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Trading Species: A New Direction for Habitat Trading Programs

by Jonathan Remy Nash

Editors' Summary: Prof. Jonathan Nash suggests that it may be possible to construct a viable development rights trading regime that would protect ecosystems and endangered species by relying on lessons from other trading programs, such as air emissions credits. Virginia Albrecht finds the analogy to air emissions credits weak because it fails to take into account the private-property rights inherent in land, the many competing demands on land use, and the fungibility of air. Michael Bean believes there are some lessons to be learned by considering development rights trading schemes, but that ultimately they are unlikely to succeed given current limitations to our knowledge about species and habitat.

I. Introduction

Development of natural habitat poses a substantial threat to many endangered species. The Endangered Species Act (ESA) seeks to protect species.[1] It does so using a clumsy command-and-control approach—an approach that ignores concerns of both efficiency and science. Instead of command and control, commentators have recommended economic incentive approaches, especially a tradable development rights approach. Under a tradable rights approach, landowners may only develop land if they hold development permits that authorize them to do so.

Difficulties remain, however, in designing a tradable permit approach that properly takes into account economic and scientific realities. These difficulties are accentuated in the case of preserving habitat for endangered species because different tracts of land tend to be of varying value to the continued well being of the endangered species at issue. A straight trade of a development permit from one landowner to another does not take the differential in habitat value into account. For this reason, the basic model of a tradable permit system's design fails to ensure protection of endangered species' habitat.

Commentators have proposed more nuanced versions of tradable permit systems in an attempt to address this problem. Most prominent among these proposals is the habitat transaction method. Under this method, different tracts of land are assigned different values based upon their importance to the endangered species. Values are also adjusted to reflect both the land's size and shape—two factors that tend to have an effect on habitat value. The habitat transaction method also has its shortcomings, however. First, it is administratively complex: both administrative and transaction costs would be substantial. Second, the method's valuation system is static: it fails to take into account changes in habitat value over time.

Commentators have suggested different design proposals in another setting in which environmental effects differ depending upon location—the setting of air pollution emissions. Environmental economists have traditionally advanced three tradable pollution permit design alternatives to account for the varying harm of air pollution emissions: (1) multiple zone markets; (2) markets in units of environmental degradation; and (3) markets in pollution offsets. Finding these alternatives to have serious drawbacks, my colleague, Richard Revesz, and I have proposed a fourth alternative—a constrained emissions permit trading system.

Lessons from the air pollution context can be used to design better marketable permit systems in the setting of endangered species and ecosystems. Markets in units of environmental degradation may be easier to implement in the endangered species setting than in the air pollution setting. Additionally, the constrained emissions permit trading system approach would appear well designed to achieve the broader protection of entire ecosystems.

This Article considers the question of how best to design marketable permit schemes that are economically and scientifically appropriate, and that work particularly, to ensure the preservation of endangered species' habitat, and more generally, entire ecosystems.

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1. 16 U.S.C. §§1531-1544, ELR Stat. ESA §§2-18.

II. Overview of the Act

Section 9 of the Act renders it generally unlawful to "take" any specimen of an endangered fish or wildlife species.[2] The Act defines "take" broadly to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."[3] Regulations under the Act define the term "harm" in the definition of "take" to mean "an act which actually kills or injures wildlife,"[4] and specify that "harm" "includes significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering."[5] The Act provides certain exceptions to the proscription against "takings,"[6] the most important of which is §10's permitting authority. Section 10 grants the responsible government department[7] discretion to issue a permit that allows a taking that is "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity."[8] As part of the application process, the Act requires the submission of a "conservation plan"[9]—commonly known as a "habitat conservation plan."[10]

III. Problems With the Act's Approach

The Act, as currently structured, suffers from two main flaws—one scientific and the other economic. First, from a scientific perspective, the Act fails to incorporate habitat preservation—the key to preserving species—and, more generally, ecosystem protection—the key to the preservation of biodiversity—into its structure. Many critics assail the Act for its failure to set as a goal the preservation of ecosystems. Ecosystem preservation would preserve all the species, endangered or otherwise, within the ecosystem by preserving all species' habitats. A regulatory regime focused on ecosystem protection thus would help to maintain biodiversity better than the Act's current focus on endangered species. Moreover, ecosystem preservation is more likely to ensure the preservation of particular species—including endangered species—than a habitat preservation approach. Preservation of the ecosystem in which an endangered species lives guarantees the continuation of the entire system in which the species exists. By contrast, preservation of habitat guarantees preservation only of the endangered species' habitat. The current system fails to consider that endangered species may depend on other species, for example as prey.

Second, many commentators criticize the Act's reliance upon command-and-control regulation. Specifically, the Act's command-and-control structure fails to achieve species or habitat preservation in a cost-effective way. Worse, its inflexibility gives rise to incentives that run counter to preservation and expansion of species' habitat. First, landowners whose land consists of habitat for endangered species have an incentive to engage in activities that discourage the species from either inhabiting or traversing the land. Second, a similar incentive results if a species has yet to be listed as endangered or if a habitat has yet to be identified as protected but there is a sense that such actions are imminent.

2. *Id.* §1538(a)(1)(B), ELR Stat. ESA §9(a)(1)(B). Other actions deleterious to the preservation of the species are also proscribed. *See generally id.* §1538(a)(1), ELR Stat. ESA §9(a)(1). Determinations of those species that are endangered are made pursuant to §4 of the Act and regulations thereunder. *See id.* §1533, ELR Stat. ESA §4. The Act also authorizes actions to protect species that are merely "threatened" with extinction, but not yet endangered. *See id.* §1533(c), (d), ELR Stat. ESA §4(c), (d). The government has extended §9's "take" prohibition to protect threatened species as well. *See* Barton H. Thompson Jr., *The Endangered Species Act: A Case Study in Takings and Incentives*, 49 Stan. L. Rev. 305, 314 (1997).

