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Payments for Ecosystem Services: Past, Present and Future

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ARTICLE

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TABLE OF CONTENTS

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I. INTRODUCTION

While we don't tend to think about it, healthy ecosystems provide a variety of critical benefits. Ecosystem goods, the physical items an ecosystem provides, are obvious. Forests provide timber; coastal marshes provide shellfish. While less visible and generally taken for granted, the services underpinning these goods are equally important. Created by the interactions of living organisms with their environment, ecosystem services provide the conditions and processes that sustain human life.[1] If you doubt this, consider how to grow an apple without pollination, pest control, or soil fertility.

Once one realizes the importance of ecosystem services, three points quickly emerge: (1) landscapes provide a stream of services ranging from water quality and flood control to climate stability—the economic value of which can be significant; (2) the vast majority of these services are public goods and not exchanged in markets, so landowners have little incentive to provide these positive externalities; and (3) we, therefore, need to think creatively about creating markets for these services so they are not under-provided. This is the basis of the policy approach known as Payments for Ecosystem Services ("PES").

In its simplest form, PES is a transaction between landholders and the beneficiaries of the services their land provides. Thus, downstream communities might pay upper-watershed landowners to plant riparian vegetation to ensure water quality or to halt deforestation to ensure flood protection. Duck hunters might pay land owners to conserve wetland habitat to support ducks and geese. Groups concerned about climate change might pay Costa Rica to plant trees to sequester carbon.

An obscure term just fifteen years ago, PES has come of age—whether it is described as "natural capital," "nature's fortune," or simply "investing in nature."[2] From the United Nations[3] to the cover of

1. NATURE'S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS 3 (Gretchen C. Daily, ed., 1997).

2. GRETCHEN C. DAILY & KATHERINE ELLISON, THE NEW ECONOMY OF NATURE: THE QUEST TO MAKE CONSERVATION PROFITABLE (2002); PAUL HAWKEN, THE ECOLOGY OF COMMERCE: A DECLARATION OF SUSTAINABILITY (2010); MARK R. TERCEK & JONATHAN S. ADAMS, NATURE'S FORTUNE: HOW BUSINESS AND SOCIETY THRIVE BY INVESTING IN NATURE (2013).

3. *The Economics of Ecosystems and Biodiversity*, U.N. ENV'T, https://www.unenvironment.org/explore-topics/green-economy/what-we-do/economics-ecosystems-and-biodiversity (last visited Aug. 28, 2018) [https://perma.cc/PFL2-Q8AJ]; *see also*

The Economist magazine,[4] interest in PES has risen around the globe and is still rising.[5] There are now hundreds of PES programs around the globe, in both developed and developing countries, with annual transactions well over ten billion dollars.[6] It has become a central component of China's nationwide environmental-protection strategy.[7] The Obama Administration announced a federal policy to strengthen agency mitigation policies through a "net benefit" goal.[8]

Industry has jumped on board the PES bandwagon. Goldman Sachs created the Center for Environmental Markets group in 2006.[9] Environmental groups have also supported this approach.[10] In many PES examples (though not all), payments take pride of place in the environmental-policy toolkit ahead of prescriptive regulations. As a result, libertarians and property-rights advocates have taken a special interest in this strategy.[11] Perhaps the greatest interest has come from the academic community, with an explosive growth in publications over the last two decades, as the graph below demonstrates.[12]

The Initiative, ECON. OF ECOSYSTEM & BIODIVERSITY, http://www.teebweb.org/about/the-initiative/ (last visited Aug. 28, 2018) [https://perma.cc/QAG4-UNKZ].

4. *See Rescuing Environmentalism (and the Planet)*, ECONOMIST (Apr. 23, 2005), http://www.economist.com/node/3888006 [https://perma.cc/BGP3-N8T6] (displaying that week's cover); *see also Rescuing Environmentalism*, ECONOMIST (Apr. 21, 2005), https://www.economist.com/leaders/2005/04/21/rescuing-environmentalism [https://perma.cc/Z6MM-GE2K] (cover article).

5. *See* Morgan Robertson et al., *Stacking Ecosystem Services*, 12 FRONTIERS ECOLOGY & ENV'T 186 (2014); *see also* Anne D. Guerry et al., *Natural Capital and Ecosystem Services Informing Decisions: From Promise to Practice*, 112 PROC. NAT'L ACAD. SCI. U.S. 7348 (2015).

6. *See infra* Figure 3–5.

7. Gretchen C. Daily et al*., Securing Natural Capital and Human Well-Being: Innovation and Impact in China*, 33 ACTA ECOLOGICA SINICA 677, 678 (2013).

8. Memorandum from the President on Mitigating Impacts on Nat. Res. from Dev. & Encouraging Related Private Inv. (Nov. 3, 2015), https://obamawhitehouse.archives.gov/the-press-office/2015/11/03/mitigating-impacts-natural-resources-development-and-encouraging-related [https://perma.cc/YV8T-LH2T]. President Trump reversed this shortly after taking office. Jim Salzman, *The Overlooked Part of Trump's Executive Order on Climate Change*, LEGAL PLANET (Apr. 6, 2017), http://legal-planet.org/2017/04/06/the-overlooked-part-of-trumps-executive-order-on-climate-change/ [https://perma.cc/EHF8-YPBY].

9. *Environmental Market Opportunities*, GOLDMAN SACHS, http://www.goldmansachs.com/citizenship/environmental-stewardship/market-opportunities/center-for-environmental-markets/ (last visited Aug. 25, 2018) [https://perma.cc/9M3U-ZXTZ].

