THE ROLE OF FEDERAL POLICY IN ESTABLISHING ECOSYSTEM SERVICE MARKETS

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ABSTRACT

The public good nature of ecosystem services has historically frustrated their inclusion within a traditional free-market framework. The inherent attributes of public goods—joint consumption and the inability to exclude users—vitiate incentives for their efficient provision and production through conventional markets. Government intervention typically has been necessary to correct this market failure with respect to other traditional public goods, such as law enforcement, national defense, and transportation infrastructure. Correspondingly, government intervention will be requisite in correcting market failures to supply ecosystem service public goods, such as climate regulation. The mechanisms by which government can correct these market failures are contingent upon the nature of the public good itself, and range from command-and-control approaches to market incentives. Where private good attributes are present, such as excludability and non-joint consumption, quasi-market incentives may be employed in concert with command-and-control strategies to supply a public good.

Climate regulation ecosystem services, especially those provided by forests, are unique in that carbon can act as a proxy of the services provided. Because carbon exhibits many private good attributes, market approaches can be employed to provide climate regulation services. However, while voluntary markets for ecosystem services

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currently exist in the United States, these are unlikely to produce an efficient level of the ecosystem service due to insufficient demand and the persistence of free-ridership problems. Government regulation will be necessary to complement these market approaches, establishing compliance markets that induce demand for ecosystem service proxies, set standards, and foreclose on free-ridership. Many ecosystem services are difficult or costly to measure directly, thus the government also must establish rigorous standards and guidelines to ensure the veracity of the proxies used. Using traditional public goods as a template, federal policy can help create private interests in commonly owned ecosystem services, fostering a vigorous, profitable exchange of goods and services while providing for the restoration and maintenance of the ecosystems that provide these services.

In the United States, natural systems currently offset roughly one-fifth of total carbon emissions, largely via forest sequestration. Maintaining and increasing this percentage is essential for the United States to meet its climate and energy goals. Thus, the federal role in this ecosystem service market must address both the direct goods traded from any individual ownership (tons of emissions reductions sequestered on a specific parcel of land) and the larger ecosystem (forests and other natural lands) that provide context and stability for the function of that parcel.

The federal government must establish policies mandating that:

> *1. The underlying regulatory structure of the markets established via "cap and trade" legislation includes forest and other land sequestration as part of that system;*
>
> *2. The "rules of the game" for the offset and trading market recognize that biological carbon regulatory compliance units, or RCUs (as opposed to voluntary offsets), are integrally dependent upon the ecosystem that provides them; and*
>
> *3. There is investment in securing the natural infrastructure of land that provides the basic "factory" producing these ecosystem services to the market.*

I. Introduction

To establish ecosystem markets, the government must develop systems to reconcile the often opposing forces of markets and the public trust. Ecosystem markets are distinguished by the fact they provide *private goods*, such as carbon emission reductions, that are premised on sustaining *public goods*, such as the climate regulation services provided by forest ecosystems. While largely voluntary in the United States to date, ecosystem service markets are unlikely to fully achieve the goals of either the market or the public good without federal structuring and standards. Federal policy can help create private property interests in commonly owned ecosystem services, fostering a vigorous, profitable exchange of goods and services while providing for the restoration and maintenance of the ecosystems that provide these services.

The advantages of using markets in combination with regulatory approaches to achieve public policy goals have emerged more clearly in the last two decades. Voluntary ecosystem service markets must evolve and adapt to a quasi-regulatory approach if the goals of both public policy and the market are to be fully realized. The federal role in this quasi-regulatory approach includes many of the same essential functions and partnering as other private-sector economies, such as law enforcement, transportation, education and energy. It also includes the establishment of standards to maintain the systems that provide these goods and services. Where ecosystem services arise on private lands, federal partnerships with the private-sector are key to the success of ecosystem markets. Government investment must be made in the development of the production capacity of these goods and services. Standards and guidelines regarding the services to be provided must be defined by the government to both reduce market risk and ensure consumer safety, but also to ensure that these take into account the viability of the ecosystem from which these services spring, not just the private service or good itself.

Of the various ecosystem services for which private market mechanisms are likely to prove effective, those relating to global climate stabilization hold considerable promise. In the United States, natural systems currently offset nearly one-fifth of total national emissions, largely via forest sequestration.[1] Maintaining and increasing this percentage is essential if the U.S. is to meet its climate goals. Tons of carbon emissions reductions can be used as a convenient proxy measurement for targets in achieving climate stabilization. Thus, the federal role in this ecosystem services market must address both the direct goods traded from individual ownership (tons of emissions reductions sequestered on a specific parcel of land) and the larger ecosystem (forests and other natural lands) that

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1. *See* U.S. ENVTL. PROT. AGENCY, INVENTORY OF GREENHOUSE GAS EMISSIONS AND SINKS: 1990–2007 ch. 7 ¶ 24 (2008).

provide context and stability for the function of that parcel.

More specifically, in order to realize the value of the ecosystem service of climate regulation, the federal government must establish policies mandating that:

1. The underlying regulatory structure of the markets established via "cap and trade" legislation includes forest and other land sequestration as part of that system;

2. The "rules of the game" for the offset and trading market recognize that biological carbon regulatory compliance units, or "RCUs" (as opposed to voluntary offsets), are integrally dependent upon the ecosystems that provides them; and

3. There is investment in the natural infrastructure that provides the basic "factory" producing these ecosystem services for the market.

In the first area, "cap and trade" legislation (be it trade, dividend or other) must fully include the role of natural systems as both essential actors for sequestration and sources of emissions. The legislation must also require accurate accounting for the transfers of carbon tons within and between emissions sectors that are linked, such as forests, which sequester carbon, and energy or transportation, which may utilize wood as a fuel source. Lastly, legislation must require accounting systems that reflect the carbon flows transmitted to or sequestered from the atmosphere, regardless of whether these are from capped (energy) or uncapped sectors (natural systems). Emissions reductions from natural systems should be fully tradable with those from other sectors once the accounting requirements, and the definitional and quality requirements noted below, are met.

In the second area, the essential role of the federal government is in defining the quality standards for a ton of emissions reductions such that these are fungible across all sectors. While much progress has been made in defining basic standards for voluntary offsets, such as with the Climate Action Reserve,[2] those for regulatory compliance, RCUs, will only be defined as regulatory programs such as California's AB 32 become established.[3] These RCUs will be used to meet any regulatory cap established to help stabilize climate, thus it is essential that they meet not only metrics for carbon within a specific site, but also reflect that such carbon tons are derived from sustained

2. CLIMATE ACTION RESERVE, FOREST PROJECT PROTOCOL 2–3 (Version 3.1 2009).

3. CAL HEALTH AND SAFETY CODE § 38550 (West 2009).

ecosystems that will endure sufficiently to meet climate stabilization goals over time.

The third proposed role for the federal government is a traditional one that involves sharing the cost of developing new markets, especially lowering the cost of capital by partnering to invest in necessary infrastructure development. Here the federal government should invest in securing and restoring the "factories" of ecosystems that provide essential sequestration services. This would be parallel to investments in the energy sector in which the government shares in the costs of building new physical infrastructure, such as generation facilities.[4] Given the major bifurcation in federal and private land ownership in the United States,[5] investment should be tailored to each ownership type and the threats to sequestration connected to each ownership type. The investments should be directed at addressing those threats. Hence, on federal lands, investments for climate should be focused on restoration that will maintain resilient, adaptive ecosystem carbon stocks. On private lands, federal investment should be helping prevent conversion of forests, especially via conservation easements. This will maintain the forestland base and the basis for sequestration. Overall, federal investment in ensuring the sequestration services of both public and private lands should be commensurate with the value of the net emissions reductions these lands provide.