   Section 7 of the Act directs the government generally to act in means that are "not likely to jeopardize the continued existence of any endangered species or threatened species" and that will not "result in the destruction or adverse modification of habitat of such species." 16 U.S.C. §1536(a)(2), ELR Stat. ESA §7(a)(2). Barton Thompson explains:

   > For most of the 23-year history of the [Act], attention was focused on the Act's restrictions on *federal* projects and programs. . . . Until the 1980s, almost all property owners developed and used their land in blissful ignorance of section 9 and its sweeping restrictions. The federal government did not actively enforce the prohibition, and environmental groups had not yet added it to their arsenal of weapons for use against private landholders. That has dramatically changed.

   Thompson, *supra*, at 309-10.

3. 16 U.S.C. §1532(19), ELR Stat. ESA §3(19). *See also* 50 C.F.R. §17.21(c) (2004).

4. 50 C.F.R. §17.3.

5. *Id.*; *see also* Babbitt v. Sweet Home Chapter of Communities for a Great Or., 515 U.S. 687, 25 ELR 21194 (1995) (upholding regulatory definition of "take" as reasonable). For criticism of the U.S. Supreme Court's decision in *Sweet Home*, see Richard A. Epstein, Babbitt v. Sweet Home Chapters of Oregon*: The Law and Economics of Habitat Preservation*, 5 Sup. Ct. Econ. Rev. 1 (1997).

6. Exceptions to the Act's proscriptions are found in §§6 and 10. *See* 16 U.S.C. §§1535(g)(2), 1539, ELR Stat. ESA §§6(g)(2), 10. Section 7 also allows for incidental takings by government agencies. *See id.* §1536(a)(2), (b)(4), (o)(2), ELR Stat. ESA §7(a)(2), (b)(4), (o)(2).

7. The statute refers to the "Secretary." *Id.* §1539(a)(1), ELR Stat. ESA §10(a)(1). The Act defines "Secretary" to refer, depending upon context, to the Secretary of the Interior or the Secretary of Commerce (or, in very limited circumstances, the Secretary of Agriculture). *See id.* §1532(15), ELR Stat. ESA §3(15).

8. *Id.* §1539(a)(1)(B), ELR Stat. ESA §10(a)(1)(B). Regulatory elucidation is found in 50 C.F.R. §17.22(b).

9. Section 10 of the Act specifies:

   > No permit may be issued by the Secretary authorizing any taking referred to in paragraph (1)(B) unless the applicant therefor submits to the Secretary a conservation plan that specifies—
   >
   > (i) the impact which will likely result from such taking;
   > (ii) what steps the applicant will take to minimize and mitigate such impacts, and the funding that will be available to implement such steps;
   > (iii) what alternative actions to such taking the applicant considered and the reasons why such alternatives are not being utilized; and
   > (iv) such other measures that the Secretary may require as being necessary or appropriate for purposes of the plan.

   Id. §1539(2)(A), ELR Stat. ESA §10(2)(A). *See also* 50 C.F.R. §17.22(b)(1). For a general discussion of so-called habitat conservation plan (HCP) permits, see J.B. Ruhl, *How to Kill Endangered Species, Legally: The Nuts and Bolts of Endangered Species Act "HCP" Permits for Real Estate Development*, 5 Envtl. L. 345 (1999). For a brief historical summary of the habitat conservation plan exception, see Oliver A. Houck, *On the Law of Biodiversity and Ecosystem Management*, 81 Minn. L. Rev. 869, 954-55 (1997); Karin P. Sheldon, *Habitat Conservation Planning: Addressing the Achilles' Heel of the Endangered Species Act*, 6 N.Y.U. Envtl. L.J. 279, 295-99 (1998); *see also* Richard B. Stewart, *A New Generation of Environmental Regulation?*, 29 Cap. U. L. Rev. 21, 73 (2001) ("Although enacted for quite different and more limited purposes . . . the Department has made wide use of this provision to negotiate habitat conservation plans . . . in agreements with developers or other commercial interests that wish to undertake activities that will disrupt the habitat of a listed species.").

10. *See* 50 C.F.R. §17.3 ("Conservation plans also are known as 'habitat conservation plans' or 'HCPs.'").

Third, once landowners are on notice that development in an area will, at some point at least, be restricted by virtue of the presence of endangered species, the current system gives rise to the incentive to develop land sooner—before restrictions begin to inhere—than later. This incentive flouts both science and efficiency because development rights are allocated according to who first seeks permission to develop, not according to whose development is more likely to cause greater harm to endangered species or which party would value more greatly the development rights.

The habitat conservation plan (HCP) option is more attractive than the Act's basic command-and-control approach. Still, HCPs offer limited benefits. The government and each particular applicant negotiate the plans, likely resulting in substantial administrative and transaction costs. Moreover, because each plan includes only the particular applicant—or, at most, a small number of applicants—the flexibility that each plan offers necessarily is circumscribed. The regulatory scope is simply too narrow. Richard Stewart thus categorizes the HCP approach as microcontractual,[11] i.e., arising out of an agreement between the government and one societal actor or a limited number of actors,[12] and not macrocontractual, i.e., arising out of an agreement between the government and a much larger group of societal actors.[13] While microcontractual approaches are more efficient than traditional command-and-control approaches, they are still less efficient than macrocontractual approaches. Stewart laments the continued lack of availability of a macrocontractual solution to habitat protection, explaining: "Without further progress toward fungibility and commodity-like markets, resource-trading systems are likely to remain a variation on microcontract methods, hostage to regulatory discretion in the permitting process."[14]

11. *See* Stewart, *supra* note 9, at 73-76 (presenting HCPs as an example of a microcontractual approach).

