banking.<sup>65</sup> Additionally, because streams are a “difficult to replace resource,” stream impacts must be compensated by stream restoration.<sup>66</sup> This policy has created a demand for stream restoration credits, and in response, entrepreneurs have created stream mitigation banks similar to those for wetlands.<sup>67</sup> Stream mitigation banking has adapted the wetland mitigation banking model to riverine systems,<sup>68</sup> and while only recently becoming nationwide, stream markets have surpassed wetlands markets in the number of trades in some states, as in the case of North Carolina described in Part II *infra*.<sup>69</sup>

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<sup>58</sup> See Downing, *supra* note 37 (examining the history of “navigable waters” as defined by the courts).

<sup>59</sup> See *Rapanos v. United States*, 547 U.S. 715, 716–17 (2006).

<sup>60</sup> 2008 Compensatory Mitigation Rule, *supra* note 46, at 19,595.

<sup>61</sup> See *Rapanos*, 547 U.S. at 716–17.

<sup>62</sup> 2008 Compensatory Mitigation Rule, *supra* note 46, at 19,594–19,596.

<sup>63</sup> See ENVTL. LAW INST., BANKS AND FEES: THE STATUS OF OFF-SITE WETLAND MITIGATION IN THE UNITED STATES 7–10 (2002) [hereinafter ELI 2002].

<sup>64</sup> See *id.* at 18.

<sup>65</sup> 2008 Compensatory Mitigation Rule, *supra* note 46, at 19,618 (explaining that “compensation for difficult to replace resources . . . should be provided through in-kind rehabilitation”); 33 C.F.R. § 323.3(b)(4).

<sup>66</sup> See *id.*

<sup>67</sup> Rebecca Lave et al., *Why you Should Pay Attention to Stream Mitigation Banking*, 26 ECOLOGICAL RESTORATION 287, 287–89 (2008).

<sup>68</sup> *Id.* (explaining that “[s]tream mitigation banking is rapidly becoming a major driver of the stream restoration industry”).

<sup>69</sup> See also *id.* at 287.

### C. *Water Quality Services*

The Clean Water Act provides for trading of credits for nitrogen (“N”) and phosphorus (“P”),<sup>70</sup> both of which are leading sources of pollution in the United States, particularly in the Mississippi River basin and Gulf of Mexico,<sup>71</sup> as well as in many Atlantic river basins, including the Chesapeake Bay, and the Albemarle-Pamlico sound of North Carolina.<sup>72</sup> Under the Clean Water Act, “point source” (“PS”) is distinguished from “non-point source” (“NPS”) pollution: PS pollution is federally regulated under the National Pollution Discharge Elimination System (“NPDES”),<sup>73</sup> which is focused on discrete pollution emitters (e.g., wastewater treatment facilities), and sets discharge limits and technology standards for point sources.<sup>74</sup> In contrast, NPS is regulated under total maximum daily load (“TMDL”) requirements, which focus on ambient water quality in watersheds.<sup>75</sup> Nationally, NPS pollution, particularly from agricultural sources, comprises seventy-six percent of Nitrogen and fifty-six percent of Phosphorus reaching waterways.<sup>76</sup> Although the EPA is responsible for NPDES regulation, administration of the NPDES is typically delegated to state agencies.<sup>77</sup> Some states regulating NPDES have allowed water pollution trading districts to form, specifically allowing the emergence of both point source–to–point source (“PS-PS”) trading and point source–to–non-point source (“PS-NPS”) trading programs.<sup>78</sup>

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<sup>70</sup> See 33 U.S.C. § 1267 (2006).

<sup>71</sup> Richard B. Alexander, *Effect of Stream Channel Size on the Delivery of Nitrogen to the Gulf of Mexico*, 403 NATURE 758, 758–61 (2000) [hereinafter Alexander] (discussing the impacts of excessive nitrogen); see also EPA, WATER: NUTRIENTS: GULF OF MEXICO, available at <http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/gulfofmexico.cfm> (discussing increase of phosphorus and nitrogen in the Mississippi River and Gulf of Mexico).

<sup>72</sup> See *Water Quality Issues: Nitrogen and Phosphorus Pollution*, CHESAPEAKE BAY FOUND., <http://www.cbef.org/page.aspx?pid=913> (last visited Nov. 7, 2011); U.S. DEPT. OF THE INTERIOR, U.S. GEOLOGICAL SURVEY, WATER QUALITY IN THE ALBEMARLE-PAMLICO DRAINAGE BASIN: NORTH CAROLINA AND VIRGINIA 1992–1995, available at <http://pubs.usgs.gov/circ/circ1157/circ1157.pdf>.

<sup>73</sup> See 33 U.S.C. § 1342(f) (2006).

<sup>74</sup> See *id.* § 1342(k).

<sup>75</sup> See *id.* § 1313.

<sup>76</sup> RUHL ET AL., *supra* note 15, at 228.

<sup>77</sup> See generally *U.S. State Information*, EPA, <http://cfpub.epa.gov/npdes/stateinfo.cfm> (last visited Nov. 7, 2011) (explaining how the NPDES permit program is delegated to the states by region).

<sup>78</sup> See Richard T. Woodward & Ronald A. Kaiser, *Market Structures for US Water Quality Trading*, 24 REV. OF AGRIC. ECON. 366, 373 (2003).

Under the same theory driving atmospheric emissions trading programs,<sup>79</sup> PS-PS trades should allow PS polluters to come into compliance more efficiently than if each polluter were required to come into compliance individually.<sup>80</sup> Moreover, because NPS can usually make reductions in their pollution for relatively little cost (low marginal nutrient abatement costs) compared to PS, PS-NPS trades should have even greater potential than PS-PS trades to achieve regulatory compliance at reduced costs.<sup>81</sup> While these markets have great potential for regulatory and economic purposes, within the thirty-seven nutrient trading districts created, only eight have conducted any trades, and only thirteen trades (one PS-NPS trade) had occurred as of 2007.<sup>82</sup>

Water quality trading does not initially appear to qualify as an ecosystem market since the commodity being traded is a chemical measured in pounds of N or P rather than an ecosystem service measured in ecological assessment metrics.<sup>83</sup> In the case of PS-NPS trading, NPS loads are not measured directly, as they are for PS or in air quality markets.<sup>84</sup> Rather, NPS pollution reductions arise through land use changes, specifically by landowners adopting best management practices ("BMPs") (e.g., riparian buffers and detention basins).<sup>85</sup> Just as wetland area or stream length serve as surrogate estimates of wetland or stream ecosystem function, so land use change through BMPs is used as a surrogate estimate of water quality change.<sup>86</sup> Environmental management agencies must develop ecological assessment techniques that provide conversion factors linking land use, soil type, and other variables with their impacts on water quality and nutrient (or other pollutant) loading. As a result, we can consider NPS water quality trading programs to be operating ecosystem service markets under the same definition used to articulate wetland and stream markets.

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<sup>79</sup> James Boyd et al., *Trading Cases*, 217 ENVTL. SCI. & TECH. 216(A), 217 (2003).

<sup>80</sup> See Woodward & Kaiser, *supra* note 78, at 373.

<sup>81</sup> See Zoe Hamstead & Todd K. BenDor, *Nutrient Trading for Enhanced Water Quality: A Case Study of North Carolina's Neuse River Compliance Association*, 28 ENVT AND PLANNING 1 (2010).

<sup>82</sup> RUHL ET AL., *supra* note 15, at 229.

<sup>83</sup> See Robertson 2006, *supra* note 17, at 297.

<sup>84</sup> See generally NPDES, EPA, <http://cfpub.epa.gov/npdes/index.cfm> (last visited Nov. 7, 2011) (explaining NPDES permits with respect to point sources).

<sup>85</sup> Robertson 2007, *supra* note 24, at 506–07.

<sup>86</sup> See *id.* at 501, 507.

D. *Habitat Conservation Banking*

Habitat conservation banking is a recent development in ecosystem service markets.<sup>87</sup> Conservation banking occurs when habitat for a recognized (listed) threatened or endangered species is impacted and offset with habitat preservation, enhancement, restoration, or creation at a different location.<sup>88</sup> Conservation banking is a similar concept to wetland and stream banking, whereby compensation is performed in one location to offset similar impacts at multiple locations.<sup>89</sup> The advantage of conservation banking is that the conservation bank sites are often large, contiguous, and sited more strategically (to protect habitat) than impact sites.<sup>90</sup> Like wetland banking, this can produce economies of scale leading to higher quality restoration and ecological benefits not seen in small, fragmented conservation areas.<sup>91</sup>

Conservation banking was first introduced in California by the U.S. Fish and Wildlife Service (“FWS”) to distinguish banks developed specifically for federally listed endangered species from banks specifically designated for wetland mitigation.<sup>92</sup> Unlike stream and wetland mitigation, which now is subject to very specific federal regulation, conservation banking remains regulated by an FWS guidance document.<sup>93</sup> Although this guidance is comparable to early wetland/stream banking guidance documents, the stated goal of conservation banking is to conserve species, which can only be achieved through restoration or enhancement of the habitat needs of that specific species.<sup>94</sup> Thus, while habitat conservation banks operate almost identically to wetland or stream mitigation banks, their evaluation (by a review team similar to the Mitigation Bank Review Team (“MBRT”))

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<sup>87</sup> See *A Practical Guide to Habitat Conservation Banking Law and Policy*, *supra* note 31, at 26–27 (explaining agencies’ belief that conservation banking is beneficial for species as well).

<sup>88</sup> See *id.* at 26.

<sup>89</sup> See *id.* at 26–29.

<sup>90</sup> Mead, *supra* note 32, at 17.

<sup>91</sup> See Mark W. Schwartz, *Choosing the Appropriate Scale of Reserves for Conservation*, 20 ANN. REV. OF ECOLOGY AND SYSTEMATICS 83, 99–100; see also Todd K. BenDor & N. Brozovic, *Determinants of Spatial and Temporal Patterns in Compensatory Wetland Mitigation Banking*, 40 ENVTL. MGMT. 349, 361.

<sup>92</sup> *A Practical Guide to Habitat Conservation Banking Law and Policy*, *supra* note 31, at 28.

<sup>93</sup> See Memorandum from the U.S. Dep’t of the Interior, Guidance for The Establishment, Use and Operation of Conservation Banks (May 2, 2003), available at [http://www.usace.army.mil/CECW/Documents/cecwo/reg/conserv\\_bank\\_guide.pdf](http://www.usace.army.mil/CECW/Documents/cecwo/reg/conserv_bank_guide.pdf).