This paper investigates the role of federal policy in establishing ecosystem service markets, focusing specifically on the establishment of markets for the climate change mitigation benefits conveyed by forests. It reviews the underlying economic theory behind the historic market treatment of forests and the services they provide, and uses this as a basis for elucidating the role of government in establishing an ecosystem service market for forest carbon. Part II introduces the science behind forests and climate change, and the ways in which forest management regimes can render forest ecosystems as either an asset or a liability with respect to global climate change. It addresses the services forests provide and investigates the manner in which these services have or have not been incorporated into traditional market frameworks and the implications of such treatment. Part III

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4. Joshua P. Fershee, *Misguided Energy: Why Recent Legislative, Regulatory, and Market Initiatives are Insufficient to Improve the US Energy Infrasatructure*, 44 HARV. J. ON LEGIS. 327, 347–48 (2007).

5. U.S. DEPT. OF AGRIC., FOREST SERV., GTR-NC-241, FOREST RESOURCES OF THE UNITED STATES, 2002 at 3 (2005).

explores the economic theory behind the provision and production of traditional public goods while Part IV uses this as a basis to inform future strategies for maximizing the climate services afforded by forests. Finally, parts V and VI draw upon the preceding analysis to articulate the role of the government in establishing an effective, robust ecosystem service market for forest climate benefits.

II. FORESTS AND CLIMATE

The warming of the global climate system has been recognized from observations of increased global average air and ocean temperatures, melting of snow and ice, and a rising global average sea level. Most of the increases in global average temperature since the mid-twentieth century have been attributed to rapidly increasing concentrations of anthropogenic greenhouse gases. Between 1970 and 2004, annual emissions of carbon dioxide, the most important anthropogenic greenhouse gas, increased by 80 percent.[6] Global atmospheric concentrations of carbon dioxide and other anthropogenic greenhouse gases have been increasing in the atmosphere since 1750, and now far exceed the atmospheric concentrations preceding industrialization. Unless strategies are pursued to abate emissions and mitigate atmospheric concentrations of greenhouse gases, a changing climate will increase the risk of disruption to ecological, social, and political systems across the globe.[7]

U.S. forests play an integral role in global climate regulation by reducing net greenhouse gas levels in the atmosphere. Together, the public and private lands that compose our domestic forests sequester and store about one-fifth of all U.S. greenhouse gas emissions annually.[8] Despite the tremendous value our forests provide in stemming climate change,[9] their continued ability to furnish these carbon sequestration services is not guaranteed, and in many cases is being undermined by a variety of market forces and public policies.[10]

6. Intergovernmental Panel on Climate Change, Working Groups I, II, and III to the Fourth Assessment Report of the IPCC, *Climate Change 2007: Synthesis Report,* ¶ 36 (Nov. 2007) (*prepared by* Rajendra K. Pachauri & Andy Reisinger).

7. *Id.* at 37.

8. *See* U.S. ENVTL. PROT. *supra* note 1, ch. 7 ¶ 24 (2008).

9. R.K. Dixon et al., *Carbon Pools and Flux of Global Forest Ecosystems*, 263 SCIENCE 185, 188 (1994).

10. *See* U.S. DEPT. OF AGRIC., FOREST SERV., PNW-GTR-797 FOREST-LAND CONVERSION, ECOSYSTEM SERVICES, AND ECONOMIC ISSUES FOR POLICY: A REVIEW 3 (2009); Christopher L. Lant, J.B. Ruhl & Steven E. Kraft, *The Tragedy of Ecosystem Services,* 58 BIOSCIENCE 969, 974 (2008).

U.S. public and private forests vary considerably in terms of ownership objectives, management histories, and current forest conditions.[11] As a result, each faces a related, but unique, suite of challenges that threaten their continued ability to sequester and store carbon.

A. Climate Duality of Forests

Forests have a dual role with respect to climate. As stated earlier, forest ecosystems sequester and store vast amounts of carbon when conserved, providing an important service in the regulation of global climate.[12] Conversely, when forests are disturbed, the carbon stored within these ecosystems is emitted, releasing greenhouse gases into the atmosphere.[13] Further, the consequences of forest conversion are not simply a discrete, one-time release of greenhouse gases into the atmosphere.[14] In addition to the emission of the biological carbon stored within forest ecosystems, conversion also sacrifices the future sequestration capacity of these ecosystems.[15] Hence, the conversion of forests both increases the quantity of greenhouse gases in the atmosphere, exacerbating global climate change, and undermines our ability to remove these gases from the atmosphere in the future.[16] Indeed, the historic clearing of global forests has vastly reduced our current global forest area, and is responsible for nearly 35 percent of total anthropogenic carbon emissions in the atmosphere today.[17]

Over 1.5 million acres of private U.S. forestland are lost to conversion and development annually, thereby emitting the biological

11. *See* U.S. DEPT. OF AGRIC., FOREST SERV., FS-874, INTERIM UPDATE OF THE 2000 RENEWABLE RESOURCES PLANNING ACT ASSESSMENT 28–29 (2007).

12. Dixon et al., *supra* note 9, at 188–89.

13. Kurt S. Pregitzer & Eugénie. S. Euskirchen, *Carbon Cycling and Storage in World Forests: Biome Patterns Related to Forest Age*, 10 GLOBAL CHANGE BIOLOGY 2052, 2052 (2004).

14. William R. Emanuel & George G. Killough, *Modeling Terrestrial Ecosystems in the Global Carbon-Cycle with Shifts in Carbon Storage Capacity by Land-Use Change*, 65 ECOLOGY 970, 978–79 (1984).

15. Andreas Fischlin et al., *Ecosystems, Their Properties, Goods, and Service,* CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY, CONTRIBUTIONS OF WORKING GROUP II TO THE FOURTH ASSESSMENT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 211, 221 (2007).

16. *Id.*

17. Jeanine M. Rhemtulla et al., *Historical Forest Baselines Reveal Potential for Continued Carbon Sequestration*, 106 PROC. NAT'L ACAD. SCI. 6082, 6082 (2009); *see also* R.A. Houghton, *The Annual Net Flux of Carbon to the Atmosphere from Changes in Land Use 1850–1990,* TELLUS 51B, 298 (1999).

carbon stored in these ecosystems and sacrificing the future sequestration potential of these lands.[18] Over the next half century, this trend is expected to continue, and an additional 50 to 75 million acres of private forestland are projected to be lost to conversion and development.[19] While afforestation and reforestation efforts may offset some of this loss, the climate benefits of newly planted forests cannot begin to replace the vast carbon storage and sequestration potential forgone when mature forests are converted.[20] As a consequence of earlier land use patterns on private lands, many forests are now characterized by younger stands, which store far less carbon than mature forests.[21] Allowing these forests to grow older will result in substantially greater stores over time, if they are allowed to remain as forest.[22]

Public forests, while composing roughly one-third of the total U.S. forestland, store substantially more carbon per acre on average than do private forests. These public forests are the cornerstone of the United States' ability to combat climate change through biological sequestration.[23] However, with the exacerbation of forest stressors posed by a changing climate, public forests and their attendant carbon stocks are also at increasing risk of disturbance and emission.[24] Ensuring the ongoing robustness and resilience of public forests, and capitalizing on the vast untapped carbon storage potential of the remaining private forestlands, which account for nearly 60 percent of all domestic forestlands, will be critical to addressing climate change.[25]

B. Ecosystem Services

The carbon sequestration provided by our nation's forests is an example of an ecosystem service. Ecosystem services have been

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18. U.S. DEPT. OF AGRIC., FOREST SERV., FS-874*., supra* note 11, at 20 (23 million acres converted between 1982 and 1997, or 1.5 million annually).