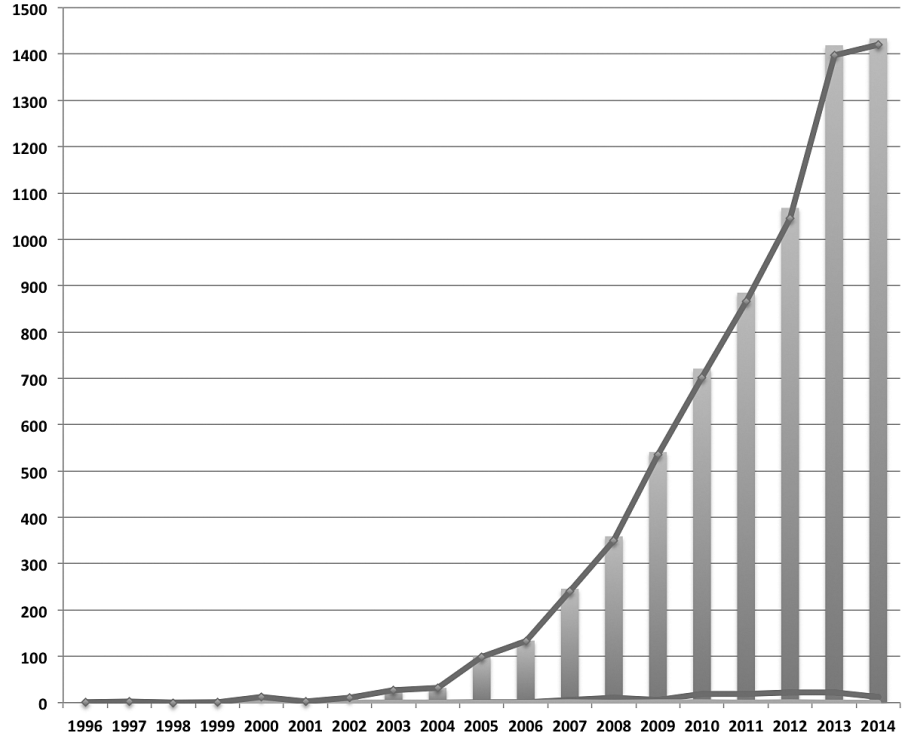
10. It is no coincidence that the president of The Nature Conservancy, Mark Tercek, created and led Goldman Sachs environmental markets group prior to being hired. Not all environmentalists, though, support the PES approach. *See, e.g.,* Michelle Nijhuis, *Bridging the Green Divide,* NEW YORKER (Dec. 9, 2014), https://www.newyorker.com/tech/elements/bridging-conservation-divide [https://perma.cc/96AH-YKTX].

11. The Property and Environment Research Center, for example, has published a number of articles on PES. *See, e.g.,* James Salzman, *Ecosystem at Your Service,* 28 PROP. & ENV'T RES. CTR. 22, 24–25 (2010).

12. Google Scholar search for articles containing either terms "payments for environmental services" or "payments for ecosystem services," screening out multiple versions of the same article. The trends from Google Scholar data were confirmed by the

FIGURE 1

Google Scholar Search of Journal Articles Discussing PES from 1996–2014



Promising as these developments are, the dramatic increase of interest in PES across the private and public sectors risks masking as much as it reveals, for it tells us little about the details and evolution of particular payment mechanisms. Put simply, does the explosive rise in interest over PES reflect the rise of PES in the field?

Along with a few academics, I started working on this topic in the late 1990s, publishing the first law review article on the subject.[13] I have remained active, publishing a series of articles and reports on the legal and institutional issues involved in the creation of PES.[14] While I have been both surprised and delighted to see the field expand so rap-

same search on Web of Science (which only has relevant data from 2005). *See* Paul J. Ferraro, *The Future of Payment for Environmental Services*, 25 CONSERVATION BIOLOGY 1134, 1134 (2011).

13. James Salzman, *Valuing Ecosystem Services,* 24 ECOLOGY L.Q. 887 (1997).

14. *See, e.g.,* James Salzman, *A Field of Green?: The Past and Future of Ecosystem Services*, 21 J. LAND USE & ENVTL. L. 133 (2006) [hereinafter Salzman, *A Field of Green?*]; James Salzman, *What is the Emperor Wearing?: The Secret Lives of Ecosystem Services,* 28 PACE ENVTL. L. REV. 591 (2011) [hereinafter Salzman, *What is the Emperor Wearing?*].

idly, I am also concerned over unrealistic expectations—that the hype may exceed the performance. Put another way, I have become increasingly worried that so many parties jumping on the PES bandwagon risks breaking the axles.

Because PES represents such a recent addition to the toolbox of environmental-policy instruments with disparate practices at local, regional, and national levels, consistent and reliable information has proven difficult to find. There have been plenty of individual success stories. Perhaps the most famous is New York City's decision to pay communities in the Delaware and Catskills watersheds for land management practices that ensure water quality rather than investing in a treatment plant.[15] Given the choice of investing in green versus gray infrastructure, New York City found that payment for ecosystem services was less expensive and more effective.[16] Many other case studies have been published by scholars and respected bodies such as the International Institute for Environment and Development[17] and the World Bank.[18] Apart from case studies, though, it has proven hard to find an objective, rigorous examination of PES in the field.

PES does not lack boosters. I have been among the most vocal champions. But enthusiasm and case studies are not enough. One cannot truly assess the lessons learned from PES in the field without a clear understanding of what actually has happened in the field. Hence the impetus for this research project.

Working with the Ecosystem Marketplace, a non-profit group that collects and analyzes PES transactions around the globe (and publishes its analyses on its website, ecosystemmarketplace.org), we set out to provide the first comprehensive empirical assessment of the state of PES mechanisms—voluntary, subsidy, and compliance—across the domains of water, biodiversity, and carbon around the globe. Using data collected by the Ecosystem Marketplace since 2005, this Article moves beyond case studies and analyzes metrics on the historical growth and current status of the many different PES sectors. We consider the various dimensions of growth (including number of programs, geographic spread, and dollar value) to understand better the variety of PES mechanisms and their evolution.

15. Salzman, *A Field of Green?*, *supra* note 14, at 139–40.

16. ALBERT F. APPLETON, HOW NEW YORK CITY USED AN ECOSYSTEM SERVICES STRATEGY CARRIED OUT THROUGH AN URBAN-RURAL PARTNERSHIP TO PRESERVE THE PRISTINE QUALITY OF ITS DRINKING WATER AND SAVE BILLIONS OF DOLLARS 9 (2002), http://www.forest-trends.org/documents/files/doc_761.pdf [https://perma.cc/X37T-AMWT].

17. NATASHA LANDELL-MILLS & INA T. PORRAS, SILVER BULLET OR FOOLS' GOLD?: A GLOBAL REVIEW OF MARKETS FOR FOREST ENVIRONMENTAL SERVICES AND THEIR IMPACT ON THE POOR (Mar. 2002), http://pubs.iied.org/pdfs/9066IIED.pdf [https://perma.cc/3L2H-9HH2].