12. More specifically, Stewart explains that microcontracts consist of formalized regulatory agreements between regulatory agencies and regulated entities that provide for alternative, more flexible requirements than those that would otherwise apply under standard regulatory laws. In many cases the agency requires as a condition of such agreements that the regulated entity achieve a higher level of environmental performance than could otherwise be mandated in exchange for increased flexibility in regulatory requirements or a release from otherwise applicable civil penalty liabilities for prior regulatory violations. *Id.* at 63-64; *see* Thompson, *supra* note 2, at 316-17 (summarizing empirical data that indicate the tendency for HCPs to involve relatively small parcels of land); *cf.* Sheldon, *supra* note 9, at 336-37 (identifying a single statewide multi-species HCP).

13. Stewart explains that macrocontracts "differ . . . from . . . microcontracts . . . which set alternative requirements for an individual facility or development project, in that they generally apply to all the relevant operations of a firm or entire industry." Stewart, *supra* note 9, at 81. As such, macrocontractual approaches have "broader application" than do their microcontractual counterparts. *Id.* Stewart observes: "In the United States, most [contractual agreements with the government to address environmental protection] are concluded at the facility or project level—'microcontracts.' In Europe, environmental covenants are typically negotiated at the industry or firm levels—'macrocontracts.'" *Id.* at 60.

14. *Id.* at 127; *cf. id.* at 77 ("[T]here appears to be much more flexibility in wetlands mitigation projects than in Project XL or HCP projects.").

IV. The Promise and Potential Shortcomings of Tradable Permits

A. General Overview and Benefits

In order to implement a tradable pollution permit system, the government first identifies the relevant region in which regulation is to be sought. The government then determines the maximum allowable degradation that consistent with regulatory goals, is to be allowed over a given time period—usually annually. It then divides that amount among degradation permits, which are then distributed to societal actors. The permits may be distributed by auction or, as is generally the case with extant permit systems, by means of a grandfathering system under which existing polluters receive permits in rough proportion to their pre-program degradation history. Last, the government authorizes trading of the permits among societal actors.[15]

Tradable environmental degradation permits offer two primary benefits over nonmarket-based forms of environmental regulation. First, tradable permits offer a cost-effective means of environmental protection: given a particular level of environmental protection, and assuming a smoothly functioning market, a tradable system will achieve the desired level of environmental protection at the lowest possible cost. Those who face comparatively high marginal costs of increased environmental protection will be free to purchase permits from those who face comparatively lower marginal costs.

Second, subject to wealth effects, trading will allocate a scarce resource—here, developable land—to those who value it most. This, too, is an economically efficient result.

B. Potential Problems

1. Spatial Differentiation

Environmental trading programs generally assume fungibility of the commodities being traded.[16] Often, however, the environmental impact of rights being traded differ greatly. Environmental economics employs the term "spatial differentiation" to describe the situation where the externalities that result from identical acts of environmental degradation differ only because the acts of degradation originated in different locations.[17]

In the case of habitat protection, development effects are highly likely to be spatially differentiated. The environmental effect of the development of one tract of land will probably differ substantially from the environmental effect of the development of another. For example, one of the tracts may be integral to maintaining the contiguous habitat that a species requires to survive.

15. *See* Jonathan Remy Nash, *Too Much Market? Conflict Between Tradable Pollution Allowances and the "Polluter-Pays" Principle*, 24 Harv. Envtl. L. Rev. 465, 483-85 (2000).

16. *See generally* James Salzman & J.B. Ruhl, *Currencies and the Commodification of Environmental Law*, 53 Stan. L. Rev. 607 (2000). *See also* Stewart, *supra* note 9, at 111 (emphasizing the importance of a "uniform homogenous commodity" to a successful marketable permit program).

17. *See* Jonathan Remy Nash & Richard L. Revesz, *Markets and Geography: Designing Marketable Permit Schemes to Control Local and Regional Pollutants*, 28 Ecology L.Q. 569, 577 (2001).

Most extant pollution trading programs ignore the problem of spatial differentiation in all its varieties.[18] This is the result of three factors: (1) a desire to get trading programs up and running as quickly as possible; (2) the belief that the complications that would result from refining the programs to address spatial differentiation would both make the programs less likely to be implemented and more likely to fail if they were implemented; and (3) the belief that the likelihood that problems actually would result from spatial differentiation is relatively low in the short run and that monitoring could be used to determine whether such problems actually would arise, perhaps with the idea in mind of refining the system as necessary to address actual problems.[19]

To whatever extent these points may be sound in the context of trading systems for air pollutants and other forms of pollution emissions, they are not transferable to habitat trading systems. The spatial differentiation in externalities resulting from development of different land tracts is much more likely to be quite substantial. Even one trade may have devastating and irreversibly deleterious effects on a habitat. Therefore, the strategy of instituting a program that ignores spatial differentiation until problems arise would be unsuitable in the context of habitat protection; it is quite possible that grave problems may arise even at the outset.