19. *See id.* at 5.

20. Sebastian Luyssaert et al., *Old-Growth Forests as Global Carbon Sinks*, 455 NATURE 213, 213 (2008).

21. *See* Jeanine M. Rhemtulla et al., *supra* note 17, 6082.

22. *See id.*

23. Richard Birdsey et al., *Mitigation Activities in the Forest Sector to Reduce Emissions and Enhance Sinks of Greenhouse Gases, in* U.S. DEPT. OF AGRIC., FOREST SERV., RMRS-GTR-59, THE IMPACT OF CLIMATE CHANGE ON AMERICA'S FORESTS: A TECHNICAL DOCUMENT SUPPORTING THE 2000 USDA FOREST SERVICE RPA ASSESSMENT 112, 112 (2000).

24. Constance I. Millar et al., *Climate Change and Forests of the Future: Managing in the Face of Uncertainty*, 17 ECOLOGY APPLICATIONS 2145, 2149–50 (2007).

25. *See e.g.*, Jeanine M. Rhemtulla et al., *supra* note 17, at 6084–85.

broadly defined as the processes of ecosystems that directly or indirectly support human wellbeing.[26] These services may be grouped into four broad categories according to the functions they perform: regulation, habitat, production, and information functions.[27] Regulation functions relate to the capacity of ecosystems to regulate essential ecological processes, such as the regulation of global climate, through bio-geochemical and biospheric processes. In addition to maintaining ecosystem and biosphere health, regulation functions provide substantial direct and indirect benefits to humans, such as clean air, water, soil, and biological control services.[28] Habitat functions refer to the services ecosystems offer in the provision of refuge and reproductive habitat for flora and fauna, the conservation of evolutionary processes, and biological and genetic diversity.[29] Production functions pertain to the creation of ecosystem goods through photosynthesis and nutrient uptake by autotrophs. These functions create a wide variety of carbohydrate structures, many of which provide goods for human consumption, ranging from food to raw materials to energy resources.[30] Information functions refer to the maintenance of human health that ecosystems offer through the provision of opportunities for recreation, cognitive development, aesthetic experiences and spiritual enrichment.[31]

While all of these services are important, regulation functions are essential to a healthy, functioning biosphere, and are therefore necessary for the maintenance of all other ecosystem functions. In the context of climate change, the regulation functions provided by the atmosphere and ecosystems like forests are of critical importance to the overall health and functioning of the global biosphere. Because the maintenance of global climate is a regulation function, the diminishment of climate services through the continued concentration of atmospheric carbon has implications for the other ecosystems functions contingent upon climate regulation.[32]

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26. *See, e.g.*, Marc Levy et al., *Ecosystems and Human Well-Being: Current State and Trends*, 1 ECOSYSTEMS & HUMAN WELL-BEING 123 (2005).

27. 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).

28. *Id.* at 396–97.

29. *Id.* at 395.

30. *Id.*

31. *Id.*

32. *Id.* at 396.

C. An Intersection of "Tragedies"

While production functions generally result in the creation of discrete, easily commoditized ecosystem goods, such as timber and mineral resources, regulation functions provide services that are less concrete in nature, and do not lend themselves to ready quantification or exchange in the traditional marketplace. As a result, conventional markets often fail to efficiently and cost-effectively support the services arising from regulation functions, leading instead to the degradation and destruction of these services in favor of production functions.[33] The market failure of forest ecosystem services is even more unique, however, because it falls at the intersection of two distinct environmental "tragedies": A lack of internalized positive *and* negative externalities.

1. The "Tragedy of the Commons"

Degradation of the global climate is a classic example of Garrett Hardin's "tragedy of the commons."[34] While Hardin's definition of the "commons" has since been clarified as actually describing "open-access" resources, this seminal work has catalyzed the analysis of market failure in the context of common-pool resources such as the atmosphere.[35] The "tragedy" to which Hardin referred was that of an *open-access resource*, where property rights to moderate resource usage were poorly developed or non-existent.[36] This is distinct from a *commons*, which refers to a property rights regime that determines the rules by which a community may access and use a common-pool resource.[37] In the absence of common property laws, a common-pool resource like the atmosphere becomes an open-access resource, which can be exploited to collapse. This destruction is the inevitable outcome Hardin describes as resulting from the "remorseless working of things."[38]

Open-access resources are characterized by non-excludability and subtractability. The first characteristic, that of non-excludability, refers to the difficulty inherent in excluding users from an open-

33. Franz W. Gatzweiler, *Organizing a Public Ecosystem Service Economy for Sustaining Biodiversity,* 59 ECOLOGICAL ECON. 296, 298–99 (2005).

34. Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243, 1243–48 (1968).

35. ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION (Cambridge University Press, 1990).

36. *Id.*

37. Lant, Ruhl, & Kraft, *supra* note 10, at 969.

38. Hardin, *supra* note 34, at 1244; Lant, Ruhl, & Kraft, *supra* note 10, at 969.

access resource.[39] The second characteristic, subtractability, refers to the diminishment (or subtraction) of value that the exploitation of an open-access resource by one user incurs for other users.[40] Emitting carbon is an example of using an open-access resource, namely, using the atmosphere as a waste receptacle.

Because of the amorphous nature of many ecosystem services, quantification of value in reliable, discrete terms is often difficult. This frustrates the ability to clearly define property rights governing the use of an environmental resource, and the subsequent assignment of pecuniary value to harms and benefits associated with its use. Without a defined value or property right, excluding users or holding them accountable for their use can be difficult or impossible. Consequently, conventional markets are unable to accurately account for the costs and benefits associated with open-access resources, and tend to fail with respect to an efficient allocation of resource use.[41]

2. Externalized Costs

Though the parties responsible for using an open-access resource may not incur the costs of their resource use, their actions certainly do have costs. Currently, society at large bears these costs in the form of reduced air quality and a disruption of global climate regulation services. These externalized costs, or *negative externalities*, are borne by outside parties while the resource user exclusively enjoys the benefits derived from the externality-inducing activity.[42] In the absence of regulation, emitters may freely use the atmosphere as a medium to dispose of waste emissions. The atmosphere as an open-access resource exhibits partial subtractability in this respect; when one group of users utilizes it as a repository for waste emissions, its utility may be diminished for other uses. Society at large, which relies on the atmosphere as a resource to maintain air quality and provide key ecosystem services like climate regulation, finds these other use values marginalized by excessive emissions. Yet, because the

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39. Vincent Ostrom & Elinor Ostrom, *Public Goods and Public Choices*, *in*: POLYCENTRICITY AND LOCAL PUBLIC ECONOMIES (Michael D. McGinnis, ed., University of Michigan Press 1999).

40. Elinor Ostrom et al., *Revisiting The Commons: Local Lessons, Global Challenges*, 284 SCIENCE 278, 278–79 (1999); OSTROM & OSTROM, *supra* note 39; Thomas Dietz et al., *The Struggle to Govern the Commons,* 302 SCIENCE 1907, 1907 (2003).