<sup>94</sup> See *A Practical Guide to Habitat Conservation Banking Law and Policy*, *supra* note 31.

is held to species-specific criteria, rather than general criteria used to evaluate wetlands and streams.<sup>95</sup>

Fisheries mitigation banks are perhaps the most relevant conservation banks in the context of fresh water markets,<sup>96</sup> although very few trades have occurred.<sup>97</sup> In two cases in California, over 100 acres were restored to create the habitat specifically needed for a federally listed endangered species.<sup>98</sup> This area included tidal marsh habitat primarily acquired as habitat for delta smelt, as well as Sacramento River floodplain habitat for several fish species, including Chinook salmon.<sup>99</sup> In contrast to markets for wetlands, streams, and water quality, fisheries banks have exhibited little market activity (trades) or research interest to date, but we expect change as more regions experiment with implementing habitat conservation banks.<sup>100</sup>

*E. Some Regulatory Issues: Monitoring, Service Areas, and In-lieu Fee Programs*

There are several issues with current ecosystem market regulation that require elaboration, particularly given the impacts that regulations can have on promoting successful ecological and economic outcomes.<sup>101</sup> First, regulations governing all of the markets that we have described put very little emphasis on monitoring the ecological service actually being traded.<sup>102</sup> In wetlands mitigation, a range of services are considered to be preserved, enhanced, and restored, including flood attenuation, nutrient retention, and wildlife habitat.<sup>103</sup> The only success criteria (denoting a mitigation project as “successful”) measured in most Corps districts, however, relate to hydrology (water table elevation), soil type, and vegetation

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<sup>95</sup> *See id.* at 30.

<sup>96</sup> *See generally* Tom Cannon & Howard Brown, *Fish Banking*, in CONSERVATION AND BIODIVERSITY BANKING 159, 159–70 (N. Carroll et al. eds., 2008) (discussing the history and potential future application of fish banks).

<sup>97</sup> *See id.* at 163.

<sup>98</sup> *Id.* at 159–60.

<sup>99</sup> *See id.*

<sup>100</sup> *Id.* at 163–64.

<sup>101</sup> *See* Sunding & Zilberman, *supra* note 52, at 60–61 (analyzing the potential to reform the most often issued wetland permit, National Wetland Permit 26).

<sup>102</sup> In the case of stream mitigation in North Carolina, biological monitoring data from in-stream communities are not required for any work, although they may be required on a case-by-case basis. U.S. ARMY CORPS OF ENGINEERS–WILMINGTON DIST., STREAM MITIGATION GUIDELINES (2003). To our knowledge, no monitoring of in-stream biological communities has been required for mitigation permits to date.

<sup>103</sup> *See* Salzman & Ruhl, *supra* note 22, at 612, 635.

type/survival.<sup>104</sup> While these are ecological components of wetlands, it is unclear whether these components are sufficient proxies to capture the range of ecosystem services that regulations seek to protect under the auspices of the Clean Water Act.<sup>105</sup> Furthermore, while the 2008 federal mitigation regulation requires the establishment of more explicit standards defining ecological success criteria,<sup>106</sup> it does not explicitly define the range and type of ecological functions and services that act as proxies for mitigation “success,” leaving these to be determined by individual District Engineers.<sup>107</sup>

In the case of streams in many states, only physical characteristics of stream channel shape—width, slope, and riparian vegetation—are measured or restored under compensatory mitigation.<sup>108</sup> Although restoring ecological functions (e.g., species recovery, nutrient retention) is the stated purpose of compensatory stream mitigation, specific ecological aspects (e.g., community composition of fish or macroinvertebrates, nutrient retention) are rarely monitored as a requirement for approval of the bank to sell its credits.<sup>109</sup> Evaluating the success of compensatory mitigation programs is difficult because of this disconnect between the purpose of mitigation (functional replacement) and the reality, as it is far from clear what is being achieved when just the physical habitat is being changed.<sup>110</sup>

Recently published scientific literature is in fact casting doubts on whether stream restoration can deliver demonstrable changes.<sup>111</sup> Commonly assumed hydrological benefits of restoration, such as sediment retention or flood attenuation, have been shown to be more difficult to either restore or measure than previously thought.<sup>112</sup> Biological changes

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<sup>104</sup> See NRC, *supra* note 41, at 35.

<sup>105</sup> See Salzman & Ruhl, *supra* note 22, at 626 (explaining potential complications associated with wetland mitigation).

<sup>106</sup> 2008 Compensatory Mitigation Rule, *supra* note 46, at § 332.5.

<sup>107</sup> See 2008 Compensatory Mitigation Rule, *supra* note 46, at § 332.4(c).

<sup>108</sup> See U.S. ARMY CORPS OF ENGINEERS—WILMINGTON DISTRICT, *supra* note 102, at 24–25.

<sup>109</sup> In a review of several state regulations and Corps of Engineer Districts, we have found a consistent pattern of requiring monitoring of physical variables (e.g., channel width, depth) and riparian vegetation, but no in-channel biological data. For examples see U.S. ARMY CORPS OF ENGINEERS—MOBILE DIST., COMPENSATORY STREAM MITIGATION STANDARD OPERATION PROCEDURES AND GUIDELINES 31, 34 (Draft Edition, 2009); U.S. CORPS OF ENGINEERS, STATE OF MISSOURI STREAM MITIGATION METHOD 11 (2007).

<sup>110</sup> See *infra* notes 111–18 and accompanying text.

<sup>111</sup> For limited effects of restoration on sediment loads see F. Douglas Shields, *Do We Know Enough About Controlling Sediment to Mitigate Damage to Stream Ecosystems?*, 35 *ECOLOGICAL ENG'G* 1727, 1732 (2009). For limited effects of restoration on flood attenuation see Joel Sholtes & Martin Doyle, *Effect of Channel Restoration on Flood Wave Attenuation*, 137 *J. OF HYDRAULIC ENG'G* 196 (2011).

<sup>112</sup> See Shields, *supra* note 111, at 1730–32.

are also proving difficult to demonstrate, as based on case studies or systematic reviews of many studies of fish and aquatic insect communities.<sup>113</sup> There is ongoing scientific debate about the potential benefits of stream restoration for nutrient retention, with some studies showing its efficacy, and others its limitations.<sup>114</sup> One limiting factor that has too often been ignored is that background water quality may be so poor as to be both toxic to aquatic organisms<sup>115</sup> and saturating of any nutrient retention effects;<sup>116</sup> that is, in-stream water restoration may be moot given back

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<sup>113</sup> For fish studies, Phil Roni and his colleagues conducted a systematic meta-analysis of published literature. See Phil Roni et al., *Global Review of the Physical and Biological Effectiveness of Stream Habitat Rehabilitation Techniques*, 28 N. AM. J. OF FISHERIES MGMT. 856 (2008) (noting that definitive conclusions on many techniques of stream rehabilitation are difficult to make due to a lack of biological information); Ian A. Tattam et al., *Scale Pattern Analysis of Selected Scale Characteristics and the First Annulus for Distinguishing Wild and Hatchery Steelhead in the Hood River, Oregon*, 23 N. AM. J. OF FISHERIES MGMT. 856 (2003); see also Ashley H. Moerke & Gary A. Lamberti, *Responses in Fish Community Structure to Restoration of Two Indiana Streams*, 23 N. AM. J. OF FISHERIES MGMT. 748 (2003); J.L. Pretty et al., *River Rehabilitation and Fish Populations: Assessing the Benefit of Instream Structures*, 40 J. OF APPLIED ECOLOGY 251 (2003).

While a similar meta-analysis for insects is not available, case studies cast doubt on stream restoration effectiveness. See S.S.C. Harrison et al., *The Effect of Instream Rehabilitation on Macroinvertebrates in Lowland Rivers*, 41 J. OF APPLIED ECOLOGY 1140 (2004); David J. Price & Wesley J. Birge, *Effectiveness of Stream Restoration Following Highway Reconstruction Projects on Two Freshwater Streams in Kentucky*, 25 ECOLOGICAL ENG'G 73 (2005).

<sup>114</sup> There are two main studies that show that stream restoration increases nutrient retention. See Sujay S. Kaushal et al., *Effects of Stream Restoration on Denitrification in an Urbanizing Watershed*, 18 ECOLOGICAL APPLICATIONS 789 (2008); Paul A. Bukaveckas, *Effects of Channel Restoration on Water Velocity, Transient Storage, and Nutrient Uptake in a Channelized Stream*, 41 ENVTL. SCI. AND TECH. 1570 (2007).

However, both have been interpreted incorrectly. For the Kaushal study, the effect of restoration was measured on riparian zone denitrification, not in-stream processes. For Bukaveckas, it is important to note that temperature in the stream increased dramatically in the restored stream; thus denitrification increases are confounded by this effect, not necessarily the in-stream restoration work. For studies showing the limitation of stream restoration for nutrient retention see Todd V. Royer et al., *Timing of Riverine Export of Nitrate and Phosphorus from Agricultural Watersheds in Illinois: Implications for Reducing Nutrient Loading to the Mississippi River*, 40 ENVTL. SCI. AND TECH. 4126, (2006); Elizabeth B. Suddoth et al., *Testing the Field of Dreams Hypothesis: Functional Responses to Urbanization and Restoration in Stream Ecosystems*, 21 ECOLOGICAL APPLICATIONS 1972 (2011).

<sup>115</sup> See Julio A. Camargo & Alvaro Alonso, *Ecological and Toxicological Effects of Inorganic Nitrogen Pollution in Aquatic Ecosystems: A Global Assessment*, 32 ENV'T INT'L 831 (2006); Julio A. Camargo et al., *Nitrate Toxicity to Aquatic Animals: A Review with New Data for Freshwater Invertebrates*, 58 CHEMOSPHERE 1255 (2005).

<sup>116</sup> See Stevan R. Earl et al., *Nitrogen Saturation in Stream Ecosystems*, 87 ECOLOGY 3140

ground conditions. In response to criticisms of stream restoration, there is often an argument that restoration projects need more time, although historical studies have shown long-term ineffectiveness as well.<sup>117</sup> Based on these mixed results, scientists are suggesting that stream restoration has limited effects on biological processes in comparison with the effects of the broader watershed land use conditions, and thus site location rather than project-specific design elements may be most important, although this is an ongoing arena of active research.<sup>118</sup>

The second issue pertains to geographic “service areas,”<sup>119</sup> which is a key consideration in the economic and ecological success of an overall ecosystem market.<sup>120</sup> When wetlands or streams are destroyed, regulators prefer the mitigation to be as close as possible to the impact, and if possible, within the same watershed. The reasoning for this was articulated in the first federal guidance on wetland mitigation, where regulators argued that wetlands mitigated near impacts were more likely to provide similar ecosystem services.<sup>121</sup> The area that any single mitigation bank can serve is therefore limited to the same watershed (“service area”) as the impacts for which it provides compensation.

However, the scale of these “watershed” service areas remains difficult to define explicitly, and the 2008 Compensatory Mitigation Rule has been intentionally vague on this critical issue, essentially leaving it to each Corps’ District Engineer to establish and enforce the scale they consider most appropriate.<sup>122</sup> If a service area is too large, then many impacts can

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(2006) (discussing nitrogen saturation within streams, stemming from increased terrestrial use).