18. STEFANO PAGIOLA ET AL., SELLING FOREST ENVIRONMENTAL SERVICES: MARKET-BASED MECHANISMS FOR CONSERVATION AND DEVELOPMENT (2002).

A short version of our results was published in the peer-reviewed scientific journal, *Nature Sustainability.*[19] This Article builds on our *Nature Sustainability* piece and considers more fully the trajectories of PES—namely, which factors have contributed to significant success for particular PES sectors and which barriers frustrated growth. The recent emergence of PES and the wide range of policy mechanisms provide a particularly rich opportunity to examine the relative merits of coercive versus market instruments. We find that PES has operated as a carrot in some circumstances and as a stick in others.

II. WHAT IS PES?

While one can find isolated examples of PES from decades ago, the current interest and rise of activity dates from the late 1990s.[20] The confluence of influential publications in scientific journals,[21] books featuring case studies of PES,[22] adoption of ecosystem services as the metric for the Millennium Ecosystem Assessment,[23] and the networking and research activities of groups such as Forest Trends and its Katoomba Group quickly raised the prospect of PES as a promising policy approach.[24] The alarming trends of increasing deforestation, rising greenhouse gases, and loss of biodiversity made clear that traditional conservation measures were proving inadequate and that additional strategies were needed.[25]

In economic terms, PES seeks to internalize the positive externalities generated by natural systems, creating incentives for landholder behavior that ensures service provision.[26] In some circumstances, PES can create additional revenue streams for landholders that, on the margin, can push land management toward conservation rather than development.[27] This approach has been described as "making trees worth more standing than cut down."[28] It is important to recognize, however, that PES captures only a fraction of the values provided by

19. James Salzman et al., *The Global Status and Trends of Payments for Ecosystem Services,* 1 NATURE SUSTAINABILITY 136 (2018).

20. *See, e.g.*, John P. Holdren & Paul R. Ehrlich, *Human Population and the Global Environment*, 62 AM. SCIENTIST 282, 282–83 (1974) (describing the importance of "natural services").

21. Graciela Chichilnisky & Geoffrey Heal, *Economic Returns from the Biosphere*, 391 NATURE 629, 629 (1998); Robert Costanza et al., *The Value of the World's Ecosystem Services and Natural Capital,* 387 NATURE 253, 259 (1997).

22. DAILY & ELLISON, *supra* note 2, at 8, 12.

23. *Overview of the Millennium Ecosystem Assessment*, MILLENNIUM ECOSYSTEM ASSESSMENT, http://www.millenniumassessment.org/en/About.html (last visited Sept. 5, 2018) [https://perma.cc/X3KH-TMME].

24. *What is the Katoomba Group?*, FOREST TRENDS, https://www.forest-trends.org/ecosystem_marketplace/what-is-the-katoomba-group/ (last visited Aug. 23, 2018) [https://perma.cc/BZK4-BL6K].

25. *See id.*

26. *See* Salzman, *What is the Emperor Wearing?*, *supra* note 14, at 601.

27. *See id.*

28. *Id.* at 600.

natural systems. Existence values, option values, and many public goods benefits are usually outside the scope of PES mechanisms.

There have been at least nine different definitions of PES proposed in the literature.[29] We take a broad view, defining it as the exchange of value for land management practices intended to provide or ensure ecosystem services. Researchers have also proposed different ways to categorize the various types of approaches.[30] We group PES mechanisms into three broad categories:

- Voluntary PES – Beneficiaries of ecosystem services agree to compensate landholders for activities that maintain or enhance ecosystem services delivery. There is no sanction for refusing to agree to the transaction. This includes the purchase of biodiversity offsets and carbon offsets by extractive industries and companies motivated by corporate social responsibility to reduce their habitat or climate change impacts. These are private transactions where PES operates as a carrot.
- Subsidy PES – Public finance payments reward land managers for enhancing or protecting ecosystem services. The buyer is a public entity acting on behalf of the public good and not necessarily a direct beneficiary of ecosystem services enhancement or protection. This includes government programs in Costa Rica and China that pay landholders for reduced deforestation or afforestation activities that enhance flood protection, water quality, or other ecosystem services. Here, public funds operate as a carrot.
- Compliance PES – Parties facing regulatory obligations compensate other parties for activities that maintain or enhance comparable ecosystem services or goods in exchange for a standardized credit or offset that satisfies their mitigation requirements. This includes water quality trading, wetlands mitigation banking, and the European Union's emissions trading scheme for greenhouse gases. Because the services are purchased as a means of regulatory compliance, this mechanism operates as a stick.

Within these categories, there is a wide range of specific mechanisms, reflecting the creativity of policy makers and entrepreneurs seeking to create revenue streams for service providers. The chart below sets out some of the more common PES approaches.

29. *See* Sandra Derissen & Uwe Latacz-Lohmann, *What are PES? A Review of Definitions and an Extension*, 6 ECOSYSTEM SERVS. 12, 12–13 (2013).

30. *See, e.g.*, Stefanie Engel et. al, *Designing Payments for Environmental Services in Theory and Practice: An Overview of the Issues*, 65 ECOLOGICAL ECON. 663, 666–68 (2008).

FIGURE 2

The Range of PES Mechanisms

PES Transaction Type	Sector	Dominant Payment Approach	Carrot versus Stick
Public Payment for Water Services ("PWS")	Water	Public Finance	Carrot
Instream Buybacks	Water	Bilateral Deals	Carrot
Trading & Offsets	Water	Credit Trading	Stick
Bilateral PWS	Water	Bilateral Deals	Carrot
Wetland Mitigation	Biodiversity	Bilateral Deals Credit Trading	Stick
Biodiversity Mitigation	Biodiversity	Bilateral Deals Credit Trading	Stick
Voluntary Biodiversity Offsets	Biodiversity	Bilateral Deals	Carrot
Compliance Forest Carbon	Carbon	Offset Trading	Stick
REDD+ Finance	Carbon	Public Finance	Carrot
Voluntary Forest Carbon	Carbon	Offset Trading	Carrot
Certified Commodities	All	Certification and Standards	Carrot

The sections that follow are set out within four basic groupings: water PES for hydrological services such as water quality and flood control; payments for the management and conservation of land for habitat and for biodiversity; carbon payments for sequestration, avoided deforestation and land degradation; and bundled payments that secure all or a combination of these services in certification of the product, such as timber. This is followed by a discussion of lessons learned.