41. Daniel C. Esty, *Revitalizing Environmental Federalism,* 95 MICH. L. REV. 570, 577–84 (1996).

42. ARTHUR C. PIGOU, THE ECONOMICS OF WELFARE, 174, 183–188 (Macmillan and Co., 4th ed. 1932) (1920).

externalized costs of greenhouse gas emissions are currently omitted from the economic calculus of individual emitters, the market dictates overuse of the resource as a waste-storage medium.[43] As a result, even if the costs society collectively bears in terms of reduced air quality and diminished climate regulation exceed the individual benefits emitters enjoy, there is no incentive to limit emissions because the responsible actors only bear a fraction of the social marginal cost. Consequently, markets are unable to achieve allocative (Pareto) efficiency in the face of externalities, thereby failing to maximize total social welfare and leading to market failure.[44] Hardin's tragedy is that of externalized costs.[45]

3. Externalized Benefits

While the tragedy of open-access resources articulated by Hardin arises from the externalization of each user's cost of using a resource, externalities are not limited solely to the unaccounted costs of an activity.[46] The failure to internalize external benefits, or *positive externalities*, of an activity within the cost calculus has been recognized as leading to a related, albeit distinct, type of market failure. Where positive externalities occur, the beneficiaries of a service enjoy that service without compensating those responsible for its production.[47] Ecosystem services are a classic example of the type of benefits markets fail to provide efficiently. Due to the often amorphous nature of ecosystem services and the difficulty in quantifying them, their benefits frequently are externalized from the economic calculus. In an encomium to Hardin's seminal thesis, the consequent underproduction of the services arising from this market failure has been described as the "tragedy of ecosystem services."[48] This tragedy is that of externalized benefits.

Forestland management decisions are unique in that they occur at the intersection of these tragedies, creating both positive and negative externalities with regard to global climate. Forest ecosystems sequester carbon when conserved and emit carbon when

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43. Carol M. Rose, *Rethinking Environmental Controls: Management Strategies for Common Resources*, 1991 DUKE L.J. 1, 5 (1991).

44. Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347, 348–49 (1967).

45. *See* Lant, Ruhl, & Kraft, *supra* note 10, at 970.

46. *See id.*

47. *Id.* at 971.

48. *Id.*

converted, meaning that forests can act either to the benefit or detriment of the global community for climate regulation. However, because private landowners currently have no means by which to seek recompense for the carbon sequestration their lands provide, society currently is able to "free-ride" on these benefits, enjoying their value but not sharing in the costs of their production.[49] Correspondingly, just as these positive climate externalities are not currently included in the cost calculus of forestland management, neither are the negative externalities arising from forest management. When forests are overharvested, or converted and developed to other uses, the carbon stored in these ecosystems is emitted to the atmosphere, contributing to global climate change and the tragedy of open-access resources that befalls the atmosphere. Society collectively bears the costs of these actions in the form of heightened levels of atmospheric carbon and diminished biological carbon sequestration capacity while the landowner enjoys the exclusive benefits that accrue from these actions.

D. Averting Tragedy: Correcting Market Failure

Correcting these market failures turns on the ability to bring externalized costs and benefits to bear on the parties responsible. Even in the absence of clearly defined property rights, such as is the case with open-access resources, negotiation can yield an economically efficient allocation of resources.[50] Bargaining among affected parties can allow externalized costs to be included within the economic cost calculus, resulting in an internalization of costs and allowing the free market to dictate an efficient outcome regardless of each party's liability.[51] However, arriving at an efficient outcome requires the negotiation of each party affected, a proposition that includes costs. As the number of affected parties increases, the administrative costs involved in negotiation between all necessary actors may quickly become prohibitively expensive. Even when all parties can be brought to the table, rent seeking and other strategic behavior can vastly inflate the costs of negotiating an optimal outcome.[52] Additionally, there may be little incentive for responsible

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49. *See* Trista M. Patterson & Dana L. Coelho, *Ecosystem Services: Foundations, Opportunities, and Challenges for the Forest Products Sector*, 257 FOREST ECOLOGY & MGMT. 1637, 1639 (2009).

50. *See* Ronald H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1, 7 (1960).

51. *See id.* at 7–8.

52. *See id.* at 20.

parties to voluntarily enter into negotiations to internalize costs that would otherwise remain externalized.[53] Due to the foregoing factors as well as costs associated with the subsequent policing and enforcement of such agreements, the negotiation of an optimal agreement may become very costly for private actors to undertake. These collective costs are termed "transaction costs," and may exceed the benefits derived by internalization, leaving affected parties little choice but to bear these externalized costs.[54] In instances like climate change, where externalities affect a global constituency, the sheer number of stakeholders overwhelms the ability of collective bargaining to achieve resolution, and some degree of government intervention is necessary to correct this market failure.[55]

E. Private and Public Goods

1. Private Goods

Because the climate costs and benefits of forest management have yet to be monetized, they continue to be externalized from the economic calculus.[56] As a result, the market can be expected to induce private forestlands to overproduce activities that create negative climate externalities and underproduce activities that create positive externalities. Because forest landowners generally receive no compensation for the production of regulation functions, their lands are often developed to produce goods with clear, monetized market benefits. These items are the result of the production function services provided by ecosystems, and are known as *private goods*.[57] Private forest goods include traditional commodities, such as timber and property development, and are characterized by excludability, which refers to the ability to control the use of a good or resource, and subtractability, which denotes the diminishment in value one user incurs for all other users of the resource.[58] These characteristics allow private goods to be valued readily and easily exchanged in the marketplace.

53. Esty, *supra* note 41, at 591.
54. Demsetz, *supra* note 44, at 349.
55. *See* Esty, *supra* note 41, at 638, 652.
56. *See* Lant, Ruhl, & Kraft, *supra* note 10, at 972.
57. OSTROM & OSTROM, *supra* note 39, at 77–78.
58. *Id*.

2. Public Goods

In contrast to private goods, climate regulation and other ecosystem services cannot be easily quantified or monetized for ready inclusion within the marketplace. The benefits derived from these services are neither easily excludable nor subtractable; rather, the carbon sequestration benefits forests provide are enjoyed by all of society through the maintenance of a well-regulated climate. Items of this nature are termed *public goods*.[59] While demand exists for the provision of public goods and the protection of the public trust, the inability to exclude users and extract compensation for the production of a public good means that no incentives exist for the market to produce these goods. The dedication of lands to the production of private goods is further perpetuated by an inherent bias in U.S. common law against leaving land in an undeveloped state, deterring any remaining incentive for property owners to manage their lands for the provision of ecosystem services.[60] This arises from an inherent utilitarian premise in common law that the development of resources invariably puts land to better and higher use, thereby maximizing social welfare.[61] This results from the law's premise that the value of best possible land use options will be reflected accurately in monetary terms.[62] Beyond merely disincentivizing the retention of ecosystem services on private lands, common law correspondingly offers few options to redress those harmed from the loss of ecosystem services. Because ecosystem services are not recognized under common property law, beneficiaries have no legal recourse when these services are lost.[63] As a result, governments must intervene to correct the market's failure in providing traditional public goods, such as public education, national defense, law enforcement, medical research, national transportation infrastructure, or the establishment of natural reserves such as parks, national forests or wildlife refuges.

59. OSTROM & OSTROM, *supra* note 39, at 75–76. Public goods were first formally described by Paul A. Samuelson in *The Pure Theory of Public Expenditure,* 36 REV. ECON. & STAT. 387, 389 (1954).

60. *See* John G. Sprankling, *The Antiwilderness Bias in American Property Law*, 63 U. CHI. L. REV. 519, 590 (1996).

61. Lant, Ruhl, & Kraft, *supra* note 10, at 972.

62. *Id*.

63. J.B. RUHL ET AL., THE LAW AND POLICY OF ECOSYSTEM SERVICES, 108–109 (2007).

III. ORGANIZING PUBLIC ECONOMIES

Goods and services are generally conceived of as occurring on a spectrum of excludability and subtractability. Those that are perfectly excludable and subtractable are termed *pure private goods*, while those that are perfectly non-excludable and non-subtractable are described as *pure public goods*.[64] In reality, most goods and services occupy a position somewhere between these extremes. These characteristics are important in determining the most effective means of providing and producing a particular good or service. Items that tend to be more reminiscent of pure private goods are easily provided for and produced by the market. Conversely, as items become more of a public good in nature, they become increasingly more difficult to provide through traditional markets. Because the exclusion of users is infeasible for public goods, markets for these goods break down on the demand side, where users are unwilling to pay for something that freely accrues to them. Cost-minimizing users have little incentive to contribute their share to supplying a good when they can continue enjoying it free of cost.[65] Even if voluntary efforts to produce the good exist, the persistence of this free-ridership problem means that voluntary efforts are unlikely to produce a satisfactory amount of the public good.