<sup>117</sup> Douglas M. Thompson, *Did the Pre-1980 Use of In-Stream Structures Improve Streams? A Reanalysis of Historical Data*, 16 *ECOLOGICAL APPLICATIONS* 784 (2006) (noting “growing concerns about the long-term stability and environmental impact of instream structures”).

<sup>118</sup> Christopher J. Walsh et al., *Riverine Invertebrate Assemblages Are Degraded More by Catchment Urbanization Than by Riparian Deforestation*, 52 *FRESHWATER BIOLOGY* 574 (2007). *But cf.* W.M. Lewis & D.P. Morris, *Toxicity of Nitrite to Fish: A Review*, 115 *TRANSACTIONS OF THE AM. FISHERIES SOCIETY* 183 (1986); Aaron A. Moore & Margaret A. Palmer, *Invertebrate Biodiversity in Agricultural and Headwater Streams: Implications for Conservation and Management*, 15 *ECOLOGICAL APPLICATIONS* 1169 (2005).

<sup>119</sup> Womble & Doyle, *supra* note 23; 2008 Compensatory Mitigation Rule, *supra* note 46, at § 332.2.

<sup>120</sup> See Robert Bonnie & David S. Wilcove, *Ecological Considerations*, in *CONSERVATION AND BIODIVERSITY BANKING* 53, 53–67 (N. Carroll, et al. eds., 2008).

<sup>121</sup> EPA & CORPS OF ENGINEERS, MEMORANDUM OF AGREEMENT BETWEEN THE EPA AND THE DEPARTMENT OF ARMY CONCERNING THE DETERMINATION OF MITIGATION UNDER THE CLEAN WATER ACT SECTION 404(B)(1) GUIDELINES (1990), *available at* <http://water.epa.gov/lawsregs/guidance/wetlands/mitigate.cfm>.

<sup>122</sup> See 2008 Compensatory Mitigation Rule, *supra* note 46, at § 332.3(c)(4).

be concentrated in one geographic area, while all of the mitigation can be geographically distant, leading to impact hot spots and localized net loss.<sup>123</sup> If service areas are too narrowly constrained, then there is potentially insufficient demand in any one area to justify taking on the economic risk of a speculative mitigation bank, i.e., a bank residing in a thin market.<sup>124</sup>

Corps districts have not been consistent in defining the scale of service areas, following on the devolution of responsibility in the Corps to the District Engineer with whom authority resides for individual permit decisions.<sup>125</sup> The most common geographic service area used by Corps districts is an eight-digit Hydrologic Unit Class ("HUC"); in a survey of compensatory mitigation policies in 2010, twenty-five of thirty-eight Corps districts used HUC-8 as their geographic service area size.<sup>126</sup> Other Corps districts define geographic service areas as agglomerations of eight-digit watersheds, and still others allow trades across entire states.<sup>127</sup> Still in others, service areas are set as twenty or forty mile radii from the mitigation bank, within which impacts can be compensated.<sup>128</sup> Other Corps districts also included secondary service areas in which permittees could purchase credits if no mitigation were available within the primary service area.<sup>129</sup> In many areas, where local regulations augment the Corps' authority, these service areas are further constrained by political boundaries such as counties.<sup>130</sup>

Issues involving service area size differ across types of ecosystem service markets: the goal of wetland and stream banking or water quality trading programs such as PS-NPS programs is to sustain the quality of local or receiving water bodies, and thus setting the geographic service area at the watershed scale makes intuitive and regulatory sense.<sup>131</sup> However, there may be cases where local mitigation is not ideal, and distant mitigation is actually desired. For instance, the goal of conservation banks is to preserve viable species populations.<sup>132</sup> Moreover, one of the foremost

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<sup>123</sup> See Todd K. BenDor et al., *Assessing the Socioeconomic Impacts of Wetland Mitigation in the Chicago Region*, 73 J. OF THE AM. PLAN. ASS'N 263, 276 (2007) [hereinafter *Assessing the Socioeconomic Impacts*].

<sup>124</sup> See Salzman & Ruhl, *supra* note 22, at 663, 666–67.

<sup>125</sup> A significant number of provisions in the 2008 Federal Rule give the District Engineer significant control over program implementation. See 33 C.F.R. §§ 325, 332 (2008).

<sup>126</sup> Womble & Doyle, *supra* note 23, at 19.

<sup>127</sup> Wilkinson, *supra* note 54, at 65.

<sup>128</sup> Womble & Doyle, *supra* note 23, at 19.

<sup>129</sup> *Id.*

<sup>130</sup> See Robertson 2006, *supra* note 17, at 299 (highlighting restrictions in Illinois counties).

<sup>131</sup> See NRC, *supra* note 41, 140–49.

<sup>132</sup> See Mead, *supra* note 32, at 9.

causes of habitat loss is urban and suburban development.<sup>133</sup> Thus, it may be entirely defensible or even preferable to allow the loss of habitat in a rapidly developing region in exchange for mitigation in a distant region, if the distant region is the best source of quality, long-term conservation land or genetic conservation resources.<sup>134</sup> That is, there are likely opportunities in which giving up spatial proximity is justified in order to provide the most ecologically beneficial restoration sites.<sup>135</sup> Arguably, the inadequate success to date<sup>136</sup> of most ecosystem restoration suggests that there should be a balance between sites that are close but have limited restoration potential, and sites that are further away that have greater restoration potential.

A third issue regards in-lieu fee programs.<sup>137</sup> For traditional mitigation trading to occur, offsets (in the case of wetlands and streams, this implies mitigation banks) must be at least partly established before new impacts are permitted.<sup>138</sup> “Advance” mitigation involves speculation on the part of bankers who have limited information on the future of impacts in a region or may have limited confidence in the stability of regulations that govern banking.<sup>139</sup> This uncertainty acts as a barrier to entry for bankers into the mitigation credit market, causing situations in which insufficient credits are available in an area to compensate for new impacts.<sup>140</sup> ILF programs allow for potential impactors to pay a fee in lieu of actual mitigation, essentially providing an ecological IOU program. It is questionable whether ILF programs are ever appropriate, as they undermine both the economic and ecological original intent of mitigation banking. Ecologically, banks are meant to be established prior to impacts, thus reducing the time delay between impacts and an operational ecosystem.<sup>141</sup> When using an ILF, there is an inherent time delay between impacts and establishment of a compensating ecosystem function, thus undermining an important component of ecologically responsible mitigation.<sup>142</sup>

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<sup>133</sup> See EPA, WETLANDS: REPORT ON THE ENVIRONMENT DATABASE (March 10, 2011), available at <http://cfpub.epa.gov/eroe/index.cfm?fuseaction=list.listBySubTopic&ch=47&s=202>.

<sup>134</sup> See Paul Armsworth et al., *Land Market Feedbacks Can Undermine Biodiversity Conservation*, 103 PROCEEDINGS OF THE NAT'L ACAD. OF SCI. 5403, 5405–07 (2006).

<sup>135</sup> See BenDor et al., *supra* note 23, at 18, 20.

<sup>136</sup> See NRC, *supra* note 41, at 121–22.

<sup>137</sup> Wilkinson, *supra* note 54, at 53 (analyzing potential improvements needed to ensure the effectiveness of in-lieu fee programs).

<sup>138</sup> See 2008 Compensatory Mitigation Rule, *supra* note 46.

<sup>139</sup> See generally BenDor & Brozovic, *supra* note 91 (discussing factors, including regulation, affecting distribution of banking sites).

<sup>140</sup> See Robertson 2006, *supra* note 17, at 299–300.

<sup>141</sup> Corps 1995, *supra* note 44, at 58,605.

<sup>142</sup> Todd K. BenDor, *A Dynamic Analysis of the Wetland Mitigation Process and its Effects on No Net Loss Policy*, 89 LANDSCAPE AND URBAN PLAN. 17, 18 (2009).

Economically, ILF programs produce even more potential problems. ILF programs accept fees from developers at a rate that is assumed will be adequate to purchase and restore sites in the future and then assume all responsibility and liability for providing those mitigation credits.<sup>143</sup> ILF programs could charge fees far in excess of restoration costs, thus holding development projects hostage.<sup>144</sup> As discussed in the North Carolina case below,<sup>145</sup> however, this is often not the case. ILF programs can (and often do) in fact charge insufficient fees to offset increasing property and restoration costs, which can quickly escalate beyond expectations.<sup>146</sup> Moreover, ILF programs can potentially underprice private mitigation banks operating in the same areas by undercutting the market price for compensation—by collecting fees that are lower than those needed to actually build the project.<sup>147</sup> Because ILF programs are typically operated by public agencies or non-profit groups, undercharging for ILF credits acts to subsidize aquatic resource impacts from new public and private development by charging impactors less than the full costs of compensation.<sup>148</sup> That is, ILF programs can place public investments in direct competition with private enterprise.<sup>149</sup>

## II. CHARACTERISTICS OF THE NORTH CAROLINA STREAM AND WETLANDS MARKET

### A. *Policy Structure in North Carolina*

In order to illustrate the operation of ecosystem service markets, we will look more closely at a case study of the evolution of markets in North Carolina, particularly focusing on policy structure and extent of market activity. Stream and wetland mitigation banking in North Carolina is regulated by the North Carolina Department of Environment and Natural Resources (“NCDENR”) and the Wilmington District of the Corps.<sup>150</sup> One

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<sup>143</sup> ELI 2002, *supra* note 63, at 104, 107.

<sup>144</sup> *See id.* at 107 (noting the DuPage County, Illinois program charged \$175,000 per acre in an area where mitigation banks charged around \$50,000 per acre).

<sup>145</sup> *See infra* Part II.B.

<sup>146</sup> ELI 2002, *supra* note 63, at 107 (explaining that Pennsylvania ILF program does not account for land value when determining the fee rate).

<sup>147</sup> David T. Urban & John H. Ryan, *A Lieu-Lieu Policy with Serious Shortcomings (Article 1)*, 21:4 NAT'L WETLANDS NEWSL., July/Aug., 1999, at 5, 9–10.