2. Temporal Differentiation

Spatial differentiation of degrading acts is not the only type of differentiation that can plague emissions permit programs. In the air pollution context, for example, the damage caused by the emission of identical amounts of a pollutant from the same location can vary with the temperature and velocity of the emission, as well as with the height at which the pollutant is released into the atmosphere.[20]

Habitat trading programs also face a form of differentiation other than spatial differentiation—temporal differentiation. Two pollution emissions that are identical in all respects, e.g., location, amount, etc., except time, are temporally differentiated if they result in different environmental degradations in terms of amount, location, or a combination of the two.[21]

In the habitat trading context, it may be that destruction of a piece of forest habitat is more harmful at a later date when there are more trees at more advanced ages and more trees overall.[22]

V. Existing Proposals to Preserve Habitat via Trading

A. In General

Jon Goldstein and Theodore Heintz identify certain elements shared by all HCPs that feature tradable development rights:

- A plan for a delineated region specifying how much area will be protected together with a process for determining which areas will be conserved;
- A process for evaluating the habitat value of protected lands and assigning tradable conservation credits to the landowners;
- A process for determining the amount of mitigation (and hence conservation credits) required to undertake a proposed development
- A process for conducting transactions in conservation credits; and
- A process for securing performance, i.e., guaranteeing compliance with mitigation requirements and conservation objectives.[23]

Within these broad parameters, tradable rights programs have been proposed and, on rare occasions, implemented based upon different design approaches. The most basic, unsophisticated tradable rights design simply divides the regulated area into two or more subregions. The subregions are created based upon, and ranked according to, the relative importance of the lands within each subregion with respect to maintenance of the habitat or ecosystem. A landowner must have sufficient credits to develop her land, and can purchase credits only from other landowners whose land lies within the same subregion as, or a subregion that is less critical than, the prospective developer's subregion.[24]

B. Habitat Transaction Method

1. Original Formulation

The "habitat transaction method," proposed by Todd Olson and colleagues, offers a more complex, nuanced design.[25] Perhaps because of the complexities, the precise contours of the proposal remain unclear in some important ways.

The system contemplates trading in "standardized 'conservation units.'"[26] As Olson and colleagues explain:

> Any landowner who agrees to conserve or restore habitat within the planning area receives credits based on the conservation value that the landowner adds to the reserve system. Any landowner proposing a project that would cause a loss of conservation value is required first to offer a number of credits based on the decrease in conservation value that would result from the development. Landowners who receive credits for conservation actions may either use the credits to develop elsewhere within the planning area or sell the credits to any other landowner who needs credits to compensate for project impacts.[27]

18. *See id.* at 572.

19. *See id.*

20. *See id.* at 577-78, 638.

21. *See generally* T.H. Tietenberg, Emissions Trading: An Exercise in Reforming Pollution Policy 149-67 (1985).

22. *Cf.* Salzman & Ruhl, *supra* note 16, at 630 ("[I]f we allow a party to destroy mature forested wetlands in exchange for engaging in a seedling planting restoration project in another location, even if the restoration project is vastly larger in size we will experience a temporary net loss of habitat values.").

23. *See* Jon H. Goldstein & H. Theodore Heintz Jr., *Incentives for Private Conservation of Species and Habitat: An Economic Perspective*, *in* Building Economic Incentives Into the Endangered Species Act: A Special Report From Defenders of Wildlife 55 (Hank Fischer & Wendy E. Hudson eds., 1994) [hereinafter Building Economic Incentives].

24. An example of such a system is New Jersey's Pinelands trading system. *See id.* at 57.

25. *See* Todd G. Olson et al., *The Habitat Transaction Method: A Proposal for Creating Tradable Credits in Endangered Species Habitat*, *in* Building Economic Incentives, *supra* note 23, at 27.

26. *See id.* at 28.

27. *Id.*

Trading need not take place on a one-to-one basis, in at least one sense: Olson and colleagues leave open the possibility of "selecting a 'conservation ratio'—the number of conservation units that must be conserved for each unit lost, toward the realization of long-term conservation objectives."[28]

The method's innovation is its means of determining the habitat value of different tracts of land. The method begins with the assignment of habitat quality points to each plot of land subject to regulation. Habitat quality points range from 0.0 to 1.0,[29] and are assigned "based upon the extent to which the land is characteristic of the subject habitat type."[30] More specifically, initial point assignments are based on "such factors as soil types, slope and aspect, elevation, quality of characteristic vegetation, presence or absence of indicator species, etc."[31]

After the initial assignment of quality points to individual plots, the method invokes two adjustments to point totals: one for contiguity and another for shape of patches in the planning area. First, point totals are adjusted to reflect "the size and contiguity of patches of habitat in the planning area."[32] The authors provide a graphical example of the function that would assign the contiguity factor based upon the total quality points in a habitat patch,[33] but do not describe the specific mathematical function upon which they rely, or even how they arrived upon the example function they use. The example function assigns contiguity factors between 0.0 and 2.0,[34] with a contiguity factor of 1.0 applying to patches with 1,000 cumulative quality points. The marginal increase in contiguity factor decreases with increases in the total quality points in the patch.[35]

The second adjustment is one for size of the habitat patch. The total area (A) and perimeter (P) of the patch are calculated, and the point total (as already adjusted for contiguity) is multiplied by a "shape factor."[36]

The closer the shape factor to 1, the closer the shape of the habitat resembles a circle; likewise, the closer the shape factor is to 0, the less the circular resemblance.[37] The formula reflects the general notion that a circular shape is valuable in that it minimizes "exposure of the habitat to unprotected edges."[38]

With respect to how the point allocations apply specifically to trading, Olson and colleagues explain that "landowners will receive credits, or will be required to pay credits based upon the definition of conservation value."[39] They further state that a landowner will receive conservation units "based on the conservation value that the landowner adds to the reserve system,"[40] and that a prospective developer must offer credits "based on the decrease in conservation value that would result from the development."[41] Thus, one cannot simply calculate the habitat value of the particular tract being developed or restored without reference to the larger reserve; rather, units earned and due should be calculated based upon the change in conservation value that the entire habitat reserve experiences by virtue of the landowner's action.