III. PES MECHANISMS BY SECTOR

A. *Water*

The PES water sector is the most mature in terms of the number of programs, the ages of programs, transaction value, and geographic distribution.[31] Water is the easiest context for PES because the connection between land management in an upper watershed and the direct health benefits to downstream users appear straightforward.[32] In many cases, transaction costs are low because institutions are already in place to collect funds from diffuse beneficiaries, whether through water utilities, budgets of water agencies, or agricultural subsidy programs.[33] The chart below describes each water PES mechanism, pro-

31. Salzman et al., *supra* note 19.
32. *See id.* at 137.
33. *Id.*

vides an illustrative example, and provides metrics describing market size, number of programs, and geographic diffusion (how many countries have active programs).[34] This is followed by a discussion of the key insights that emerge from a review across watershed PES.

FIGURE 3

Watershed PES[35]

PES Mechanism (Category)	Definition	Example	Market Size 2009 → 2015	Programs 2005→ 2015	Distribution (Countries)
Subsidy PWS (government-financed)	Public finance rewards land managers for enhancing or protecting ecosystem services. The funders do not directly benefit from the management activities.	Chinese government's Sloping Lands Conversion Program pays farmers to stop cultivating on steep slopes. Roughly 53 million farmers receive compensation to improve water quality and flood control.	$6.3 billion → $23.7 billion ($12.98 billion in China).	17 → 139, with 69 in China	39
Collective Action PWS (user and government-financed)	An institution pools resources from multiple water users (private parties, NGOs, government bodies) to pay upstream landowners for management actions that provide water quality and other benefits.	Quito's Water Conservation Fund relies on a 1% surcharge on monthly water bills and monies from local electrical utility and beer company directed to finance projects protecting forests and grasslands in the watershed.	$402 million → $564 million	16 → 86	22
Bilateral PWS (user and government-financed)	A single water user compensates one or more parties for activities that deliver hydrologic benefits to the payer or serves to mitigate impacts from their activities.	In the 1990s, New York City raised a bond to pay for land use changes in the Catskills and Delaware watersheds in order to ensure the quality of their drinking water at much cheaper than a treatment plant.	$13 million → $93 million	19 → 111	27
Instream Buybacks (user and government-financed)	Water rights are purchased or leased from historic rights holders and retired, which leaves the water in-stream to deliver water quality benefits and ensure healthy ecological flows.	In Australia, the Restoring the Balance program committed over $3 billion over a ten-year period to purchase water entitlements from farmers to ensure instream flows in the Murray-Darling Basin.	$25 million → $60.7 million	15 → 20, with 18 in the USA	3
Quality trading and offsets (compliance)	Water service providers comply with regulations by paying landowners for activities that improve a measure of water quality (such as nutrients, salinity, temperature, etc.) in exchange for credits.	In the Hunter River Salinity Trading Scheme, salt credits are traded among mines and power stations based on river conditions to control the salinity.	$8.3 million → $22.2 million	10 → 31, with 29 in the USA	3

34. *See infra* Figure 3.

35. Salzman et al., *supra* note 19, at 137 tbl.1.

1. China Dominates Subsidy Payments for Watershed PES

A series of major floods and droughts in the late 1990s revealed to the Chinese government that land degradation posed major threats to water quality and flooding.[36] China has a unique political and centralized authority that has allowed it to put PES strategies in place at a scale and speed that would not be possible in other countries. This has dramatically reshaped the country's policy and physical landscape very quickly.[37]

The Ecosystem Function Conservation Areas strategy, for example, pays farmers for development restrictions on areas deemed to be important ecological or agricultural zones and, in some cases, moves the farmers.[38] The scheme's coverage is vast, spanning roughly 40% of China's land area.[39] The Sloping Land Conservation Program ("SLCP") is focused on converting steep cropland to forest and grassland while the Natural Forest Conservation Program is focused on logging bans and afforestation. Together, they represent the largest PES programs in the world, investing over $50 billion from 2000 to 2009.[40] Indeed, the SLCP paid 32 million farmers and 120 million households.[41] Additionally, these programs have an explicit purpose to develop rural areas.[42] Scholars have found that all ecosystem services from 2000 to 2010 increased (except for biodiversity habitat) with mostly positive socioeconomic benefits.[43]

Beyond water services, these programs equally serve the purpose of rural development.[44] As with most large subsidy programs, there is a trade-off between centralized decisions for administrative feasibility and local flexibility. Thus, most payments have been administratively determined rather than negotiated, which can lead to inefficiencies since payments are not tailored to local conditions.[45] There have also been concerns raised over the socioeconomic effects of these interventions.[46] Nonetheless, the twin strategy of PES for conservation and rural development remains a mainstay of Chinese policy.[47]

36. Jianguo Liu et al., *Ecological and Socioeconomic Effects of China's Policies for Ecosystem Services*, 105 PROC. NAT'L ACAD. SCI. U.S. 9477, 9477 (2008).
37. Salzman et al., *supra* note 19, at 137.
38. Liu et al., *supra* note 36, at 9479.
39. Salzman et al., *supra* note 19, at 137.
40. *Id.*
41. *Id.*
42. *Id.*
43. *Id.*
44. *See* Daily et al., *supra* note 7, at 678.
45. *See* Liu et al., *supra* note 36, at 9481.
46. *Id.* at 9478.
47. Salzman et al., *supra* note 19, at 137.