<sup>148</sup> *See id.*

<sup>149</sup> *See id.*

<sup>150</sup> *See generally* N.C. GEN. ASSEMBLY, PROGRAM EVALUATION DIV., DEP'T OF ENV'T AND NAT. RES. WETLAND MITIGATION CREDIT DETERMINATIONS, SPECIAL REPORT (April 29, 2010), available at <http://www.ncga.state.nc.us/PED/Reports/documents/Wetlands/Wetland>

of the key characteristics of North Carolina land use and environmental management has been the rapid spatial growth of several urban areas in North Carolina.<sup>151</sup> This rapid suburbanization, combined with the physiography of the Eastern half of the state (topographically flat, humid, large wetlands throughout), has led to significant impacts on streams and wetlands.<sup>152</sup> Frequent impacts requiring permits have led to extensive demand for wetlands and stream compensatory mitigation credits.<sup>153</sup>

In North Carolina, the largest impactor of aquatic resources is the North Carolina Department of Transportation (“NCDOT”).<sup>154</sup> During the mid-1990s, NCDOT began to experience project delays due to insufficient mitigation credits produced by private bankers.<sup>155</sup> In response to this, the state developed the Wetland Restoration Program in 1996, re-designated as the Ecosystem Enhancement Program (“EEP”) in 2003. The EEP is a state-administered wetlands and stream mitigation program that operates as both an ILF program and mitigation bank (the history and documentation establishing the policies and practices of the EEP are summarized in the DYE REPORT).<sup>156</sup> The EEP was intended to use projected NCDOT construction projects as a platform from which to proactively develop mitigation credits well ahead of time in the needed geographic areas (similar to a mitigation bank).<sup>157</sup> In 1998, the Corps allowed EEP-generated mitigation credits to also be purchased by private developers, effectively opening up the market to a new type of credit consumer for which the EEP was allowed to provide compensation (under an ILF program).<sup>158</sup> Thus, within North Carolina, the market for stream and wetland mitigation credits is (theoretically) made up of trades between private developers and commercial banks, trades between the NCDOT and EEP, and trades between private developers and the EEP (Figure 2). Moreover, while the EEP designs and builds some of its “own” projects (through independent contractors), a major source of wetland and streams credits is attained through reselling credits

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\_Presentation.pdf; U.S. ARMY CORPS OF ENGINEERS—WILMINGTON DISTRICT, <http://www.saw.usace.army.mil/> (last visited Nov. 7, 2011).

<sup>151</sup> See REID EWING ET AL., MEASURING SPRAWL AND ITS IMPACTS 1 (2002).

<sup>152</sup> See *State Wetland Program Evaluation: Phase I*, ENVTL. LAW INST., available at [http://www.elistore.org/reports\\_detail.asp?ID=11079&topic=Wetlands](http://www.elistore.org/reports_detail.asp?ID=11079&topic=Wetlands) (last visited Nov. 7, 2011).

<sup>153</sup> DYE MGMT. GROUP, STUDY OF THE MERGER OF ECOSYSTEM ENHANCEMENT PROGRAM AND CLEAN WATER MANAGEMENT TRUST FUND, FINAL REPORT TO THE NORTH CAROLINA GENERAL ASSEMBLY, RALEIGH, NC, at ES-1, 14–15 (2007) [hereinafter DYE REPORT].

<sup>154</sup> BenDor & Doyle, *supra* note 25, at 67.

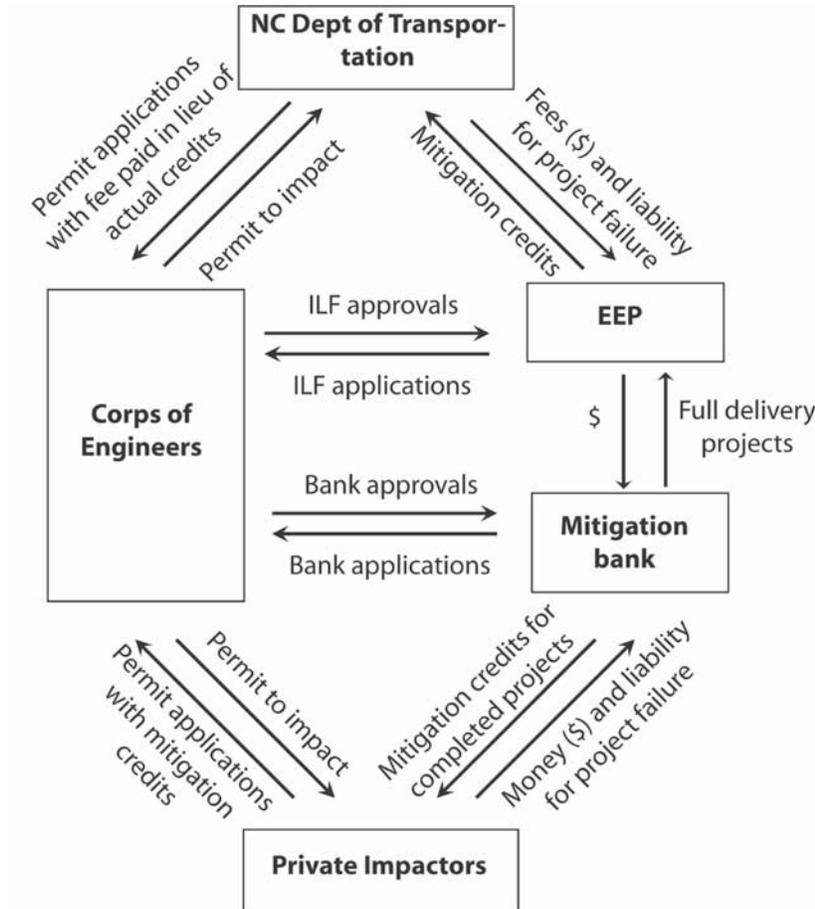
<sup>155</sup> DYE REPORT, *supra* note 153, at ES-1, 2–3.

<sup>156</sup> *Id.* at 20–29.

<sup>157</sup> *Id.* at 53.

<sup>158</sup> *Id.* at 20–22.

from “full delivery” sites—sites purchased, designed, and built by private mitigation bank firms.<sup>159</sup> Thus, private mitigation banks can sell credits to private developers, or they can develop sites specifically in response to requests from the EEP.



**Figure 2.** Relationships between agencies, impactors, and mitigation bankers in North Carolina in the presence of the Ecosystem Enhancement Program. Prior to SL 2009-337, private impactors could also pay a fee to the EEP in lieu of purchasing mitigation credits from a bank.<sup>160</sup>

<sup>159</sup> See generally N.C. ECOSYSTEM ENHANCEMENT PROGRAM, <http://portal.ncdenr.org/web/eeep> (last visited Nov. 7, 2011).

<sup>160</sup> See EEP MOA, *supra* note 29, at 6–10.

*B. North Carolina Ecosystem Markets: Economics and Geography*

The North Carolina EEP reveals some of the weaknesses inherent in ILF programs. Templeton et al. conducted an economic study of EEP projects for 2006 and 2007 and showed that while the EEP collected fees of \$232 per linear foot of stream mitigation, the inflation-adjusted expense for all projects was \$242 per linear foot.<sup>161</sup> Moreover, this expense exceeded any inflation-adjusted mitigation fee that EEP charged in previous fiscal years.<sup>162</sup> And Templeton et al. estimate that this is a conservative cost estimate as the projects are likely to still require more costs due to monitoring requirements.<sup>163</sup> Given that the data set analyzed consisted of greater than 191,000 linear feet of stream, the EEP may have undercharged developers by more than \$1.9 million.<sup>164</sup> Again, because the EEP is an ILF program, the EEP remained responsible for providing these credits even though they did not collect adequate fees (prices are set by the North Carolina General Assembly).<sup>165</sup> Presumably, the state of North Carolina provides the necessary funds to fill the gap between costs and fees collected, i.e., the state essentially provided more than \$1.9 million in subsidies for environmental degradation by land developers through the EEP.<sup>166</sup>

In addition to these economic analyses, BenDor et al. recently completed an analysis of the North Carolina stream and wetland markets and demonstrated how ecosystem markets affect the locations of ecosystem services throughout the landscape.<sup>167</sup> Between 1998 and 2007, there were 715 transactions (trades) between 496 impact sites and 161 EEP compensation sites, with 369 involving regulated wetlands and 346 involving streams (48%).<sup>168</sup> Mitigation sites were spread across the state, while impact sites were concentrated in rapidly developing urban areas (Figure 3). By specifically linking the geospatial coordinates of Corps-licensed impacts with the

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<sup>161</sup> SCOTT R. TEMPLETON ET AL., ESTIMATION AND ANALYSIS OF EXPENSES DURING DESIGN-BID-BUILD PROJECTS FOR STREAM MITIGATION IN NORTH CAROLINA, CLEMSON UNIV. DEPT OF APPLIED ECON. AND STATISTICS RESEARCH REPORT RR08-01, 18–21 (2008) [hereinafter TEMPLETON].

<sup>162</sup> *Id.* at 18.

<sup>163</sup> *Id.* at 19.

<sup>164</sup> *Id.* at 27–28.

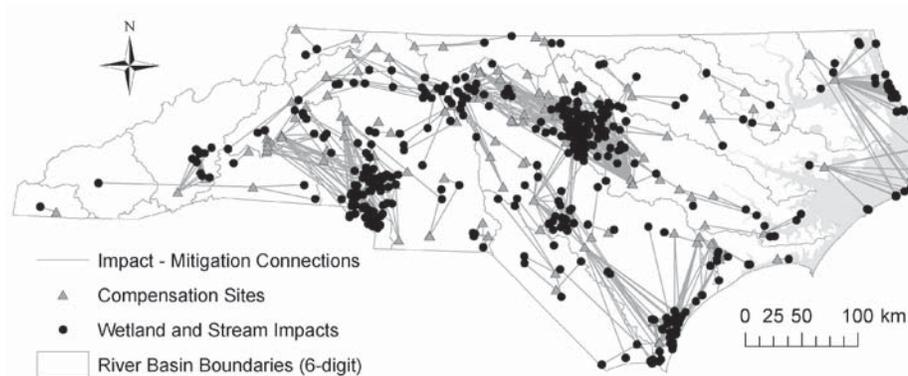
<sup>165</sup> *EEP Schedule of Fees*, N.C. ECOSYSTEM ENHANCEMENT PROGRAM, <http://portal.ncdenr.org/web/eep/fee-schedules> (last visited Nov. 7, 2011).

<sup>166</sup> See TEMPLETON, *supra* note 161, at 18–21.

<sup>167</sup> See *Assessing the Socioeconomic Impacts*, *supra* note 123, at 265–66.

<sup>168</sup> Todd K. BenDor & Audrey Stewart, *Land Use Planning and Social Equity in North Carolina's Compensatory Wetland and Stream Mitigation Programs*, 47 ENVTL. MGMT. 239, 243 (2011).

coordinates of EEP mitigation sites, BenDor and Stewart showed that mitigation transactions traded wetlands an average distance of 46.9 km between impact sites and mitigation (Figure 3).<sup>169</sup> Also, impact sites drained, on average, 144 km<sup>2</sup> compared to 43 km<sup>2</sup> at mitigation sites, meaning that mitigation sites were located in streams that were, on average, smaller than streams in impacted sites.<sup>170</sup>



**Figure 3.** EEP compensatory mitigation transactions in North Carolina.<sup>171</sup> Each arrow maps compensatory mitigation transactions, originating at a stream or wetland impact site and terminating at the compensatory mitigation site.