2. Modified Habitat Transaction Method

An oft-cited article authored by David Sohn and Madeline Cohen builds upon Olson and colleagues' habitat transaction method proposal.[42]

Sohn and Cohen endeavor to clarify the habitat transaction method to afford landowners greater flexibility. The first clarification is to treat different types of development differently. The credits required to undertake a particular development should depend not only upon the habitat to be affected, but also upon exactly how damaging to the habitat the particular development would be.[43] In that way, "landowners would have more flexibility in deciding how best to reconcile their commercial interests with the regulatory framework's conservation requirements."[44]

Second, they suggest that in order to generate new credits, landowners not be required simply to forego any development at all in perpetuity on land. Instead, as a more flexible approach, they recommend that landowners be allowed to generate fewer credits through partial conservation—that is, "by maintaining land in a condition that is of some value as habitat, while not refraining from development entirely."[45]

Third, Sohn and Cohen suggest that "because the development potential of land can shift over time, conservation decisions as to particular plots of land should be reversible."[46] Accordingly, "as long as the trading sets a total development cap for the covered area, individual landowners should be free to revise their particular land use decisions, provided they tender sufficient credits."[47]

Beyond these clarifications, Sohn and Cohen suggest modifications that would shift the habitat transaction method from a tradable credit system to a cap-and-trade system. Instead of having credits originate in landowners' decisions to set aside habitat for conservation, the government instead could create and allocate a fixed number of "development allowances" at the outset.[48] Sohn and Cohen recom-

28. *Id.* at 29.

29. *Id.* The decision to have quality points range from 0.0 to 1.0 is purely for ease; it is irrelevant to the ultimate function of the program.

30. *Id.*

31. *Id.*

32. *Id.*

33. *Id.* at 30.

34. In fact, the function appears to approach a 2.0 contiguity factor asymptotically, never actually reaching that value.

35. Mathematically, the second derivative is uniformly negative.

36. *Id.*

37. This is readily seen mathematically: A circle's area (A) equals πr^2 (where r equals the circle's radius) and its perimeter (P)—referred to as its circumference—equals $2\pi r$. The shape factor formula thus provides a shape factor of 1 for a habitat patch of precisely circular shape.

38. *Id.* at 31.

39. *Id.*

40. *Id.* at 28.

41. *Id.*

42. David Sohn & Madeline Cohen, *From Smokestacks to Species: Extending the Tradable Permit Approach From Air Pollution to Habitat Conservation*, 15 Stan. Envtl. L.J. 405 (1996).

43. *Id.* at 435.

44. *Id.*

45. *Id.* at 435-36.

46. *Id.* at 436.

47. *Id.*

48. *Id.* at 438. Sohn and Cohen suggest that "[t]he total number of allowances issued . . . equal the total number of conservation units in the entire land area covered by the program," *id.*, and that the modified system would put a cap on areawide habitat loss by the use of a conservation ratio, *see id.* They explain, by way of example:

mend conducting the initial allocation of allowances by means of a zero-revenue auction mechanism.[49]

Finally, Sohn and Cohen advance some structural recommendations regarding trading program design. First, they suggest that even under the general cap-and-trade model, landowners who restore or create new habitat be entitled to receive development allowances.[50] In order to create an incentive for the restoration and creation of habitat, they recommend that a landowner who restores or creates habitat receive more allowances than a landowner would receive for holding similar, undeveloped land at the outset of the program.[51] However, in order to ensure that the restoration or creation of habitat leads to a net environmental gain, they recommend that the same landowner nevertheless receive fewer allowances than the underlying conservation value of the land in question.[52]

3. Problems With the Habitat Transaction Method

The habitat transaction method, in both its original and modified forms, offers significant improvement over the basic tradable development rights model in terms of addressing the spatial differentiation issue. Still, the habitat transaction method has several drawbacks. First, the method entails substantial administrative and transactions costs. The government or an agent of the government would have to play a substantial role in making sure that development projects are properly supported by the requisite number of allowances. Prospective buyers would have to obtain as many allowances as required. Furthermore, the required number of allowances might change over time—for example, the allowances required for "L" to develop her lot may change if, for example, her neighbor "N" deploys allowances to start the development of an adjacent lot before "L" actually files her allowances and starts development.

Second, while the habitat transaction method, unlike standard trading regimes, properly varies the requirements for developing a plot of land according to how valuable the plot is as habitat, the number of allowances required to develop a plot will not change based directly upon the effects of intermediate development on endangered species population. Rather, the determining factor will be the extent to which adjacent plots are developed.

VI. Addressing Differentiation in the Context of Pollution Emissions Trading

A. Traditional Refinements and Their Shortcomings

There are three traditional approaches to refining a tradable permit regime to address the issue of spatial differentiation of pollution emissions: (1) multiple-zone emissions trading markets; (2) markets in units of environmental degradation; and (3) pollution offset markets. Each of these options has serious drawbacks that limit, in the emissions trading setting, their effectiveness, practicality, or both.

A multiple-zone emissions trading market design divides the regulated region into subregions. Trading is authorized within subregions and perhaps across regional boundaries. Because spatial differentiation within each subregion is minimized, trading among sources within the subregion is less likely to give rise to problems. At the same time, the use of subregions lessens, but does not eliminate, spatial differentiation. Moreover, greater reductions in spatial differentiation require increasingly smaller subregions. Smaller subregions mean that there will be fewer potential market participants; this can lead to the problem of thin markets.