2. Collective Action Funds in Latin America

In order to pay upstream landowners for management actions promoting water quality, a PES water fund pools resources from multiple water users, including private parties, NGOs, and government bodies.[48] In the last decade, at least fifty-seven funds have been created. They range widely in approaches to program size, participants, funding strategies, and forms of compensation.[49] Mostly, this is due to the Latin American Water Funds Partnership ("LAWFP").[50] LAWFP was launched in 2011 by The Nature Conservancy, FEMSA Foundation, InterAmerican Development Bank, and Global Environment Facility. It has directed an estimated $27 million in leveraged start-up capital and now has sixteen operating funds.[51] The Brazilian National Water Agency has also been active. It expanded its Water Producer program to nineteen programs across Brazil since 2007.[52]

The support of first movers—the government, private sector, and NGOs—has driven the increase by developing the institutions, expertise, and market infrastructure for watershed payments.[53] Bringing together existing organizations reduces transaction costs and builds trust more quickly.[54] It also gives stakeholders a greater governing role, identifying local champions and creating a broad base of political support.[55] Continuity of funding, especially when an endowment is established, allows programs to cover their operating expenses while also executing contracts and planning ahead.[56] Taken together, these represent major advantages over bilateral and even public subsidy water PES, many of which need to search for funding every year.

While all collective action funds share the same basic strategy of compensating landowners for watershed management actions, it is striking how little they share beyond that. Driven by local needs and concerns, the wide range of approaches in program size, participants, goals, funding sources, forms of compensation, and management activities all bear witness to the flexibility inherent in the collective action approach. Such adaptability is key to this mechanism's success.

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48. *Id.*
49. *Id.*
50. *Id.*
51. *Id.*
52. *Id.*
53. *Id.* at 138.
54. Bhim Adhikari & Arun Agrawal, *Understanding the Social and Ecological Outcomes of PES Projects: A Review and an Analysis*, 11 CONSERVATION & SOC'Y 359, 368, 372 (2013).
55. Salzman et al., *supra* note 19, at 138.
56. *Id.*

3. Instream Water and Quality Trading Require Institutional Capacity and Secure Property Rights

Legal authority for instream flow purchases and quality trading markets is in place in many countries around the world.[57] Yet they only operate in the United States, Mexico, and Australia.[58] Despite a constitutional provision and enabling legislation, for example, South Africa has not been able to create a functioning system.[59]

Capacity has proven a major challenge. Instream buybacks need robust institutions to provide clear and enforceable property rights, an accurate and accessible recording system, and monitoring capability to track flows. The legal system must also recognize instream flows as a legitimate use of water consistent with water rights. These are absent in many countries around the world. Moreover, the over-allocation of most river systems makes instream buybacks politically difficult because it, metaphorically, pits fish against farmers.[60] At times of scarcity, absent legal requirements to maintain minimum instream flows, conservation interests are likely to be outbid by competing urban users, farmers and industry—the uses for water most valued by markets.[61]

The weak diffusion is also due to the lack of regulatory drivers creating a solid demand for trades. Absent laws mandating a reduction in nonpoint sources (in the case of water quality trades), aquatic ecosystem protection (in the case of instream flows), or groundwater protection (where surface flows and groundwater are closely connected), market size will remain small and geographic reach limited.[62]

B. *Biodiversity and Habitat*

The biodiversity PES sector offsets its losses to ensure it suffers no net loss.[63] This sector is the least developed in terms of geographic scope and the most challenging for countries to put in place.[64] Unlike in water PES, where those who receive clean water and protection from flood are straightforward and local, the beneficiaries of biodiver-

57. *Id.*
58. *Id.*
59. DINEO MAILA ET AL., AN EVIDENCE-BASED APPROACH TO MEASURING THE COSTS AND BENEFITS OF CHANGES IN AQUATIC ECOSYSTEM SERVICES 121–23 (2017), http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20726-17.pdf [https://perma.cc/N8UY-PRF5].
60. *See, e.g.*, Beria Leimona, *Fair Efficient, Efficiently Fair: Lessons From Designing and Testing Payment Schemes for Ecosystem Services in Asia*, 12 ECOSYSTEM SERV. 16, 21 (2015).
61. *See* K. William Easter et al., *Formal and Informal Markets for Water: Institutions, Performance, and Constraints*, 14 WORLD BANK RES. OBSERVER 99, 111, 114 (1999).
62. Salzman et al., *supra* note 19, at 138.
63. *Id.*
64. *Id.*

sity are often spread out and the specific benefits indirect or nonmaterial.[65] Institutions that can collect fees for their many beneficiaries—like water utilities—do not exist, and common metrics are difficult to determine.[66] Accordingly, there are only thirty-six countries that employ biodiversity PES programs, and the most successful initiatives rely on regulatory drivers.[67] The very practice of offsetting is controversial: It faces strong opposition from NGOs that do not wish to endorse habitat destruction.[68]

The compliance mitigation programs that restore stream and wetland habitat benefit from strong regulations backed by credible enforcement and common agreement on currencies of exchange (such as wetland acreage).[69] This sector is the least transparent: Data on transactions or project implementation are not available. Global transactions are estimated at $2.5–8.4 billion annually, a wide range indicative of the difficulties in tracking payments.[70]

65. *Id.*
66. *Id.*
67. *Id.* We do not include conservation easements or traditional conservation finance (e.g., land purchase) because many of these are made to ensure open space rather than provision of a specific service.
68. *Id.*
69. *Id.*
70. *Id.*

FIGURE 4

Market Size Distribution[71]

PES Mechanisms (Category)	Definitions	Example	Market Size 2008 → 2016	Number of Programs	Distributions (Countries)
Wetlands and Stream Mitigation (Compliance)	To compensate for filling wetlands or streams, developers purchase credits for comparable wetlands and streams created offsite that have been certified by a government agency.	Under the U.S. Clean Water Act, a permit for development of wetlands can require the purchase of mitigation credits from an offsite bank of created wetlands.	$1.3–2.2 billion → $1.4–6.7 billion	5	1
Compliance Biodiversity (Compliance)	To comply with regulatory requirements that mitigate impacts on biodiversity, developers can purchase credits for a specific habitat type that has already been created by a third party as an offset, purchase biodiversity credits created in a similar manner, or pay into a general offset fund.	The Biodiversity Offsets and Banking Scheme (BioBanking) was launched by the state of New South Wales in 2007 to offset habitat impacts from development. Developers can purchase credits from conservation management activities such as managing grazing, removing invasive species, habitat corridors, etc., for trades that match "like for like" credits and impact according to the habitat type.	$0.5 billion → $1.1–$1.7 billion	99	33
Voluntary Biodiversity Offsets (Government-Financed)	Developers choose to mitigate the impacts of projects through measurable conservation outcomes intended to achieve no net loss, or preferably a net gain, of biodiversity with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity.	In Sabah, Malaysia, the Malua BioBank contains one of the world's highest concentrations of orangutans. The government of Saba worked with private parties to invest in the restoration and maintenance of 34,000 hectares of rainforest. The BioBank sells "biodiversity conservation certificates," with each certificate representing 100 square meters of forest restoration and protection for at least 50 years.	$20 → $10.5 million	16 implemented project sites	11