BenDor et al. also showed that mitigation performed under the EEP led to virtually no net loss of streams or wetlands at the eight-digit watershed scale, the broadest goal of wetlands and stream regulation.<sup>172</sup> However, there were several ecologically relevant effects: (1) defragmentation, (2) movement upstream in the watersheds, and (3) loss of place-specific functions. The first effect was a spatial defragmentation of streams and wetlands, as numerous small impacts were mitigated at fewer, large sites.<sup>173</sup> While there are economies of scale for compensatory mitigation

<sup>169</sup> *See id.* at 239 (averaging the distances between “impact and mitigation sites for streams (43.53 km) and wetlands (50.3 km)”).

<sup>170</sup> *Markets, supra* note 42.

<sup>171</sup> *See* BenDor & Stewart, *supra* note 168, at 244.

<sup>172</sup> Todd K. BenDor et al., *Landscape Characteristics of a Stream and Wetland Mitigation Banking Program*, UNIV. OF N.C., at 17 [http://www.unc.edu/~jsholtes/NCWRR12008\\_Presentation.pdf](http://www.unc.edu/~jsholtes/NCWRR12008_Presentation.pdf) (last visited Nov. 7, 2011).

<sup>173</sup> BenDor & Stewart, *supra* note 168, at 241.

that drive the desire for large restoration sites,<sup>174</sup> whether there are ecological advantages of single large sites over several small sites is not at all clear.<sup>175</sup>

Second, there was a preference to restore streams and wetlands further upstream in the watershed rather than the impacts for which they were compensating.<sup>176</sup> While this is not surprising, as smaller upstream sites are easier and cheaper to restore than large downstream sites, there will be ecological communities and functions that are both gained and lost through such market-induced pressures for upstream migration of restoration sites.<sup>177</sup> Third, there are place-specific functions that can be lost when impacts are mitigated at restoration sites across the landscape. For instance, when urban wetlands are destroyed and compensated by restoration in remote rural areas, there is less potential benefit for retaining storm-water runoff.<sup>178</sup> Thus, there are location-specific benefits that may be particularly problematic to compensate under mitigation banking programs.

### C. North Carolina PS-PS and PS-NPS Market Characteristics

The Division of Water Quality (“DWQ”) within the NCDENR is responsible for administering water quality programs and regulations in North Carolina.<sup>179</sup> Also within NCDENR, the Environmental Management Commission (“EMC”) creates water quality regulation within the Neuse River basin.<sup>180</sup> This 6192 square mile basin (Figure 4) contains a large portion of the state’s population in the headwaters (Raleigh-Durham metropolitan area; a significant source of PS pollution), while agricultural areas dominate the lower watershed (corn and swine; significant sources of NPS pollution).<sup>181</sup> In 1998, the Neuse River basin adopted rules requiring

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<sup>174</sup> See BenDor & Brozovic, *supra* note 91, at 361.

<sup>175</sup> See Schwartz, *supra* note 91 (explaining that conservation objectives have also been met by small reserves).

<sup>176</sup> See *Assessing the Socioeconomic Impacts*, *supra* note 123, at 263.

<sup>177</sup> See Robin L. Vannote et al., *The River Continuum Concept*, 37 CAN. J. OF FISHERIES & AQUATIC SCI. 130 (1980) (discussing the interrelationship between upstream and downstream communities).

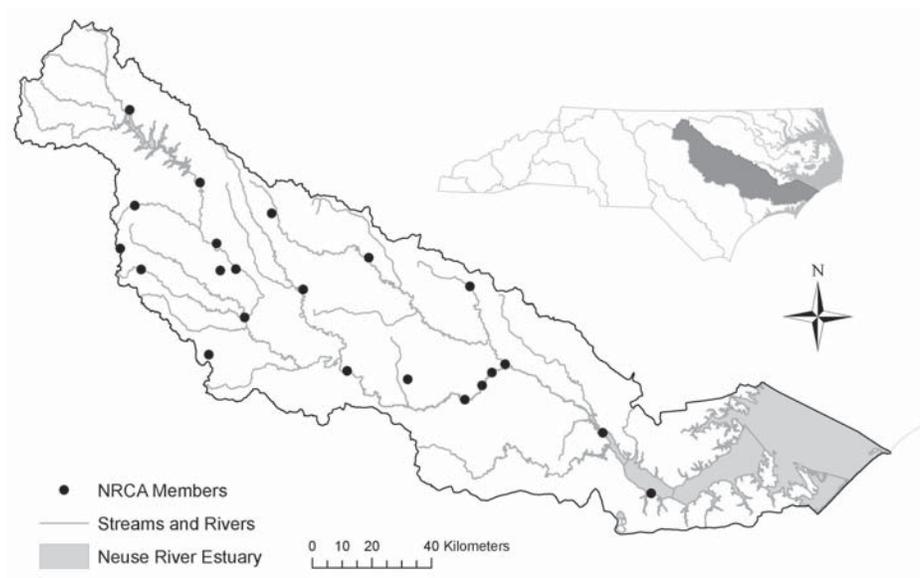
<sup>178</sup> See King & Herbert, *supra* note 10, at 12; Todd K. BenDor et al., *The Social Impacts of Wetland Mitigation Policies in the United States*, 22 J. OF PLAN. LITERATURE 341, 342, 350 (2008).

<sup>179</sup> *About Division of Water Quality*, N.C. DEP’T OF NATURAL RES., <http://portal.ncdenr.org/web/wq/home/about> (last visited Nov. 7, 2011).

<sup>180</sup> *Neuse Nutrient Sensitive Waters Strategy*, N.C. DIV. OF WATER QUALITY, <http://h2o.enr.state.nc.us/nps/neuse.htm> (last visited Nov. 7, 2011).

<sup>181</sup> *General Information on the Neuse River Basin*, NEUSE RIVER EDUC. TEAM, N.C. STATE UNIV., <http://www.neuse.ncsu.edu/geninfo.htm> (last visited Nov. 7, 2011).

a reduction in N (nitrogen) at the estuary to seventy percent of the 1991–1995 annual average by 2001.<sup>182</sup> Under the rules, PS dischargers who exceed their nitrogen discharge allocations are required to purchase offsets from other PS emitters.<sup>183</sup> The rules created an option for wastewater dischargers to meet their N reduction goals collectively by forming an association in which no individual members are fined as long as the group as a whole is in compliance.<sup>184</sup>



**Figure 4.** Neuse River Compliance Association Map. NRCA members are wastewater treatment plant operators who, as a group, must comply with nitrogen reduction targets.<sup>185</sup>

Twenty-three wastewater dischargers formed the Neuse River Compliance Association (“NRCA”) and the association was granted a basin-wide NPDES permit.<sup>186</sup> The permit allowed the association an N limit

<sup>182</sup> See Hamstead & BenDor, *supra* note 81, at 6.

<sup>183</sup> *Neuse Nutrient Sensitive Waters Strategy*, *supra* note 180, at Rule 0.0234 & 0.0240, <http://h2o.enr.state.nc.us/nps/neuse.htm> (last visited Nov. 7, 2011).

<sup>184</sup> *Neuse Nutrient Sensitive Waters Strategy*, *supra* note 180, Rule .0234, at pt. 9, <http://h2o.enr.state.nc.us/nps/2b-0234.pdf>.

<sup>185</sup> See Hamstead & BenDor, *supra* note 81, at 2.

<sup>186</sup> NEUSE RIVER COMPLIANCE ASS'N, FACT SHEET—NPDES PERMIT NO. NCC000001, *available at* [http://www.water.rutgers.edu/Projects/trading/00001nrcafactsheet\\_finalpermit.pdf](http://www.water.rutgers.edu/Projects/trading/00001nrcafactsheet_finalpermit.pdf).

equivalent to the sum of the individual limits.<sup>187</sup> By 2006, the NRCA had reduced total N reaching the estuary by sixty-seven percent, far surpassing their requirements.<sup>188</sup> However, to date there have been no permanent trades and only three temporary trades among members of the NRCA (i.e., year to year trades, or leases).<sup>189</sup>

Regulators have also been concerned about the potential creation of N pollution hot spots because the Neuse rules only require N reductions in the river's estuary (see Figure 4); there is no regulation of in-stream water quality.<sup>190</sup> Over time, rapidly growing urban areas will need to purchase greater N allotments from the agricultural areas downstream, where population is not increasing as quickly.<sup>191</sup> Upstream N loading from urban areas, combined with a lack of in-stream water quality regulation, will likely produce a water quality hot spot in the more upstream reaches of the Neuse River. While some of this nitrogen will be retained or removed from the water by natural biogeochemical processes as it is transported downstream, the levels of nitrogen that can be reached within these rivers can be quite large, with potentially toxic or biogeochemically saturating effects.<sup>192</sup>

In addition to the NRCA, which is a PS-PS market, North Carolina also allows PS-NPS trading.<sup>193</sup> It is in this case that nitrogen trading becomes an ecosystem service market as we defined earlier.<sup>194</sup> While the units of trade in the PS-NPS market are in pounds of nitrogen, NPS reductions are based on a land use classification that converts acres to pounds of nitrogen retained per year.<sup>195</sup> Specifically, buffer strips are constructed

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<sup>187</sup> See *id.* at 1–2.

<sup>188</sup> NEUSE RIVER COMPLIANCE ASS'N, 2006 ANNUAL REPORT (2007).

<sup>189</sup> *Id.*

<sup>190</sup> See *Neuse River Basinwide Water Quality Plan* (1998), N.C. DIV. OF WATER QUALITY, [http://h2o.enr.state.nc.us/basinwide/Neuse/neuse\\_wq\\_management\\_plan.htm](http://h2o.enr.state.nc.us/basinwide/Neuse/neuse_wq_management_plan.htm) (last visited Nov. 7, 2011).

<sup>191</sup> See Emily S. Bernhardt et al., *Understanding, Managing, and Minimizing Urban Impacts on Surface Water Nitrogen Loading*, 1134 ANNALS OF THE N.Y. ACAD. OF SCI. 61 (noting that few cities have addressed infrastructure issues to ensure proper nitrogen disposal).

<sup>192</sup> See Julio A. Camargo & Alvaro Alonso, *Ecological and Toxicological Effects of Inorganic Nitrogen Pollution in Aquatic Ecosystems: A Global Assessment*, 32 ENVTL. INT'L 831 (2006) (noting the consequences of increased nitrogen within rivers).

<sup>193</sup> *Water Quality Trading Program*, RUTGERS WATER RES. PROGRAM, <http://www.water.rutgers.edu/Projects/trading/WQTrading.htm> (last visited Nov. 7, 2011).

<sup>194</sup> See Robertson 2006, *supra* note 17, at 297 (explaining ecosystem service markets).