A second traditional response to spatial differentiation in the context of pollution emissions is the introduction of trading in units of environmental degradation rather than in emissions units.[53] Also referred to as an "ambient permit

> [I]f two development allowances were required for each conservation unit lost to development, then all the development allowances created in the system would only be sufficient to pay for degrading half of the system's initial conservation units. The system would guarantee preservation of at least one half of the area's habitat.

Id. This goal could be accomplished equally by retaining a 1:1 conservation ratio and simply reducing the number of authorized allowances by one-half (or whatever ratio was desired).

49. *See id.* at 439-41. Specifically, Sohn and Cohen would have the government distribute allowances provisionally to each landowner in proportion to the conservation value of his or her land (as adjusted, presumably, for development that already has taken place). This distribution would be provisional since all landowners would be required immediately to contribute the allowances to a pool. After that, the government would auction off all the allowances. Landowners, and others interested in obtaining allowances, would be free to submit demand curves, i.e., a schedule detailing the number of allowances the bidder would like to purchase at various prices. The government would use the demand curves to establish the equilibrium, market-clearing allowance price. The government then would distribute the allowances according to the demand curves, with those receiving allowances owing appropriate payment at the equilibrium price. The proceeds would be distributed to landowners in proportion to their initial, provisional allowances allocations. *See id.*

The economic superiority of, but political difficulty associated with, auction-based allocations of pollution permits in general is well documented. *See, e.g.*, Nash, *supra* note 15, at 506-07, and the authorities cited therein. I do not further address the question here.

50. *See* Sohn & Cohen, *supra* note 42, at 444.

51. Sohn and Cohen explain (operating under their assumption of a 2:1 conservation ratio, *see supra* note 48; text accompanying *supra* note 28):

> One approach would be to grant one allowance for each new conservation unit a landowner adds to the system. But, by adding one conservation unit to the habitat value of her land, a landowner increases by two the allowances needed to develop it. . . . This reduces the property's value to potential developers by an amount equal to the price of two allowances. While the landowner has gained one allowance today, she has taken the risk of a future loss equal to the price of two allowances if she later decides to develop the property or sell it to someone planning to develop. This limits the incentive to create new habitat. . . .
>
> This problem would be alleviated if the system granted two development allowances for each new conservation unit created. However, this would mean that the addition of habitat would be of no net environmental value—each unit created would generate allowances that could be used to remove a unit somewhere else in the system. A compromise approach would be to select a ratio between one-to-one and one-to-two. For example, if a landowner received one-and-one-half allowances for each new conservation unit created, it is more likely that the immediate gain would be worth the potential reduction in land value. At the same time, it would ensure that the creation of new habitat yields at least some permanent environmental gain.

Sohn & Cohen, *supra* note 42, at 444-45. The use of a conservation ratio is unnecessary under a cap-and-trade system. *See supra* note 48. Thus, to the extent that the system uses a 1:1 conservation ratio but allows for the generation of allowances beyond the initial cap, Sohn and Cohen's suggestion translates to the formulation presented in the text.

52. Sohn & Cohen, *supra* note 42, at 444-45.

53. *See* Nash & Revesz, *supra* note 17, at 618-21.

[trading] system,"[54] a market in units of environmental degradation envisions the distribution of permits, each of which authorizes its holder to degrade the environment by a fixed amount. A polluter who seeks to increase its emissions would have to determine, using a computer model, those receptor points at which its increased emissions would cause increased pollutant concentrations. It then would have to obtain the proper number of permits to increase environmental degradation at each of the receptor points that its emissions adversely affected.

Markets in units of environmental degradation will minimize the problem of spatial differentiation,[55] but they suffer from four serious drawbacks. First, they involve substantial administrative costs.[56] Second, because the system involves multiple markets for fewer permits as opposed to a unified market for all permits, the various markets for degradation permits are more likely to suffer from the problem of "thinness," i.e., an insufficiently low number of market participants.[57] Third, because polluters likely will have to obtain permits on more than one market in order to increase pollution, there is a great likelihood that the various markets will be interlinked.[58] Fourth, an ambient permit system might give rise to the problem of "slack." Slack is the excess of the maximum allowable pollution at a given receptor point over the total amount of pollution authorized by permits in distribution.[59]

The third traditional response to spatial differentiation in the pollution context is to introduce a market in pollution offsets. Unlike the ambient permit setting, however, trades are, at least nominally, of emissions permits and not of degradation permits.

While pollution offset markets minimize the effects of spatial differentiation in pollution emissions, they too suffer from substantial drawbacks. The fact that permits authorize different holders to undertake different actions leads to heightened administrative and transaction costs. Furthermore, slack is again a problem under a pollution offset market system.[60]

B. Constrained Ambient Emissions Trading

Given the shortcomings of the three traditional refinements for pollution emissions trading, Revesz and I have proposed a different design for marketable permit schemes that will allow for control of local and regional pollutants without undermining the vitality of the permit market: a constrained ambient emissions trading system.[61] Our proposal relies upon a single market for emissions permits. Receptor points and acceptable pollution levels at all receptor points based, presumably, on concerns of health, welfare, justice, and practicality,[62] would be chosen. Approval of a trade of permits would require EPA's approval before the trade could be consummated. Approval would be forthcoming provided that emissions levels after the trade would not result in pollution concentrations in excess of acceptable levels at any receptor point.