1. Compliance Biodiversity Requires Strong Institutional Infrastructure

Compliance biodiversity offsets and mitigation remain important conservation mechanisms in a small number of developed countries but have not significantly spread to other countries. As of 2014, a full two-thirds of the operating biodiversity offset or compensation pro-

71. *Id.* at 139 tbl.2.

grams were concentrated in North America and Australia/New Zealand.[72] There are no fully operational compliance-driven programs in Africa.[73] While the European Council adopted a 2020 Biodiversity Strategy calling for the European Union "to ensure no net loss of biodiversity and ecosystem services," regulations have not been produced on time and the Commission appears to favor a voluntary rather than regulatory approach.[74] The United Kingdom has similarly backed off mandating offsets in favor of voluntary schemes.[75] These concerns over the effect offset rules could have on development suggest that many nations will continue to favor voluntary approaches.

For those countries serious about compliance offsets, patience will be important. The United States and Australia have the most developed programs and it has taken them several decades to develop the suite of policy measures, tools, and information needed to operate effectively.[76] Creating similar capacity in other countries will take time, and it will likely be infeasible in most developing countries, particularly in those regions of the world with much of the global biodiversity.

2. Voluntary Biodiversity Offsets Remain an Emerging Approach

Because voluntary biodiversity offsets are a very recent policy development and were largely unknown just a decade ago, they generally take the form of one-off projects undertaken by companies for reasons ranging from social corporate responsibility to risk management. Without regulatory requirements, this approach rests on developing a persuasive business case for voluntary offsets and will be driven by how many companies engage in pilot projects and incorporate offsets into company policy. To date, the number of projects remains small, particularly those with independent verification.

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72. Genevieve Bennett et al., *State of Biodiversity Markets 2017: Markets and Compensation for Global Intrastate Development*, FOREST TRENDS 24, 26 (Oct. 2017), https://www.forest-trends.org/wp-content/uploads/2018/01/doc_5707.pdf [https://perma.cc/7ZTA-FY2C].

73. Becca Madsen et al., *State of Biodiversity Markets: Offset and Compensation Programs Worldwide*, ECOSYSTEM MARKETPLACE 33 (2010), http://www.forest-trends.org/documents/files/doc_2388.pdf [https://perma.cc/WWK9-VLJM]. South Africa is close. While its Environmental Impact Assessment regulations provide for some compensation for biodiversity loss, it does not implement a mitigation hierarchy or attempt to achieve no net loss, like-for-like, or any other spatially relevant compensatory mitigation. *Id.* at 33–34, 36.

74. *EU Biodiversity Strategy to 2020*, EUR. UNION 5 (Jun. 23, 2011), http://register.consilium.europa.eu/doc/srv?l=EN&fST%2011978%202011%20INIT [https://perma.cc/7YPP-HAA5]; *Our Life Insurance, Our Natural Capital: An EU Biodiversity Strategy to 2020*, EUR. COMMISSION 9, 12 (Mar. 5, 2011), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0244&from=EN [https://perma.cc/NTR9-WZUS].

75. Bennett et al., *supra* note 72, at 49.

76. *Id.* at 4.

Much will depend on better understanding of the costs involved. Designing, implementing, and monitoring biodiversity offsets can be resource-intensive. The very practice of offsets remains both challenging and controversial, with strong opposition to biodiversity and carbon offsets from NGOs worried about endorsing habitat destruction and harming local communities dependent on the areas affected by development.[77]

If properly designed and implemented, voluntary offsets have the potential to protect and restore more than is harmed, creating a net positive gain for biodiversity conservation, and governments in developing countries remain interested in the potential for private sources of conservation funding and developing pilot projects. The Business and Biodiversity Offsets Program's development of standards in 2012 created a common text and set of expectations. But much work still remains to bridge this gap between policy and implementation capacity.

3. Access to Capital an Important Factor for Voluntary Offset Uptake

In 2012, the International Finance Corporation revised its Performance Standard 6.[78] Projects above $10 million must put in place mitigation measures for their impacts on natural habitat "designed to achieve no net loss of biodiversity where feasible."[79] When working in critical habitat, mitigation should "achieve net gains of those biodiversity values for which critical habitat was designated."[80] Similar standards have been adopted by the Equator Principles, a voluntary code of conduct for over eighty of the world's largest banks, the European Bank for Reconstruction and Development, the European Investment Bank, and the World Bank's Operational Policy 4.04.[81] Taken to-

77. *See* Chris Lang, *More than 80 NGOs Oppose Aviation Sector's Carbon Offsetting Plans*, REDD-MONITOR (April 4, 2016), https://redd-monitor.org/2016/04/04/more-than-80-ngos-oppose-aviation-sectors-carbon-offsetting-plans/ [https://perma.cc/GY9P-8WJ7]; Chris Lang, *No to Biodiversity Offsetting*, REDD-MONITOR (Nov. 22, 2013), https://redd-monitor.org/2013/11/22/no-to-biodiversity-offsetting/ [https://perma.cc/KM32-QEEC].

78. *Performance Standard 6*, WORLD BANK (Jan. 1, 2012), https://www.ifc.org/wps/wcm/connect/bff0a28049a790d6b835faa8c6a8312a/PS6_English_2012.pdf?MOD=AJPERES [https://perma.cc/N5V6-PQQE].