<sup>195</sup> RTI INT'L, A STUDY OF THE COSTS ASSOCIATED WITH PROVIDING NUTRIENT CONTROLS THAT ARE ADEQUATE TO OFFSET POINT SOURCE AND NONPOINT SOURCE DISCHARGES OF NITROGEN AND OTHER NUTRIENTS, FINAL REPORT (2007), available at [http://www.nceep.net/pages/Final\\_RTI\\_Report\\_Nutrient\\_Offset\\_June\\_2007.pdf](http://www.nceep.net/pages/Final_RTI_Report_Nutrient_Offset_June_2007.pdf).

on riparian lands,<sup>196</sup> and the area of buffer strips is converted into pounds of nitrogen using a conversion factor.<sup>197</sup> These nitrogen credits can be sold to a PS emitter as an offset.<sup>198</sup> In North Carolina, to our knowledge, the first trade between private entities for PS-NPS occurred in 2008.<sup>199</sup> Thus, the state of the market remains unclear. Regardless, it is worth noting that the PS-NPS market mixes a traditional environmental market, based on pounds or volume, with a market based on complex ecological assessment techniques (ecosystem service markets).<sup>200</sup>

### III. ISSUES ON THE HORIZON

#### A. *Science: Do Offsets from Compensatory Mitigation Work?*

The critical question underlying all ecosystem service markets is whether or not they work. That is, are restored ecosystems comparable to predevelopment ecosystems? To date, there have been very few studies that have documented actual ecological success of stream restoration projects,<sup>201</sup> and the value and efficacy of wetland restoration continues to be questionable.<sup>202</sup>

Emerging policies are placing greater emphasis on documenting real ecological change rather than relying on indicators or surrogate variables, as has been the standard approach in the past.<sup>203</sup> For instance, in North Carolina, the Division of Water Quality in 2008 released its guidance for stream restoration via dam removal, which required substantial documentation of recovery of actual ecological functions (e.g., species and water quality), as opposed to recovery of simple channel geometry, in order to receive approval for the site from the MBRT as a compensation site.<sup>204</sup> Presumably, more rigorous standards for data collection and monitoring

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<sup>196</sup> Lewis L. Osborne & David A. Kovacic, *Riparian Vegetated Buffer Strips in Water Quality Restoration and Stream Management*, 29 FRESHWATER BIOLOGY 243, 245 (1993).

<sup>197</sup> RTI INT'L, *supra* note 195, at 1–4.

<sup>198</sup> N.C. ADMIN. CODE § 15A NCAC 2B.0240(a) (2006).

<sup>199</sup> Personal Communication, Adam Riggsbee, Riverbank Ecosystems, Austin, Tex. (Sep. 7, 2010).

<sup>200</sup> *Markets*, *supra* note 42.

<sup>201</sup> See Emily S. Bernhardt et al., *Synthesizing U.S. River Restoration Efforts*, 308 SCIENCE 636, 637 (2005).

<sup>202</sup> See NRC, *supra* note 41, at 3.

<sup>203</sup> See *id.* at 7.

<sup>204</sup> U.S. ARMY CORPS OF ENGINEERS & EPA, DETERMINING APPROPRIATE COMPENSATORY MITIGATION CREDIT FOR DAM REMOVAL PROJECTS IN NORTH CAROLINA 3–5 (2008), available at [http://www.nceep.net/pages/Comp%20Mitig%20Credit\\_Dam\\_Removal\\_Proj%20\\_NC\\_21308.pdf](http://www.nceep.net/pages/Comp%20Mitig%20Credit_Dam_Removal_Proj%20_NC_21308.pdf).

will increase the care with which project sites are designed and, more importantly, selected.<sup>205</sup> Regardless of the specific monitoring required, we expect that there will be greater emphasis on regulatory requirements for empirically-based evaluation of restoration projects in the future, thereby broadening the information available to guide future programs.<sup>206</sup> Indeed, the 2008 federal compensatory mitigation rule places much greater emphasis on documenting ecological effects of restoration as a part of future compensatory mitigation practices.<sup>207</sup>

*B. Policy: Geographic Service Areas and ILF Programs*

One of the key considerations for any ecosystem service market is the size of the geographic service area that can be served by a mitigation bank.<sup>208</sup> There has been great inconsistency in the application of service areas to ecosystem markets, be they wetland, stream, or conservation banks.<sup>209</sup> For streams and wetlands, the 2008 compensatory mitigation rule, while establishing a “watershed approach,” leaves the scale of the market unspecified, and thus up to the interpretation and discretion of the local District Engineer.<sup>210</sup> Determining a bank’s service area has critically important implications for the financial viability of individual banks, as well as an ecosystem service market in general.<sup>211</sup>

ILF programs represent another major policy hurdle for the private sector in future ecosystem markets. State regulators, departments of transportation, and many private developers have argued that ILF programs are vitally necessary to prevent development restrictions,<sup>212</sup> and for providing compensation in geographic areas that do not generate sufficient impacts (demand) necessary for a private banker to establish a bank.<sup>213</sup> ILF programs suffer from substantial problems, however, potentially leading to insufficient and unsuccessful restoration, as well as the real potential

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<sup>205</sup> See *id.* at 16–17.

<sup>206</sup> NRC, *supra* note 41, at 8–9.

<sup>207</sup> 2008 Compensatory Mitigation Rule, *supra* note 46, at § 332.5, § 332.6.

<sup>208</sup> See *supra* Part I.E.

<sup>209</sup> See generally Womble & Doyle, *supra* note 23, at 2078, 88–90 (analyzing spatial relationships in stream and wetland impact and compensation sites).

<sup>210</sup> See 2008 Compensatory Mitigation Rule, *supra* note 46, at § 332.3(c)(2).

<sup>211</sup> See LEONARD SHABMAN, ET. AL, ENVTL. LAW INST., APPLYING LESSONS LEARNED FROM WETLAND MITIGATION BANKING TO WATER QUALITY TRADING, 21 (2005), available at <http://www.eli.org/pdf/wqtforum/LanSiemStedShab05.pdf> (noting that the ELI has identified service area as a critical factor in determining the success of mitigation banks).

<sup>212</sup> See *id.* at preamble.

<sup>213</sup> Jack T. Chowning, *In-Lieu-Fee Programs Belong Among Mitigation Options*, 21 NAT’L WETLANDS NEWSL., July/Aug., 1999, at 8–9 (1999).

for creating artificially low or high prices.<sup>214</sup> These factors combine to create a system in which negative resource impacts from land development can be essentially subsidized through the provision of artificially under-priced restoration sites, as shown by the Templeton et al. study for North Carolina.<sup>215</sup> Moreover, many of these ILF restoration sites are completed after impacts, in contrast to their private mitigation bank counterparts, which are required to be (at least partly) completed and certified prior to impacts.<sup>216</sup> Thus, the advantages of ILF programs are, arguably, primarily for developers.

We may now be seeing a distinct shift away from ILF programs, at least in North Carolina. Perhaps the most damning political action in North Carolina against ILF programs came after the 2008 state legislature hearings on the EEP.<sup>217</sup> During these hearings, an unusual coalition of environmental groups, private restoration industry, and home builders all lobbied against the state's ILF program.<sup>218</sup> The result was the unanimous passage of Public Law 2008-152 (amended as Session Law 2009-337),<sup>219</sup> "An act to promote compensatory mitigation by private mitigation banks."<sup>220</sup> This bill stipulates that non-NC DOT impactors must use credits from private mitigation banks if those credits are available in the impacted area, and that payment to the EEP ILF Program is only acceptable if no mitigation bank credits are available.<sup>221</sup> A critically important aspect of this outcome is that private mitigation banks will no longer have to compete with the EEP in providing wetland or stream credits if the mitigation banks have credits available.<sup>222</sup>

Unfortunately, the North Carolina mitigation bank act does not address the fact that many areas in the state have no private mitigation bank.<sup>223</sup> Increasing the geographic service area of banks (Figure 5) is one

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<sup>214</sup> See TEMPLETON, *supra* note 161.

<sup>215</sup> See *generally id.* (discussing North Carolina's Ecosystem Enhancement Program for financing mitigation projects).

<sup>216</sup> See Corps 1995, *supra* note 44.

<sup>217</sup> Ecosystem Enhancement Program: Hearings on N.C. GEN. STAT. § 143-214.11 Before the General Assembly of North Carolina, Sess. L. 2008-152, SB 1885 (2007).

<sup>218</sup> *Id.*

<sup>219</sup> See Ecosystem Enhancement Program: Compensatory Mitigation, Pub. L. No. 2008-152, N.C. Sess. Law No. 2009-337.

<sup>220</sup> *Id.*; N.C. GEN. STAT. § 143-214.11 (2009).

<sup>221</sup> See N.C. GEN. STAT. § 143-214.11 (2009).

<sup>222</sup> See *id.*

<sup>223</sup> See *Mitigation Banks in North Carolina*, N.C. DIV. OF WATER QUALITY, <http://portal.ncdenr.org/web/wq/swp/ws/401/certsandpermits/mitigation> (last visited Nov. 7, 2011) (providing a list of all mitigation banks in North Carolina).

way to provide compensatory mitigation to these areas without relying on ILF programs. Increasing the service area would provide much greater incentive for private bankers to develop their own sites, which would provide proactive restoration rather than reactive restoration, as is the case in ILF programs. In addition, larger service areas would encourage large restoration projects, as greater certainty in demand would likely lead to greater willingness to invest in larger restoration projects to take advantage of economies of scale.<sup>224</sup> Although we lack empirical evidence, our ecological understanding of other systems and processes (e.g., island biogeography theory),<sup>225</sup> leads us to suspect that large restoration sites are ecologically superior to small ones. Finally, rather than having a discrete banking area, regulators could leverage trading ratios based on the distance away from impacts.<sup>226</sup> Banks that were far away from the impacts, or in a different watershed (“low spatial quality” in Figure 5), would be given higher ratios than those that were close.<sup>227</sup> Large mitigation banks would still be desirable to develop since the banker could be ensured that there would be some demand somewhere in the market for their credits.

In sum, current regulations have sought to avoid the proximity problem by implementing mitigation methods (such as ILF programs) that allow mitigation to occur after impacts. Sacrificing the benefits of advance timing of mitigation is presumably made up by the advantages of geographic proximity. In North Carolina, the stated focus of the EEP has centered on ensuring proximity of mitigation to impact sites, while ecological success criteria receive reduced emphasis, and current guidelines facilitate post-impact mitigation (“low temporal quality” in Figure 5) rather than advance mitigation. This approach represents a systemic problem with in-lieu fee programs around the United States,<sup>228</sup> and has been justified by the argument that spatial proximity between impacts and mitigation sites is of paramount concern, i.e., spatial quality is preferred over temporal quality (Figure 5).<sup>229</sup> This reflects recommendations that stream

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<sup>224</sup> See TEMPLETON, *supra* note 161, at 19–20 (providing analysis of economies of scale in stream restoration projects).