Responsibility for grants and denials of approval would rest with a website,[63] which would harness a pollution dispersion model. All pertinent data regarding polluters and prospective polluters that the model required to predict pollutant concentrations—including emission locations, stack heights, temperature and velocity of emissions, and weather and topographical data—would be loaded onto the website. After verification that the initial allocation of permits would not result in unacceptably high pollutant concentrations, the website would await requests for approval of trades. In determining whether to grant approval for a trade, the website would modify temporarily its emissions data to reflect provisionally the shift in permit use. The website then would use the dispersion model to predict pollutant concentrations in the wake of the trade. If the model predicted that pollutant concentrations would be at or less than acceptable levels at all receptor points, then the website would grant approval for the trade and retain the modified emissions data. If, however, the model predicted that the pollutant concentration at any receptor point or points would exceed acceptable levels, then the website would reject the trade and revert to the pre-trade emissions data. Either way, the website then would be ready to consider requests for approval for other trades.

Revesz and I demonstrate that our proposal for a constrained emissions permit regime is preferable to other proposed refinements to trading systems in addressing the problem of spatial differentiation. First, unlike a multiple-trading zone system, our system will address the problem of spatial differentiation effectively.[64] Second, unlike other design approaches, our system retains relatively thick markets over time: other than the restriction that trades not give rise to improperly high pollutant concentrations at any receptor point, the system allows any permit holder to transact freely with any willing buyer.[65] Third, unlike a system of markets in environmental degradation, our system keeps administrative and transactions costs down by requiring the establishment and maintenance of only one market for permits.[66] Fourth, unlike markets in environmental degradation and pollution offset markets, our system does not introduce the problem of slack insofar as any actor who wishes to increase pollution emissions must obtain permits to do so.[67]

A constrained ambient emissions trading system can include in its design a feature to guard against temporal differentiation of emissions. Many extant emissions trading systems allow for the banking of permits. Banking allows permit holders who do not use permits in the year in which they were issued to use the permits in future years.[68] Permit bank-

54. *See id.* at 618.

55. The extent to which the effects of spatial differentiation are minimized will depend upon the fineness with which one structures the grid of receptor points, and the choice of acceptable pollutant concentration at each receptor point.

56. *Id.* at 619.

57. *Id.* at 619-20.

58. *See id.* at 621.

59. *Id.* at 623; *see id.* at 632 (noting that although the academic literature has focused on slack as a product of markets in pollution offsets, the problem also arises under markets in units of environmental degradation).

60. *Id.* at 624.

61. *See id.* at 624-28.

62. *See id.* at 654-55 and authorities cited therein.

63. *See id.* at 627 & n.320.

64. *See id.* at 629-30.

65. *See id.* at 630-31.

66. *See id.* at 631-32.

67. *See id.* at 632-33.

68. *See id.* at 660.

ing effectively allows for intertemporal trading of permits. A constrained ambient emissions trading system can guard against the problem of temporal differentiation that intertemporal trading of permits raises by setting up different emissions databases for different years. The system would constrain the use of banked permits, allowing their use only where the emissions would not lead to an ambient standard violation in that year.[69]

VII. Applicability of Pollution Emissions Refinements to Tradable Permit Systems in the Setting of Endangered Species Protection

A. Lessons From Traditional Refinements

A market in units of environmental degradation will only work in the species conservation context to the extent that there is accurate computer modeling capability. A computer model would be required to predict what effect the development at issue—taking into account existing development, habitat features, and other pertinent information—would have on species population.[70]

To the extent that the computer modeling is accurate,[71] the notion of a market in units of environmental degradation is superior to the habitat transaction method. The value of a plot of land would change over time based upon the effect of the plot upon species population, not simply external factors that may often, but not always, function as a proxy for species viability.

However, the use of computer models is not the only lesson that the air pollution emissions experience offers for trading in the context of biodiversity. The constrained emissions permit regime that Revesz and I have proposed offers a way to extend trading to ensure the preservation of multiple species and, in the end, ecosystems.

B. The Use of a Constrained Development Permit Regime to Achieve Ecosystem Protection

Ecosystem protection involves the protection of numerous species that coexist within the ecosystem. Some commentators have recommended methods by which the goal of ecosystem protection might be achieved simply by focusing legal regulation on the protection of a single species and its habitat—such as by protecting "keystone" species—a species that indicates whether the ecosystem itself survives or collapses—or by protecting the species with the largest habitat.[72] These methods use particular species as proxies for entire ecosystems. Such an approach might be more likely to achieve ecosystem protection than an approach that instead focuses on other species within an ecosystem. However, while the use of a proxy might facilitate trading, it also might frustrate the achievement of the ultimate goal by failing to protect ecosystems. In effect, the fact remains that indicator species population or, equally, the population of a species with a comparatively large habitat is the wrong currency for ecosystem protection.

A solution to the problem is to require landowners to consider the effects of their proposed development on the population of the numerous species that constitute the ecosystem. Were the government to proceed with a model based on markets in units of environmental degradation, this would require landowners to obtain sufficient permits to impair multiple species. Thus, the government would have to establish numerous markets in respect of each ecosystem—one market for each constituent species. However, such an approach reintroduces the complicating factor of

69. *See id.* at 660-61.

70. Computer population viability models are difficult to develop. Moreover, each species is likely to require a different model, calibrated to specific characteristics of the species and the habitat. Still, the development of these models is not pure science fiction. As Jacqueline Lesley Brown explains:

> According to [Edward O.] Wilson, ecologists someday may be able to predict diversity patterns in places where they do not currently exist and in groups of organisms that are currently few in number. Certain ecological principles should determine ecosystem development rules and statistical trends. Wilson points out that ecologists have recently developed a method to deduce the assembly rules of faunas and floras within their communities. These assembly rules reconstruct the sequence that adds species to a community when it comes into being. Some of the major landscape ecology and conservation biology principles that are applicable to ecosystem management include, "'hierarchy theory,' 'natural variability,' and 'coarse-filter conservation strategy.'" If those administering the endangered species program understand these ecological principles and patterns, they may be able to predict with reasonable accuracy how ecosystems will evolve in the future. This will enable regulators to create a predictable species preservation system.