To compensate for the market's inability to produce public goods, some form of collective action is necessary whereby beneficiaries are induced to pay their proportionate share for the production of the good while sanctions can be used to foreclose on free-riders. Because no market demand exists for a non-excludable public good, government intervention is needed to induce the supply of this good through the creation of a *collective consumption unit*.[66] Collective consumption units are authoritative entities established to provide demand for a public good and levy compulsory assessments, taxes or user charges to ensure beneficiaries provide their proportionate share in the production of the public good. An appropriate collective consumption unit is designed to include the beneficiaries of a public good within its boundaries while excluding

64. OSTROM & OSTROM, *supra* note 39, at 77.
65. *Id.* at 80–81.
66. *Id.* at 83.

those who do not benefit.[67]

Once established, collective consumption units must make decisions over the provision and production of the good or service. Provision choices refer to the decisions over whether to provide the good at all, while production specifications refer to the actual processes involved in the creation of the good.[68] Provision decisions affect the type, quantity and quality of goods and services furnished to the public, the type and degree of private regulation necessary, and the amount and type of revenue to be raised (e.g., taxes, bond measures).[69] Once these decisions are established, the production aspect, or the actual technical processes by which the goods and services will be made, must be specified. Unlike private goods, where the price conveys information about the demand for that good, tax-supported expenditures convey little about the beneficiaries' preferences—except their willingness to comply with tax laws rather than face incarceration.[70] Consequently, collective consumption units must create alternate means of articulating user preferences over the provision of a public good.

Once the provision decisions are made regarding the type and quantity of a public good to be supplied, a production unit must be established to aggregate technical factors of production to meet the provision specifications articulated by the collective consumption unit. The organization of a production unit may occur in a variety of arrangements. A collective consumption unit might vertically integrate and operate its own production unit (e.g., a municipality with its own fire or police department).[71] Alternatively, it might contract with external private vendors in the production of the public good (e.g., a municipality that contracts with a private firm for snow removal services).[72] In another scenario, a collective consumption unit might not organize a production unit at all, but, rather, establish service standards for the provision of a public good and relegate discretion for the production of that public good to consumers (e.g., a municipality that licenses refuse collection firms, but leaves it to the consumer to choose a private vendor and purchase service).[73] Where

67. Esty, *supra* note 41, at 587–597.

68. OSTROM & OSTROM, *supra* note 39, at 86

69. Gatzweiler, *supra* note 33, at 300.

70. OSTROM & OSTROM, *supra* note 39, at 84.

71. *Id.* at 85.

72. *Id.*

73. *Id.*

a collective consumption unit does not establish an in-house production unit, the organization of a public economy may encompass multiple autonomous parts, comprising various levels of government, private enterprises and voluntary associations.[74] Under such circumstances, the government itself does not serve individual citizens. Rather, public goods are produced by a variety of different public service industries, such as the police industry, the education industry, the water industry, the fire protection industry, the welfare industry, the health services industry, the transportation industry, and others. While the role of the government will vary in the production unit of each public-service industry, most will have important private components.

Organizing the provision and production factors of ecosystem public goods, however, differs from that of traditional public goods. Here the choice to provide an ecosystem service typically does not need to be made; it is already provided by the ecosystem. Thus, the provision decision entails determining of whether to *continue* providing the good through the maintenance of the ecosystem that produces it.[75] However, in contrast to traditional public goods, the provision decisions governing ecosystem public goods often are not directly made by a public body. Rather, the amount and quality of a particular ecosystem service is dictated by the management decisions made on the lands that provide it. This means that the decision of whether to provide a public service largely remains in the hands of private resource managers.[76] This is indeed the case concerning U.S. forests, where private landholdings compose more than half of all domestic forestland.[77] Further complexity is inherent, due to the fact that ecosystem services are provided across ecosystems, which span property and political boundaries. Thus, decisions regarding the provision of ecosystem services must transcend political boundaries to be made at the scale in which they operate.

IV. STRATEGIES FOR OVERCOMING MARKET FAILURES

The tragedy of open-access resources is a failure to account for negative externalities, while the tragedy of ecosystem services is a failure to internalize positive externalities. The emerging challenge

74. *Id.* at 87–88
75. Gatzweiler, *supra* note 33, at 300.
76. Lant, Ruhl, & Kraft, *supra* note 10, at 972.
77. *See* U.S. DEPT. OF AGRIC., INTERIM UPDATE 2000, *supra* note 11, at 27.

then becomes internalizing these costs and benefits within the economic calculus to correct the failure of the market to prevent resource use that perpetuates both tragedies. Correcting these market failures will necessitate the internalization of *both* externalized costs and benefits, and will require: (1) inducing the provision of a public good when the provision decisions and factors of production largely are privately controlled; and (2) the creation of disincentives for activities that cause climate harm through the emission of carbon. Government has traditionally played the role of correcting these market failures, and will again be critical to doing so in the context of forests and climate.

Governments can approach the correction of market failures in several ways. The policy instruments for achieving environmental objectives are typically bifurcated into two categories: regulatory, "command-and-control" approaches, and market or incentive-based mechanisms.[78] Regulatory approaches provide firms with little flexibility, specifying compliance strategies for achieving a rigidly defined environmental benchmark.[79] In contrast, market strategies provide firms with incentives to achieve a sustained level of environmental progress and offer great flexibility in compliance approaches.[80] Under a purely regulatory regime, desired behavior is specified through a command-and-control approach, and compliance standards and methodologies are explicitly defined by a regulatory body. Alternatively, market regimes take steps to valuate and monetize ecosystem benefits and harms previously externalized, allowing policymakers to harness the market in correcting behavior. Disincentives are created to internalize the costs of socially undesirable behavior while externalized benefits are recognized and monetized to incentivize desirable behavior. Historically, environmental policy has utilized both of these approaches, or, depending upon the particular scenario, a combination of the two.[81]

The advantages inherent to market approaches over command-and-control policies have long been described, and include efficiency, transparency, cost-effectiveness, and the ability to foster investment

78. Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law: The Democratic Case for Market Incentives*, 13 COLUM. J. ENVTL. L. 171 (1988).

79. Richard B. Stewart, *Controlling Environmental Risks through Economic Incentives*, 13 COLUM. J. ENVTL. L. 155 (1988).

80. Robert W. Hahn & Robert N. Stavins, *Economic Incentives for Environmental Protection: Integrating Theory and Practice,* 82 AM. ECON. REV. 464, 465 (1992).

81. *See id.* at 465–67.

and innovation.[82] Unlike command-and-control approaches, where behavior is mandated, market approaches allow individual firms to select an appropriate level of environmentally desirable behavior. Rather than specifying required behavior via external bureaucratic directives, market strategies retain operating decisions in the hands of those who are best qualified to make them—the affected firms. Under a market strategy, each firm is enabled to pursue its most cost-effective level of environmental progress, equating abatement costs on the margin and achieving a given level of environmental quality for the least cost.[83] While this latitude in compliance means that market approaches may not be as suitable for threshold damage functions with highly localized damages, market-based approaches are particularly suited in instances where more uniform mixing of pollution occurs over larger geographic areas, such as in climate change.[84]

The most effective approach depends on the nature of the good or service to be provided. In instances where the organization of a public economy has private good attributes, a quasi-market scheme can be developed in concert with more traditional regulatory schemes.