<sup>225</sup> Schwartz, *supra* note 91, at 90–91.

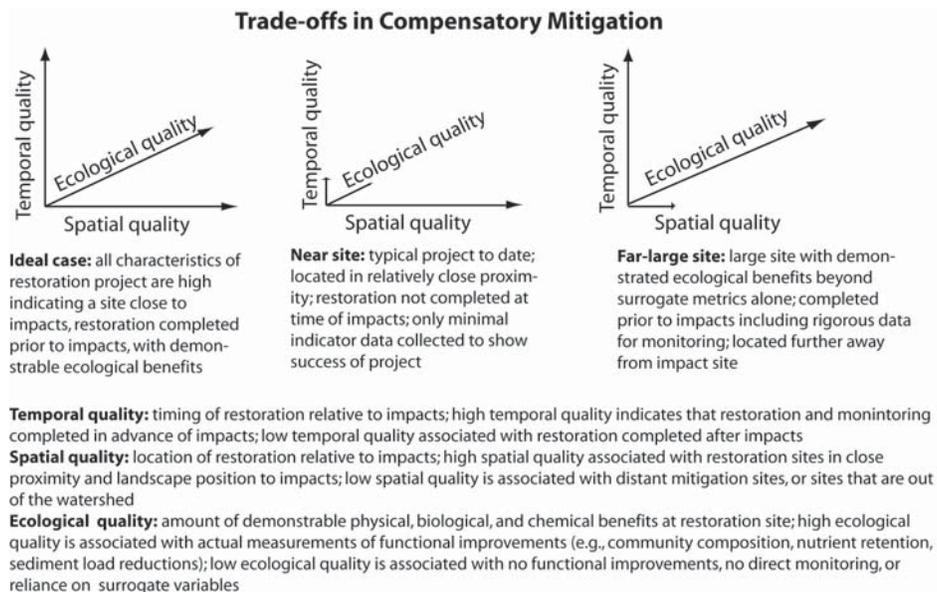
<sup>226</sup> See BenDor & Brozovic, *supra* note 91, at 361–62.

<sup>227</sup> *Markets*, *supra* note 42.

<sup>228</sup> See ELI 2006, *supra* note 53, at 45–46 (discussing remedial action provisions and contingency funds).

<sup>229</sup> See Philip Womble & Martin Doyle, *Army Corps Needs to Examine Rationale for Mitigation Territories*, ECOSYSTEMMARKETPLACE, (March 18, 2011), [http://www.ecosystemmarketplace.com/pages/dynamic/article.page.php?page\\_id=8136&section=news\\_articles&eod=1](http://www.ecosystemmarketplace.com/pages/dynamic/article.page.php?page_id=8136&section=news_articles&eod=1).

and wetland restoration consider “landscape position” and take a “watershed approach” as recommended by the NRC.<sup>230</sup> However, the NRC review of compensatory mitigation of wetlands throughout the United States also noted that compensatory mitigation should preferably be established prior to permitted impacts.<sup>231</sup> Determining the extent to which spatial proximity, timing, and mitigation project size affect project quality is a critical question that will only be answered through case studies and landscape-scale analysis of mitigation programs (Figure 5).



**Figure 5.** Conceptual model of tradeoffs in compensatory mitigation programs among spatial proximity, timing, and quality of restoration.<sup>232</sup>

### C. *Technical Limitations to Establishing Property Rights*

Property rights are central to environmental trading as they specify who must pay whom to modify actions relating to the environment. These rights also develop in response to changes in economic values, which

<sup>230</sup> See NRC, *supra* note 41, at 4–5.

<sup>231</sup> *Id.* at 61.

<sup>232</sup> BenDor et al., *supra* note 23.

stem from the development of new technology and the emergence of new markets.<sup>233</sup> Establishing property rights for ecosystem services is particularly difficult because these services are based on ecological assessment criteria rather than direct measurements of weight or volume (even though these assessment criteria are then often used to convert into weight or volume units).<sup>234</sup> Establishing property rights for ecosystem services requires sufficiently precise and accurate measurement of the quantity and quality of the service.

In sulfur dioxide (“SO<sub>2</sub>”) emissions markets, actual SO<sub>2</sub> is measured at the smokestack.<sup>235</sup> That is, the quantity of measurement is mass, and the quality of measurement is precise to the unit being traded (tons of SO<sub>2</sub>).<sup>236</sup> In this manner, it is like trading many other commodities for which the unit of trade is precisely known and the quality of the commodity is measured directly (e.g., gasoline, corn, hogs, and nickel).<sup>237</sup> In contrast to air quality markets, ecosystem service markets are plagued with uncertainty.

For over two decades, the intent of wetland trading regulation has been to ensure no net loss of the bundle of wetland ecosystem functions and services in an area.<sup>238</sup> Because of the difficulty in measuring the loss or restoration of functions at individual wetland sites, particularly small sites, measures of wetland spatial extent (area) were deemed to be reasonable surrogates for function.<sup>239</sup> This enshrined the use of size as the primary mechanism for seeking no net loss in wetland mitigation.<sup>240</sup> Subsequent ecosystem service markets, such as streams and endangered species habitat, have adopted similar approaches that establish functional no net loss as a goal, but implement the regulation through size measures (e.g., length for streams, species habitat area).<sup>241</sup> Thus, the currency used to commodify streams, wetlands, and habitat in ecosystem service markets is typically related to size, rather than ecologically derived functional characteristics.

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<sup>233</sup> Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347, 350 (1967).

<sup>234</sup> Robertson 2006, *supra* note 17, at 297–98.

<sup>235</sup> Paul L. Joskow et al., *The Market for Sulfur Dioxide Emissions*, 80 AM. ECON. REV. 669, 670 (1998).

<sup>236</sup> *See id.* at 670–71.

<sup>237</sup> *See id.*

<sup>238</sup> CONSERVATION FOUND., PROTECTING AMERICA’S WETLANDS: AN ACTION AGENDA, THE FINAL REPORT OF THE NATIONAL WETLANDS POLICY FORUM 18 (1988).

<sup>239</sup> *See* J.C. WARD ET AL., MONITORING CHANGES IN WETLAND EXTENT: AN ENVIRONMENTAL PERFORMANCE INDICATOR FOR WETLANDS 2 (1999) (identifying categories used to monitor wetlands).

<sup>240</sup> *Markets*, *supra* note 42.

<sup>241</sup> *See generally* Salzman & Ruhl, *supra* note 22 (discussing environmental trading “currencies”).

Area can be measured precisely and quickly (some Corps requirements now require compensatory mitigation for impacts over 0.1 acres),<sup>242</sup> but accurately or precisely quantifying measures of ecosystem quality is far more difficult. In a stream or wetland market, critical questions remain unanswered as to what specific functions must be present to determine that the specific site is a “certifiable” ecosystem from which credits can be drawn. In the case of PS-NPS trading, some land area (e.g., riparian buffer) is converted from acres into pounds of nitrogen.<sup>243</sup> A crucial yet unresolved issue is whether the farmer’s actions installing a buffer strip actually produce a measurable reduction in nitrogen loads downstream, or whether the conversion of land itself is sufficient to generate water quality credits.<sup>244</sup> How should water quality improvements be verified? Changes in the ecological quality of traded ecosystems changes how regulators choose to monitor actions and enforce precise property rights.<sup>245</sup> While monitoring specific ecological functions has received increasing recognition in new regulations,<sup>246</sup> it remains an ongoing area of study for researchers.<sup>247</sup>

*D. Economic Issues: Unbundling, Unstacking, and Double-Dipping*

One of the critical issues, or opportunities, in the function of ecosystem markets is the potential for “credit stacking”—selling separate services furnished by the same ecosystem in separate markets.<sup>248</sup> For instance, 100 acres of a wetland bank are first sold as wetland mitigation units, and then sold again as water quality credits, endangered species credits, or even carbon credits. Credit stacking has also been called “unbundling,”

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<sup>242</sup> See U.S. ARMY CORPS OF ENGINEERS, CHICAGO DISTRICT, REGIONAL PERMIT PROGRAM 13 (2007), available at <http://www.lrc.usace.army.mil/co-r/rppbrief.htm>.

<sup>243</sup> See RTI INT'L, *supra* note 195, at 8–11.

<sup>244</sup> See Richard C. Schultz, *Effectiveness of a Constructed Buffer Strip in Capturing Nitrogen in the Midwestern Agricultural Landscape*, U.S. GEOLOGIC SURVEY <http://water.usgs.gov/wrri/96grants/ncr15ia.htm> (last updated March 23, 2005) (proposing to study the effectiveness of buffer strips capturing nitrogen in an agricultural setting).

<sup>245</sup> See generally CARY COGLIANESE & JENNIFER NASH, *LEVERAGING THE PRIVATE SECTOR: MANAGEMENT-BASED STRATEGIES FOR IMPROVING ENVIRONMENTAL PERFORMANCE* (2004), available at <http://www.hks.harvard.edu/m-rcbg/research/rpp/reports/RPPREPORT6.pdf> (discussing management-based private/public strategies).

<sup>246</sup> See 2008 Compensatory Mitigation Rule, *supra* note 46, at § 332.5.

<sup>247</sup> See NRC, *supra* note 41 (“[E]valuat[ing] both the ecological performance of mitigation projects and the institutions under which mitigation projects are conducted.”).

<sup>248</sup> See generally WORLD RES. INST., *WRI FACT SHEET: STACKING PAYMENTS FOR ECOSYSTEM SERVICES 1* (2009) [hereinafter WRI].

or “double-dipping,”<sup>249</sup> although there are several distinctions between these three concepts. Ecosystem service unbundling involves treating ecosystems as a set of discrete services that are fully distinct and segregable from one another.<sup>250</sup> Credit stacking is the act of selling two or more ecosystem services present on a single property as separate unbundled commodities, compensating for different permitted impacts.<sup>251</sup> Double-dipping is similar to stacking, except that credits are understood to “double up” natural resource benefits.<sup>252</sup>

The distinction between stacking and double-dipping is an arena of very unclear and unspecified policy. Fox argues that part of the distinction pertains to the additional activities that are necessary to gain the additional credits.<sup>253</sup> For example, if 200 acres of riparian buffer are established specifically to sell as endangered species habitat credits, but are then sold additionally into a market for NPS water quality credits, then Fox argues that the banker would be guilty of double-dipping, because the water quality credits were established separately on the same land with no additional land management activities.<sup>254</sup> To circumvent double-dipping, Fox argues that the natural resource value accounting must be careful and precise; it must clearly separate the riparian buffer needed for water quality provision and that needed for salamander habitat provision, thereby allowing these two areas to be sold separately.<sup>255</sup> This approach relies on the concept of “additionality,” the idea that the ecosystem services provided by an ecological restoration project are over and above the benefits that would have been present without the project.<sup>256</sup> However, the current precision and accuracy of ecosystem service accounting is exceedingly low, thereby causing potential barriers to establishing such closely coexisting

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<sup>249</sup> See Jessica Fox, *Getting Two for One: Opportunities and Challenges in Credit Stacking*, in CONSERVATION AND BIODIVERSITY BANKING 171, 172 (N. Carroll et al. eds., 2008); J.B. Ruhl, *Mitigation: Stacking and Bundling and Bears, Oh My!*, 32 NAT'L WETLANDS NEWSL., Jan./Feb. 2010, at 24.