79. *Id.*

80. *Id.*

81. *The Equator Principles,* EQUATOR PRINCIPLES, http://equator-principles.com/about/195/ (last visited Sept. 8, 2018) [https://perma.cc/7JMK-BLDX]; Christopher Wright, *European Investment Bank: Promoting Sustainable Development, "Where Appropriate"*, CCE BANKWATCH NETWORK 6 (Nov. 2007), https://bankwatch.org/documents/EIB_where_appropriate.pdf [https://perma.cc/XE96-YJ7D]; *Equator Principles Financial Institutions*, WORLD BANK, https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/company-resources/sustainable-finance/equator+Principles+Financial+Institutions (last visited Sept. 8, 2018) [https://perma.cc/BMY7-TNQT].

gether, these financial institutions provide capital for a significant amount of development activity that impacts habitats around the world. This should significantly increase the number of projects with no net loss conditions. Because the standards are so recent, however, it is not yet clear whether they will be strictly implemented and, therefore, drive the demand for voluntary offsets.

4. Mitigation Credit Banks are Growing but Only in Developed Countries

Compensatory mitigation banking continues to grow: Transactions are estimated at $3.6 billion per year.[82] But it has not spread geographically. Almost all the growth has only occurred in countries where wetlands are the largest habitat type offset: The United States, Australia, Canada, and Germany.[83] Mitigation banking is found in developed countries except in a few limited circumstances. It has been introduced in Malaysia on a voluntary basis, in Northern Mariana Islands for compliance purposes, and is in the process of being piloted in Colombia.[84] In developing countries, permittee-responsible mitigation—mitigation by the impacting party or a subcontractor—is the most commonly found option for compliance. However, many countries (including Brazil, Cameroon, China, Colombia, Egypt, India, Mozambique, and South Africa) allow developers to compensate in lieu of offsetting, which is generally used to fund conservation projects by the public sector or an NGO.[85]

Mitigation banks take on the risks and complexity of undertaking an offset from developers.[86] Large mitigation banks can achieve economies of scale in design, maintenance, and monitoring. This enables them to protect larger, contiguous areas that offer better ecological payoff than smaller, isolated permittee-responsible mitigation projects.[87] An effective mitigation system requires laws, monitoring of compliance, and tough enforcement.[88] But transparency can be a problem.[89] Despite the market's size, data on credit prices is hard to find, and relatively little market infrastructure (like brokerages, accounting services, and standards) has emerged compared to newer markets like carbon.[90] It also remains unclear whether the currency of exchange adequately reflects ecosystem service values and can meaningfully ensure no net loss.[91]

82. Salzman et al., *supra* note 19, at 138.
83. *Id.*
84. *Id.*
85. *Id.*
86. *Id.*
87. *Id.*
88. *Id.*
89. *Id.*
90. *Id.*
91. *Id.*

C. *Forest Carbon*

Of all PES sectors, the forest and land use carbon market has received the most attention.[92] It is a policy instrument to combat climate change, and since 2009, it has spent $2.8 billion for forestry and land use practices that sequester carbon and quantify its benefits in a standardized offset.[93] Over the past twenty years, markets and funding mechanisms for climate mitigation have emerged all over the globe—for example, purely voluntary exchanges (CCX), international funding mechanisms (BioCarbon Fund), state mandates (California's AB-32), and international treaty flexibility mechanisms (CDM).[94] Taken together, these and others represent many different approaches in the private and public sectors.[95] As with any experiments, some have succeeded and others have not, but they continue to rapidly evolve and adapt.[96]

The Paris Agreement endorsed continued market development and introduced the term "Internationally Transferred Mitigation Outcomes."[97] The four major sources for forest and land use carbon offsets are afforestation/reforestation, improved forest management ("IFM"), sustainable agricultural land management, and reduced emissions from land use and forest degradation ("REDD"), which may include afforestation/reforestation, IFM, or agricultural interventions.[98]

92. *Id.*
93. *Id.*
94. *Id.*
95. *Id.*
96. *Id.*
97. *Id.*
98. *Id.*

FIGURE 5

Forest and Land Use Carbon PES

PES Mechanisms (Category)	Definitions	Example	Market Size 2008 → 2016	Number of Programs	Distributions (Countries)
Voluntary Forest and Land-Use Carbon Market (User-Financed)	Buyers willingly purchase offsets outside of government regulation – though "pre-compliance" demand anticipating regulation counts as voluntary.	Companies such as Microsoft, Disney, and Natura Cosméticos voluntarily purchase forest carbon offsets to meet corporate social responsibility commitments.	$46 million (2009) → $74.2 million (2016)	N/A	67
Compliance Forest Carbon Market (Compliance)	Regulation on greenhouse gas emissions, typically through cap-and-trade, allows forest carbon sequestration or avoided deforestation to provide offsets for emissions.	California's cap-and-trade program, launched in 2013, includes U.S. forestry as one of its offset protocols.	$5 million (2009) → $551.4 million (2016)	4 (2009) →17 (2016)	8
REDD Readiness Finance (Government-Financed)	Mechanism under the UNFCCC where developing tropical forest countries receive payments from countries for implementing activities that avoid deforestation and maintain carbon stocks in standing forests.	The World Bank Forest Carbon Partnership Facility Readiness Fund provides support to countries preparing to receive REDD+ payments, including development of national REDD+ strategies, systems for monitoring, reporting, and verification, and reference emission levels.	$3.2 billion (2009) → $8.1 billion (2014)	28 (2014)	28 (2014)
Public Sector Payments for Performance (Government-Financed)	Developed countries may agree to pay developing countries for reducing deforestation (REDD), with payments flowing once results are achieved.	Norway pledged $1B to Brazil's Amazon Fund to reduce its deforestation rate. Because Brazil has reduced deforestation more than 80% since 2004, most of the money has been disbursed.	$2.9 billion committed, $218 million disbursed (2014)	3 disbursed funds (2014)	3 disbursed, 23 pending (2014)

1. Supply Exceeds Demand for Voluntary Forest Carbon

The number of voluntary projects has steadily continued to grow with billions of dollars flowing toward REDD-preparedness.[99] Forest carbon has been the dominant project type on the voluntary market for the last two years, surpassing renewable energy. Nonetheless, demand remains a small fraction of the available supply for carbon offsets.[100]