Regulations can be used to establish regulatory targets, program rules and enforcement mechanisms while a market framework can allow for efficiency in complying with these targets and create incentives for regulated entities to go beyond mere compliance obligations. This approach has been the basis for sulfur dioxide and nitrous dioxide markets established under the Clean Air Act.[85] Both the market reward and the regulatory punishment are critical to the success of these markets, as one reinforces the other and clear enforcement provides certainty and demand.

Additional financial mechanisms, such as subsidies, grants and tax measures also can be used to correct incentive alignment and induce desired behavior, complementing the regulatory and direct market approaches. The ownership pattern of private forestlands is such that, for the climate market, such mechanisms may be essential to correct the market preference for large suppliers. Over 10 million private parties own forestland in the US, but only about 9,000 of them

82. *See* Stewart, *supra* note 79, at 155; *see also* Ackerman & Stewart, *supra* note 78, at 171.

83. *See* Richard G. Newell & Robert N. Stavins, *Cost Heterogeneity and the Potential Savings from Market-Based Policies*, 23 J. REG. ECON. 43, 49 (2003).

84. Hahn & Stavins, *supra* note 80, at 465.

85. Clean Air Act of 1990, 42 U.S.C. § 7651 (1995).

have properties totaling 10,000 acres or more.[86] In such cases, prior experience shows that shifting small landowner behavior toward providing public goods (such as for habitat or water quality) have been largely effected through grants and subsidies.[87]

V. THE ROLE OF GOVERNMENT

That some vein of government intervention is necessary to correct the market failures affecting forests and climate change has certainly been established above. The specific means that the government must take, however, must still be discussed. To correct these market failures, the role of the federal government will be tripartite, and will require:

Inducement of demand for carbon through the underlying regulatory structure of the markets via cap-and-trade legislation that includes forest and other land sequestration as part of the system;

Definition of the "rules of the game" for the offset and trading market, including a definition of biological carbon compliance units that recognizes the integrity of the ecosystem in which they are embedded; and

Investment in the foundational infrastructure that provides the basic services necessary to bring these "ecosystem services" to market.

A. Establishment of National Emissions Targets

The public good nature of ecosystem services has historically frustrated their provision through traditional markets. Given their amorphous nature, the difficulty in quantifying, valuating and monetizing these services obstructs their ready inclusion in the market.[88] Climate regulation is the most likely to prove amenable to the type of quantification and valuation that will allow monetization. The quantity of carbon contained within a forest ecosystem is relatively straightforward to determine. Forest growth rates can be used to determine carbon sequestration, while levels of carbon

86. Brett J. Butler, *Family Forest Owners of the United States, 2006, in* Gen. Tech. Rep. NRS-27 at 55 (2008).

87. *See* Patrick Sullivan, et al., *The Conservation Reserve Program: Economic Implications for Rural America*, Agric. Econ. Report No. 834 (2004).

88. *See generally*, NAT'L CTR. FOR ENVTL. ECON., U.S. ENVTL. PROT. AGENCY, INTERNATIONAL EXPERIENCES WITH ECONOMIC INCENTIVES FOR PROTECTING THE ENVIRONMENT 1–5 (2004) (noting the difficulty in calculating the level of taxes, subsidies and other environmental programs necessary to capture the true cost of pollution).

storage can be calculated from the total volume of on-site biomass.[89] Thus, carbon may act as an accurate and easily quantifiable proxy[90] for the climate regulation services provided by forests, and therefore allows inclusion within a market framework. Inventorying extant carbon and then monitoring the flux of carbon in and out of a forest ecosystem can allow for an accounting of the positive and negative effects of forest management on the climate regulation ecosystem.[91] This would provide a basis for incorporating climate considerations into forest management decisions. Despite the ready quantification of carbon, its value in climate regulation has yet to be incorporated into the economic calculus beyond incipient, voluntary carbon markets. While voluntary markets have been assistive in the development of inchoate carbon markets, a lesson stressed by economists is particularly apropos: consumers are unlikely to pay for something they can get for free.[92] Consequently, voluntary approaches like donations or non-compliance offset markets have resulted in an undervaluation of carbon.[93]

While carbon may present a strong, albeit imperfect, proxy for the incorporation of forest climate regulation services into the market, this by itself does not induce demand for carbon as a good. For public ecosystem goods whose enjoyment is related to the consumption of a private good, such as the protection of watersheds for the provision of clean water, externalized costs and benefits related to the public good can be internalized into the price of the private good for which clear demand already exists (e.g., payments to landowners protecting watershed lands financed via a tax levied on the cost of drinking water).[94] Because the enjoyment of the benefits of forest climate regulation are not associated with the pre-existing consumption of a private good, they remain un-excludable, and

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89. ZACH WILLEY & BILL CHAMEIDES, HARNESSING FARMS AND FORESTS IN THE LOW-CARBON ECONOMY: HOW TO CREATE, MEASURE, AND VERIFY GREENHOUSE GAS OFFSETS 56–57 (2007).

90. While carbon itself can provide a proxy for the climate benefits conveyed by a forest ecosystem, a proxy is by nature a simplified indicator. The climate benefits forests afford depend on a complex, ecologically resilient ecosystem; protocols for quantifying forest climate benefits must include parameters that account for the ecological integrity of ecosystems, not merely coarse quantities of carbon.

91. *See* ZACH WILLEY & BILL CHAMEIDES, *supra* note 89, at 55–57.

92. B. Kelsey Jack et al., *Designing Payments for Ecosystem Services: Lessons from Previous Experience with Incentive-Based Mechanisms,* 105 PROC. NAT'L ACAD. SCI. 9465, 9468 (2008).

93. *Id*.

94. *See id.*

therefore lack demand even when quantification is possible. Consequently, compulsory mechanisms for demand generation are necessary to valuate and create a market for carbon.[95]

Congress is currently in the process of considering several different pieces of legislation to create compulsory mechanisms for carbon demand generation.[96] These mechanisms would internalize the climate harms caused by carbon emissions through the establishment of a national cap on emissions that contribute to global climate change.[97] This policy would limit, or "cap," the total amount of emissions allowable from the U.S. economy, and require emitters to purchase carbon emission allowances for the emissions they produce.[98] The level of the emissions cap would be controlled simply by the quantity of allowances made available.

In contrast to a purely command-and-control strategy, a cap-and-trade approach leverages the ability of the market to achieve emissions reductions at the least cost by allowing firms to equate compliance costs on the margin.[99] Cap-and-trade enables emitters to comply with an emissions cap either by undertaking emissions reductions in-house, or by purchasing emissions allowances from other entities. Firms would be expected to reduce emissions in-house until the marginal cost of abatement exceeded the price of a carbon emission allowance—at which point carbon emission allowances would be purchased to cover the remainder of emissions.

By allowing allowance trading and the participation of entities not included under the cap in the creation of emissions reductions, a cap-and-trade regime enables those with the lowest abatement costs to reduce emissions. This produces incentives for entities to innovate new and more effective means of creating emissions reductions—incentives that would not exist if a purely command-and-control approach had been taken. Under a cap-and-trade regime, demand for activities that sequester and store carbon, such as forest conservation, could be used to compensate landowners for the previously externalized carbon sequestration value of their land. Incentivizing these activities would induce the provision and production of public ecosystem service goods, such as the climate

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95. *See id*.

96. *See, e.g.*, American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009); The Clean Energy Jobs and American Power Act, S.1733, 111th Cong. (2009).

97. *See id.* § 311, *et seq.* (HR 2454).

98. *See id.* § 311, *et seq.* (HR 2454).