Jacqueline Lesley Brown, *Preserving Species: The Endangered Species Act Versus Ecosystem Management Regime, Ecological and Political Considerations, and Recommendations for Reform*, 12 J. Envtl. L. & Litig. 151, 238-39 (1997). Robert Thornton further explains, in the context of the Stephens' kangaroo rat (SKR):

> Population viability models are also likely to take on increasing importance in the development of [habitat conservation plans (HCPs)]. Dr. Michael Gilpin of the University of California, San Diego, has recently released a population model concerning the SKR to assist in the design of the SKR reserves. These computer models offer the ability to quantitatively test common biological assumptions. Although the uncertainties inherent in the many assumptions in these models are significant, the models are a visually powerful tool and are likely to influence significantly HCP processes.

Robert D. Thornton, *Searching for Consensus and Predictability: Habitat Conservation Planning Under the Endangered Species Act of 1973*, 21 Envtl. L. 605, 651 n.151 (1991).

71. The viability of the system depends upon computer modeling. That modeling may be inaccurate in two ways. First, the data upon which the model is based might be flawed. Second, those who developed the model may have misinterpreted the data—or have insufficient data—such that the model's predictions are flawed.

72. *See* Holly Doremus, *Patching the Ark: Improving Legal Protection of Biological Diversity*, 18 Ecology L.Q. 265, 269-86 (1991). Holly Doremus explains:

> Introduction of a carefully considered system of priorities for listing species is the most important alteration which could be made to the ESA to enhance the protection of biological diversity. This change could be made administratively, with no need for new legislation. The FWS already has regulations setting listing priorities among species; they need only alter these priorities to more accurately reflect species' importance to their ecosystems.
>
> Listing priorities should be set on the basis of several factors. Keystone species, whose protection can maintain an entire community and whose loss can disrupt that entire community, should be given the highest priority. Indicator species, whose health tends to parallel that of the ecosystem, should also be treated in this category. Top predators should be given the next priority. Because large carnivores often require more contiguous undisturbed habitat than other species, their protection can indirectly protect those other, less demanding, species.

Id. at 329-30.

multiple coexistent markets that the shift from the air pollution setting to the single-species conservation setting had eliminated.

Because of the reemergence of multiple measures of environmental degradation, constrained permit trading regains its superiority over markets in units of environmental degradation. A constrained development permit regime, analogous to a constrained emissions permit regime, might be constructed as follows. A landowner could develop land only if he or she holds a development permit. The initial allocation of development permits would be loaded onto a computer website, along with all data necessary for a computer model to predict how development of various plots would affect the population of various species. At the outset, the website would use the model to verify that the population of all species would remain at or above the minimal viable level if the development permits were exercised according to their initial allocation.[73] The website then would await proposed trades.

A broker who arranged for a proposed trade would submit to the website the location of the buyer and seller. The website temporarily would modify its permit allocation data to reflect the trade, and then use the computer model to compare the effect of development species populations at the buyer's location with the effect at the seller's. If the model predicted that all populations would remain viable, the trade would be approved; the model would save permanently the revised permit allocation data and await future trade proposals. If, however, the model predicted that the population of any species would fall below viability in the wake of the trade, then the website would reject the trade; the model would revert to the unmodified permit allocation data, and await future trade proposals.

VIII. Conclusion

Despite calls for greater use of market mechanisms—and, in particular, tradable permit regimes—in the context of habitat protection, the basic tradable development rights model remains prevalent.[74] Part of the problem may be the difficulties that arise in designing an efficient trading regime that properly takes into account habitat and ecosystem protection. This Article suggests lessons and design innovations that might be taken from trading regimes in the air pollution context and used to construct a viable trading regime that achieves ecosystem protection.

There remain important ways in which trading in air pollution emissions and trading in development rights differ. In particular, the decision to emit an additional unit of pollution in one year generally does not preclude the same source from emitting units of pollution in future years subject to the requirement that the source have permits to cover all of its pollution emissions. In contrast, once a particular plot of land is developed, it will generally be quite costly to return the land to a state that is friendly to endangered species. In this sense, one would expect a market in development rights to be more illiquid than a comparably sized market in air pollution emission rights. Were the market too illiquid, the great benefit that a trading system offers over its command-and-control counterparts—cost-effective achievement of environmental goals—might be lost.[75] This illiquidity would prove even more of an obstacle under a trading system modeled on the constrained ambient air pollutant emissions trading system, insofar as such a system precludes some trades in which actors are willing to engage.

In the end, lack of liquidity may not prove to be an insurmountable problem. To the extent that it does, perhaps greater incentives to encourage returning land to a state that is ecosystem-friendly might be introduced. The potential benefits that a market-based system offers make it worthwhile to continue efforts to design effective trading programs for ecosystem protection.

73. Because it is possible that the environment would be damaged to the extent that it would not be at the minimal viable level or may be below the minimal viable level for the species population, one solution may be to undo existing development.

74. *See* Salzman & Ruhl, *supra* note 16, at 659-60 (survey of wetlands mitigation banking entities indicates that simple acre-based currencies continue to dominate, as long as regulatory framework supports trades based on gross wetland classes and fixed ratios).

75. *See* Nash & Revesz, *supra* note 17, at 617.