<sup>250</sup> For a discussion of unbundling, see John P. Hoehn, et al., *Untying a Lancastrian Bundle: Valuing Ecosystems and Ecosystem Services for Wetland Mitigation*, 68 J. OF ENVTL. MGMT. 263, 263 (2003).

<sup>251</sup> WRI, *supra* note 248, at 1–2.

<sup>252</sup> See Fox, *supra* note 249, at 172.

<sup>253</sup> See *id.* at 177 (describing “additionality” as “the approach that credits are awarded only for those land management activities that occur above and beyond previous commitments”).

<sup>254</sup> See *id.* at 174–176 (explaining the difference between double-dipping and stacking).

<sup>255</sup> See *id.* at 172–77.

<sup>256</sup> See *id.* at 177; Joyotee Smith & Sara J. Scherr, *Capturing the Value of Forest Carbon for Local Livelihoods*, 31 WORLD DEV. 2143, 2150 (2003).

ecosystem service markets.<sup>257</sup> If regulators decide that double-dipping is undesirable, then they would need to somehow limit certification of new bank credits (for new markets) to those that are generated by additional land improvements that would not have otherwise been achieved without proactive measures.<sup>258</sup>

There are additional ecological and regulatory arguments against credit stacking. Robertson and Mikota have argued that ecosystem functions do not stack and unstack like Lego blocks, but rather are interrelated and intertwined.<sup>259</sup> One example involves nitrogen trading, where the only pathway to permanent removal of nitrogen from water involves denitrification, the conversion of nitrate (“NO<sub>3</sub>”) into gaseous nitrogen (“N<sub>2</sub>”).<sup>260</sup> However, the biogeochemical process of denitrification is limited by the availability of carbon,<sup>261</sup> thus inextricably linking carbon to nitrogen markets. Similarly, even at the most simple biochemical level, carbon, nitrogen, and phosphorus are intertwined through basic stoichiometry, making separate water quality markets for these different nutrients scientifically nonsensical.<sup>262</sup> Moving into more complex ecological interactions, such as the species interactions and food webs that are inherent to conservation banks,<sup>263</sup> will undoubtedly be substantially more complex. In the end, unbundling ecosystems as a concept is problematic to justify scientifically.

From a regulatory standpoint, it is clear that it is difficult to “unstack” ecosystem services derived from ecological restoration projects.<sup>264</sup> There are multiple agencies that regulate ecosystem features and ecosystem service markets: the Corps regulates streams and wetlands via the Clean Water Act, while the U.S. Fish and Wildlife Service regulates conservation habitat banks through the Endangered Species Act,<sup>265</sup> state

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<sup>257</sup> *E.g.*, U.S. GOV'T ACCOUNTABILITY OFFICE, CORPS OF ENGINEERS DOES NOT HAVE AN EFFECTIVE OVERSIGHT APPROACH TO ENSURE THAT COMPENSATORY MITIGATION IS OCCURRING: REPORT TO THE RANKING DEMOCRATIC MEMBER, COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE, HOUSE OF REPRESENTATIVES (2005).

<sup>258</sup> See Fox, *supra* note 249, at 172.

<sup>259</sup> See Morgan M. Robertson & Michael Mikota, *Water Quality Trading and Wetland Mitigation Banking: Different Problems, Different Paths?*, 29 NAT'L WETLANDS NEWSL., Mar./Apr. 2007, at 14.

<sup>260</sup> See Robert C. Starr & Robert W. Gillham, *Denitrification and Organic Carbon Availability in Two Aquifers*, 31 GROUND WATER 934, 934–935 (1993).

<sup>261</sup> See *id.* at 935.

<sup>262</sup> See Wyatt Cross et al., *Ecological Stoichiometry in Freshwater Benthic Systems: Recent Progress and Perspectives*, 50 FRESHWATER BIOLOGY 1895, 1896 (2005).

<sup>263</sup> Kevin S. McCann, *The Stability-Diversity Debate*, 405 NATURE 228, 230 (2000).

<sup>264</sup> See Robertson & Mikota, *supra* note 259, at 14.

<sup>265</sup> See Mead, *supra* note 32, at 10, 14.

agencies oversee water quality trading programs, and private organizations oversee the currently voluntary carbon market.<sup>266</sup> Thus, credit stacking poses a substantial administrative hurdle for any banker who wishes to engage multiple agencies simultaneously. At the most basic level, unbundling or stacking credits makes unclear what actually changes hands when credits are sold.<sup>267</sup>

When a wetland or stream credit is sold for compensatory mitigation, the banker has (1) inevitably sold a permanent easement to that property, ensuring that the physical property will stay in its wetland/stream natural condition; and (2) performed certain management actions that will ensure the viability of the wetland or stream into the future.<sup>268</sup> However, the transaction has occurred to fulfill the legal requirements of § 404(b) of the Clean Water Act.<sup>269</sup> In the case of unstacking that same property into water quality credits or endangered species credits, or even carbon credits, the sale of these credits would be to fulfill a completely separate regulatory requirement, such as the Endangered Species Act.<sup>270</sup> Quite simply, the legal status for stacking, unbundling, and double-dipping is unclear.

The policy way forward is unclear, or at least not set. At one extreme, policymakers may acknowledge the functional integration of ecosystems, perhaps by recognizing “ecological condition” as a single integrating ecological function.<sup>271</sup> Alternatively, policymakers may want to embrace the unbundling approach through acknowledging that ecosystems provide a wide range of services, and thus formulate regulations based on precise valuations of these component services via separate markets for each service.<sup>272</sup>

### *E. Markets: Unintended Consequences*

Additional issues emerge in ecosystem service markets from the nonintuitive interactions between ecosystem and market processes. To date, we have insufficient data from which to derive empirical observations about landscape scale ecosystem market behavior,<sup>273</sup> but there are a few modeling studies which provide some additional insight.

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<sup>266</sup> See Fox, *supra* note 249, at 178.

<sup>267</sup> See Robertson 2007, *supra* note 24, at 506–07.

<sup>268</sup> 2008 Compensatory Mitigation Rule, *supra* note 46, at § 332.7(a).

<sup>269</sup> 33 U.S.C. § 1344(b) (2006).

<sup>270</sup> See 16 U.S.C. § 1531 *et seq.* (2006).

<sup>271</sup> See Robertson & Mikota, *supra* note 259, at 14.

<sup>272</sup> See *id.*

<sup>273</sup> See Martin W. Doyle & Andrew J. Yates, *Stream Ecosystem Service Markets Under No-Net-Loss Regulation*, 69 *ECOLOGICAL ECON.* 820, 820 (2009).

In the case of streams, Doyle and Yates linked an economic model of free-entry equilibria with a simple ecological model in order to examine the interactions of stream markets and ecological processes in programs aimed at preventing resource net losses.<sup>274</sup> Their modeling showed that when implementing a no-net-loss program, a regulator must not only account for the ecological differences between restored and natural ecosystems, but also consider the effect of market entry on the number and size of restoration projects.<sup>275</sup> They showed that in a system with little to no restoration scale economies, the number of entrants into an ecosystem service market will be greater than the number that maximizes welfare.<sup>276</sup> The effect of this excess entry on restored ecosystems is to encourage the restoration of smaller sites rather than larger sites, which are generally considered less ecologically desirable than larger sites.<sup>277</sup> Thus, considerations of joint processes are crucial when designing and evaluating such programs. A similar conclusion was reached for a different type of ecosystem market by Armsworth et al. who examined conservation banks within a system that included real estate property market dynamics.<sup>278</sup> They showed that interaction between the local market for land and conservation purchases could actually lead to a decrease in overall biodiversity.<sup>279</sup> Conservation purchases can affect land prices and potentially displace development toward biologically valuable areas or accelerate the pace of development.<sup>280</sup>

While limited in number, emerging studies that link ecological processes and characteristics with economic models suggest that these coupled ecological-economic systems can produce unintended, or at least nonintuitive, consequences.<sup>281</sup> A critical need at this point in time is to more fully explore these types of coupled systems.

## CONCLUSION

Within freshwater ecosystems, ecosystem service markets now span wetlands, streams, non-point source water quality, and habitat

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<sup>274</sup> *Id.* at 820–27.

<sup>275</sup> *See id.* at 822.

<sup>276</sup> *See id.* at 823.

<sup>277</sup> *See id.* at 824.

<sup>278</sup> Paul R. Armsworth et al., *Land Market Feedbacks Can Undermine Biodiversity Conservation*, 103 PROCEEDINGS OF THE NAT'L ACAD. OF SCI. 5403, 5403 (2006).

<sup>279</sup> *See id.* at 5406–07.

<sup>280</sup> *See id.*

<sup>281</sup> *See* Stephen Polasky, *Why Conservation Planning Needs Socioeconomic Data*, 105 PROCEEDINGS OF THE NAT'L ACAD. OF SCI. 6505, 6505–06 (2008).

conservation.<sup>282</sup> Most importantly, the regulatory framework for these markets is very unstable, with major policy changes being the norm rather than the exception.<sup>283</sup> Moreover, under the auspices of compensatory mitigation, the science and economics of ecological restoration is also in its infancy.<sup>284</sup>

There are state and federal policies that can, if structured incorrectly, undermine many of the original intents of compensatory mitigation programs (e.g., in-lieu fee programs).<sup>285</sup> There are other policies that can make private provision of compensatory mitigation difficult (e.g., small geographic service areas).<sup>286</sup> Resolving these tensions between the policies developed for specific problems that emerge locally and the initial goals of broad, federal environmental policy will inevitably remain an ongoing problem inherent to this type of adaptive management. So long as scientific monitoring can play a role in evaluating the programmatic success for maintaining and restoring the integrity of the nation's waters, then we expect that ecosystem service markets can play an important role in freshwater ecological restoration.

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<sup>282</sup> See Doyle & Yates, *supra* note 273, at 820.

<sup>283</sup> See BenDor & Brozovic, *supra* note 91, at 355; Robertson 2006, *supra* note 17, at 299–302.

<sup>284</sup> See Doyle & Yates, *supra* note 273, at 820.

<sup>285</sup> See ELI 2006, *supra* note 53, at 1–5.

<sup>286</sup> See Womble & Doyle, *supra* note 23, at 18 (explaining that “[s]ervice areas effectively determine the market size with important implications”).