99. *See* Hahn & Stavins, *supra* note 80, at 464–465.

regulation benefits of forests, where decisions are under private management. Further, influencing the ecosystem service factors of provision and production through incentives, rather than regulation, is far more politically tractable than command-and-control regulation. This is because landowners are much more likely to embrace financial payments for the provision of these services, and a market approach to influencing behavior on private lands is far simpler than a regulatory approach, where federalism reserves primary regulatory land use for state and local governments.[100]

B. Establishment of Program Rules

By definition, public goods are inherently difficult to quantify and monetize. This characteristic has inhibited their inclusion in the marketplace and resulted in their subsequent underprovision.[101] Finding methods by which to include these ecosystem service benefits within the market can assist in correcting this market failure. In many respects, climate regulation is unique from other ecosystem services in that carbon can be used as an indicator of the climate regulation services provided by a particular ecosystem. Biological carbon may be quantified with relative ease, providing a means for valuating and including climate regulation ecosystem services within a traditional market framework. Forests and other carbon emissions sectors that can produce credible emissions reductions above a business-as-usual baseline may be incorporated into the market through the creation of a carbon "offset" program that monetizes ecosystem climate benefits.[102] These offsets would provide guaranteed carbon emission reductions, and could be used for compliance in lieu of emission allowances under a cap-and-trade program. Because offsets are premised on a reduction of atmospheric carbon functionally equivalent to the emissions they counteract, offsets are theoretically fungible with allowances. As a result, emitting entities may use offsets for compliance without eroding the integrity of the overall emissions cap.

While carbon offers a suitable private good proxy for some measure of the public good climate regulation services provided by forests, carbon itself is only a proxy, which is, by its nature, a

100. Blake Hudson & Erika S. Weinthal, *Seeing the Global Forest for the Trees: How US Federalism can Coexist with Global Governance of Forests*, 1 J. NAT. RESOURCES POL'Y RES. 353, 353 (2009).

101. OSTROM & OSTROM, *supra* note 39, at 81.

102. *See* Patterson & Coelho, *supra* note 49, at 1640.

simplified indicator of a much more complex system.[103] For example, forests maintain local environmental conditions through a variety of services, such as increased precipitation, greater moisture retention, and the moderation of spring runoff, all of which impact climate.[104] These are not reflected in the quantity of carbon, per se, that is embedded in the forest. Further, the climate regulation services provided by individual forests are embedded in a larger, integrated forest ecosystem that is acted upon by a variety of endogenous and exogenous drivers. Forest ecosystems are not static and are subject to a suite of disturbance and regenerative processes, the exact nature of which is contingent upon the ecosystem itself.[105] Management that seeks only to maximize gross quantities of carbon without heeding the overall health, resilience and integrity of the larger ecosystem itself misses this point. Managing solely for the maximization of forest carbon in the shorter term without providing for the broader ecological integrity of the forest ecosystem is ultimately likely to heighten the forest's susceptibility to disturbance.[106] This, in turn, will lead to attendant carbon emissions, resulting in the erosion of the overall climate regulation services offered by the forest ecosystem itself. As a result, while quantifying carbon flux in an ecosystem provides a measure of its overall effect on climate regulation, carbon alone is not an effective proxy unless certain parameters of the ecological health can be included in the quantification of carbon within that ecosystem. Simply put, managing forests for *climate* does not mean management for *carbon* and vice versa.

Accordingly, while the use of carbon offsets is an important step toward internalizing the climate regulation services ecosystems provide, carbon is only an indicator of the climate regulation forest ecosystems provide. Parochial policies that narrowly focus on carbon miss this broader point, and demonstrate a fundamental lack of understanding of the climate regulation services ecosystems provide.[107]

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103. *See* Margaret A. Palmer & Solanges Filoso, *Restoration of Ecosystem Services for Environmental Markets*, 325 SCIENCE 575, 575–76 (2009).

104. MILLENNIUM ECOSYSTEM ASSESSMENT, ECOSYSTEMS AND HUMAN WELL-BEING: CURRENT STATE AND TRENDS, 603 (2005).

105. *See* Virginia H. Dale et al., *Climate Change and Forest Disturbances*, 51 BIOSCIENCE 723, 723–34 (2001).

106. Susan M. Galatowitsch, *Carbon Offsets as Ecological Restorations,* 17 RESTOR. ECOL. 563, 567–568 (2009); Palmer & Filoso, *supra* note 103, at 575; *see also* Constance I. Millar et al., *supra* note at 24, 2146–47.

107. *See id.*

This reality of forest ecosystems signifies the necessity of acknowledging the complexity of the ecosystems in which biological carbon is bound, and viewing these systems holistically rather than narrowly in the production of carbon units.

Valuating carbon on forestlands will require assurance as to the quantity of carbon sequestered and the durability, or permanence, of its storage. For carbon sequestration from forests to indeed offset carbon emissions, the government must establish program rules to guarantee the credibility of forest and other biological offsets. These standards must take measures to guarantee the authenticity of carbon reductions marketed as offsets, and require that the offsets are of high quality, are additional to what would have occurred absent the offset program, are permanent, and are verifiable by an external, third-party verifier. Establishing rigorous rules of exchange and enforcement will be critical to reducing the uncertainty surrounding an offset program and inducing investment. While often thought of as a collaborative venture between the government, emitters and landowners, it is important to recognize the critical role the government must play from an enforcement perspective. From a game theory perspective, environmental trading is akin to a three-way, non-cooperative game, in which self-interested buyers and sellers of environmental credits have incentives to collude against the public interest in the diminishment of quality standards, and therefore, decrease their costs of doing business.[108] Consequently, the government must establish rigorous accounting protocols to protect the public interest and ensure the climate credibility of a carbon offset program.

C. Investment in Infrastructure

Both private and public forests are important providers of ecosystem services such as carbon sequestration. However, as these forests operate under different ownership regimes and management objectives, maximizing the climate benefits of these respective ownerships will require correspondingly distinct solutions. As such, a common, but differentiated approach will be needed to maximize the provision and production of carbon storage benefits from both private and public forests. The potential of these lands to reduce atmospheric carbon must be recognized, and investment in these lands should be commensurate with our level of investment in

108. Dennis M. King, *Managing Environmental Trades: Lessons from Hollywood, Stockholm and Houston*, 32 ENVTL. L. REP. 1317, 1320 (2002).

reducing emissions in other sectors, such as energy.

1. Private Forests

As noted above, the federal government has traditionally helped bear the cost of developing private markets that serve the public good, as with the development of the national road system, dams, and power plants on which myriad private businesses depend.[109] In each case, the government has largely, if not entirely, borne the costs of developing and maintaining the physical infrastructure upon which many private commercial enterprises rely. Funding to lower the cost of capital is made available through grants, low-cost loans and various subsidies such as tax and production credits.[110] Fundamentally, there is a public-private partnership to develop these markets, with the public capital bearing the costs of establishing, and in some cases maintaining the basic shared infrastructure and the private capital bearing the costs of producing the finished goods for market.[111] This same role is essential in the development of ecosystem service markets: the public capital should partner to bear the cost of ensuring the physical land infrastructure is intact, and the private capital, through the carbon market, should bear the cost of developing and ensuring the additional emissions reductions.

In this case, the shared infrastructure is that of land, especially forests, which cuts across public and private borders in the production of essential services. With three out of every five acres in the lower forty-eight states owned by private owners,[112] the sharing of infrastructure costs is especially pertinent, as these acres are subject to enormous threat of conversion and degradation.[113] Without investment at a scale beyond what individual owners can provide, these ecosystem services will decline and disappear due to the fragmentation and degradation of the overall system upon which they depend. As the value of development out-competes that of maintaining land in a more natural and productive state, parcelization and conversion eat away at the landscape, resulting in the proverbial death by a thousand small cuts. As this occurs, the possibility of

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109. OSTROM & OSTROM, *supra* note 39, at 87–89.

110. *See* Jack et al., *supra* note 92, at 9465.

111. Thomas Dietz et al., *supra* note 40, at 1909.

112. RUBEN N. LUBOWSKI ET AL., U.S. DEP'T OF AGRIC., ECONOMIC INFORMATION BULLETIN NO. 14, MAJOR USES OF LAND IN THE UNITED STATES, 2002, at v (2006).

113. *See* SUSAN M. STEIN ET AL., U.S. DEP'T OF AGRIC., PNW-GTR-636, FORESTS ON THE EDGE: HOUSING DEVELOPMENT ON AMERICA'S PRIVATE FORESTS 5 (2005); *accord* FOREST SERV., U.S. DEP'T OF AGRIC., *supra* note 11, at 5.

hitting climate targets, not to mention the disappearance of any additional contribution to emissions reductions of renewable fuels, declines steadily. The United States is then forced to find other means to provide these reductions at significant, and normally great, expense.[114]

To ensure that forest and other natural lands maintain current stores and have the capacity to increase them, the federal government should provide an investment parallel to that for the development of alternative and efficient energy plants: grants, low cost of capital and tax credits. In a time of federal deficits and stringency, investment for the conservation and restoration of more natural habitats will need to be tied to the overall climate policy and coordinated with existing related programs, such as those under the U.S. Department of Agriculture; the U.S. Forest Service; the Natural Resources Conservation Service; and the U.S. Fish and Wildlife Service. Funding should be derived from a set-aside of allowances and the proceeds from the auction thereof and at a level at least commensurate with the funding being established for the prevention of international deforestation. Or, more rationally, in an amount that compensates for the provision of sequestration services or the production of alternative, renewable woody biomass energy. This would argue for an allowance allocation of between five and twenty percent for the acquisition of conservation easements on private lands to maintain their sequestration services, and for grants to fund restoration activities on public and private lands. These "restoration" grants would cover costs of resilience restoration and adaptive management, such as thinning, fire risk management and reforestation. In turn, such activities would generate significant employment in rural resource dependent communities. Investments in natural lands management, primarily forestry, are in fact the most leveraged of any job investment that the country can make.[115] That is, they bring not only climate and other ecosystem service benefits; they are also major economic stimulants for job creation and retention.

Overall, the federal government must develop institutional frameworks that shift from a narrow management focus on private lands to a more holistic management approach. It must also build institutional capacity to conduct complex ecological, social and

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114. CONG. BUDGET OFFICE, PUB. NO. 2931, THE POTENTIAL FOR CARBON SEQUESTRATION IN THE UNITED STATES, 19–20 (2007).

115. *See* HANS HOOGEVEEN ET AL., DESIGNING A FOREST FINANCING MECHANISM (FFM): A CALL FOR BOLD, COLLABORATIVE & INNOVATIVE THINKING 18–19 (2008).

economic analyses to facilitate regulatory decisions in a transparent manner.[116] Effective federal climate policies must address the substantial loss of private forestlands to conversion and development each year as well as acknowledge the implications these losses have for our future ability to combat climate change. The development of a rigorous carbon offset program in concert with a mechanism for compulsory demand generation to accurately valuate these carbon offsets will provide landowners with an important new source of income for the provision of climate services.

Indeed, with the majority of U.S. forestlands being privately owned, this approach will position private landowners in a position of unique global competitiveness to attract investment in emissions reductions, providing additional economic return from the investment made by the federal government in the basic natural physical infrastructure. Private lands will provide the bulk of increases in sequestration services for future reductions in emissions (as they are the most depleted in comparison with public lands) while also helping maintain the base of current sequestration.[117]

2. Public Forests

Though the majority of U.S. forestlands are privately held, public lands are also an important source of carbon storage and sequestration. Federal forests currently compose about a third of all forested land in the United States, while another tenth is under state or other public ownership.[118] However, the exacerbation of stressors and existing disturbances through climate change is increasingly threatening the carbon sequestration and storage capacity of these federal lands.[119] Government investment must target restoration of the ecological integrity of federal lands to ensure the resilience and durability of the climate benefits they afford.

The budgeting processes used by the Forest Service have also contributed to the climate change risks faced by federal forests. During the appropriations process, negotiations with the Secretary of Agriculture, Office of Management and Budget, and Congress focus largely on funding for budget line items that are particularly controversial or economically important.[120] When the finalized

116. Lant, Ruhl, & Kraft, *supra* note 10, at 973.

117. *See* Birdsey, *supra* note 23, at 117–21.

118. *See* U.S. DEPT. OF AGRIC. *supra* at note 11, 27.

119. *See* Rhemtulla, *supra* note 25, at 6083.

120. V. ALARIC SAMPLE, THE IMPACT OF THE FEDERAL BUDGET PROCESS ON NATIONAL

budget is returned to the Forest Service, it often bears little resemblance to the budget proposal initially submitted. Production goals and associated funding predominately focus on commodity resource programs with tangible, easily measured outputs, while goals and objectives for non-commodity resource programs can fall by the wayside.

The hybrid budgeting approach used by the Forest Service was reinforced by the Forest and Rangeland Renewable Resources Planning Act of 1974 ("RPA").[121] The RPA was enacted in the 1970s after "increasing public criticism of the Forest Service for its forest management practices such as clear cutting."[122] The RPA directed the Forest Service to develop a long-range, strategic plan for the goals and objectives under which the national forests were to be managed. During the late 1970s, the RPA served as the basis for the annual budget development process, and required forest supervisors to submit at least one budget alternative that responded to the goals articulated under the RPA program.[123] This enabled the Forest Service to emphasize non-commodity forest management practices in their budget requests. Increasing appropriations to forest management activities were attributed to the RPA program's ability to highlight these activities in the annual appropriations process, as well as the Carter administration's overall commitment to non-commodity production goals.[124] However, any apparent influence the RPA program goals had on the annual appropriations process quickly vanished with the Reagan administration. Despite the multiple use goals of the RPA program, appropriations for many resource programs sharply declined while the budgeting emphasis drastically swung toward commodity production.[125] To ensure that federal forests are able to provide critical ecosystem services such as carbon sequestration, budgeting processes must reflect the substantial non-commodity value of forests and provide funding for sustaining them. The allocation of emission allowances and income from the auction thereof, as noted above, should serve as the source of such budget

FOREST PLANNING, 15–16 (1990).

121. *See* Forest and Rangeland Renewable Resources Planning Act of 1974, Pub. L. No. 93-378 (codified as amended at 16 U.S.C. 1601).

122. V. Alaric Sample, *Resource Planning and Budgeting for National Forest Management*, 52 PUB. ADMIN. REV. 339, 340 (1992).

123. *Id.* at 341.

124. *Id*. at 342.

125. *Id.* at 343.

revenues.

VI. CONCLUSION

Climate regulation by forests should be the first global scale ecosystem service to be monetized through and in the private marketplace. Government policy that sets appropriate targets for reducing carbon emissions through cap and trade is essential in creating market demand and the standards to control it. Equally, federal policy must recognize that the sequestration of carbon by forests alone is an incomplete recognition of forest climate regulation. Program rules, such as those for the definition of regulatory compliance units of forest carbon, must include ecosystem function parameters. Federal policy must also recognize that the markets alone are insufficient to pay for climate services. To fully realize a forest carbon market and achieve national climate goals, federal investment will be needed in the natural physical infrastructure of forests—investment in a manner comparable to that for developing the physical infrastructure essential to meeting our national goals for alternative energy and transportation.