99. *See id.* at 138.
100. *Id.*

2. Compliance Carbon Markets Have had Limited Impact

Neither the Clean Development Mechanism nor the European Union Emissions Trading Scheme has invested very much in forest conservation.[101] California's Air Resources Board has been more helpful to these project types: 65% of all offsets it issued as of 2017 were from forestry and land use projects.[102] But volumes transacted in 2016 (4.1 million tCO_2e) were still relatively small compared to overall offsets market activity. Further, the requirement that all offset projects be United States-based (excluding Hawaii and certain regions in Alaska) limits potential for scale.[103] The importance of forests in mitigating climate change was explicitly addressed in the Paris Agreement, but there have not yet been negotiations resulting in agreement on the role for forest and land-use carbon offsets in meeting emissions reduction targets.[104]

3. The Treatment of REDD in the UNFCCC Negotiations Will be Critical

Funding for REDD+ and REDD Readiness (building capacity to accept payments for performance) has dominated the PES carbon sector.[105] Developed countries have pledged over $8 billion for REDD Readiness through 2020 (46% from Norway) to sixty-seven tropical-forest countries and pledged almost $3 billion for actual emissions reductions.[106] Disbursing funds has been a slow process: As of 2017, only $218 million had been paid to countries for emissions reductions.[107] Without REDD+, the prospects for forest carbon PES are diminished.[108]

Without REDD, the prospects for forest carbon PES are likewise diminished.[109] The recent Paris Agreement endorsed the REDD+ approach, but due to the focus on Nationally Determined Contributions, it is uncertain how many national and subnational programs will accept REDD+ credits from other countries for compliance obligations unless there are clear and widely adopted international guidelines concerning measurement, verification, and reporting.[110]

101. *Id.*
102. *Id.* at 138–39.
103. *Id.* at 139.
104. *Id.*
105. *Id.*
106. *Id.*
107. *Id.*
108. *Id.*
109. *Id.*
110. *Id.*

D. *New Horizons: Agricultural Commodities*

Large-scale agriculture and unsustainable forest practices are responsible for roughly two-thirds of tropical deforestation and significant biodiversity loss.[111] Most of these impacts arise from the production of a small number of commodities—palm oil, soy, cattle, timber, and pulp—in developing countries (which account for 70% of the world's soy and all of its palm oil).[112] These commodities were valued at $98 billion of agricultural exports in 2013 and provide ingredients for hundreds of millions of consumer products, from candy bars to soaps, and account for a large part of supply chains' greenhouse gas emissions.[113] Maintaining these trade flows is critical to sustaining tropical countries' continued development.

An increasing number of actors throughout the supply chain have publicly committed to reduce the ecosystem impacts of the commodities that they produce or procure. These commitments vary enormously—by level of stringency, breadth of coverage, length of obligation, and many other sourcing characteristics. Established commodity groups such as the Forest Stewardship Council, Roundtable for Responsible Soy, and the Roundtable for Sustainable Palm Oil provide a forum for hundreds of companies to engage in stakeholder dialogues and develop reporting and certification standards.[114] In sum, commitments have come from companies exceeding $4 trillion in market capitalization.[115] Over 30% of these commitments were made in 2014.[116]

Because there has been no effective standardization of definitions or performance verification, it is difficult to compare across commitments. Two-thirds of the parties work within certifications systems, with the remaining outside standardized verification frameworks. And some companies go above and beyond the certification requirements in their commitment.

Certified commodities represent the most significant new opportunity for PES. This represents a major shift from ten and twenty years ago, when the push for certification primarily came from consumers. Now major retailers and suppliers are taking the lead. While a welcome development, this poses significant challenges.

Ensuring traceability requires mapping thousands of supply chains from farm and production to suppliers and retailers. Companies set-

111. MOLLY PETERS-STANLEY ET AL., SUPPLY CHANGE: CORPORATIONS, COMMODITIES, AND COMMITMENTS THAT COUNT 7 (Mar. 2015), https://forest-trends.org//wp-content/uploads/2018/04/Supply-Change_Report.pdf [https://perma.cc/KM8G-TKHZ].

112. *Id.*

113. *Id.*

114. *See id.* at 11.

115. *Id.*

116. *Id.*

ting their own goals may be engaged in greenwashing, so how can credibility be ensured? Certification organizations have an incentive to ensure others are complying with their standards, but they face a significant conflict of interest. Enforcing their standards too strictly may lead to a decrease in users, and significant monitoring costs may prove too expensive. There is therefore a need for an independent institution to ensure the systems' credibility.

IV. Assessing the Effectiveness of PES

The preceding sections set out the most comprehensive assessment to date of PES in terms of geographic coverage, number of programs, value of transactions, and rates of growth. These metrics do not, however, answer the fundamental question of PES's effectiveness. Put simply, has PES delivered in terms of service provision (a biophysical measure), efficiency (an economic measure), or improvement of social welfare (such as poverty reduction, gender equity, securing property rights, etc.)?

Perhaps surprisingly, for the vast majority of programs we simply do not know. Reviews have consistently lamented the lack of data on the effectiveness of PES.[117] As Pattanayak et al. reported in 2010, "[w]e do not yet fully understand either the conditions under which PES has positive environmental and socioeconomic impacts or its cost-effectiveness."[118] A recent review in *Science* reached the same conclusion.[119]

Like most conservation programs (public or private), few PES schemes have been established with evaluation in mind. As a result, researchers studying them at a later date have had no baseline data, control areas, or randomized design, making it difficult to evaluate counter-factuals—what would have happened without a PES program?[120] Some scholars have applied matching or difference-in-difference methods of analysis to address this problem,[121] while others have relied on proxy measures (such as acres under contract) assumed to

117. Roy Brouwer et al., *Meta-Analysis of Institutional-Economic Factors Explaining the Environmental Performance of Payments for Watershed Services*, 38 Envtl. Conservation J. 380, 388 (2011); Daniela A. Miteva et al., *Evaluation of Biodiversity Policy Instruments: What Works and What Doesn't?*, 28 Oxford Rev. Econ. Pol'y 69, 85–86 (2012).

118. Subhrendu K. Pattanayak et al., *Show Me the Money: Do Payments Supply Environmental Services in Developing Countries?*, 4 Rev. Envtl. Econ. & Pol'y 254, 268 (2010).

119. S. Naeem et al., *Get the Science Right When Paying for Nature's Services: Few Projects Adequately Address Design and Evaluation*, 347 Sci. 1206, 1206 (2015).

120. Paul J. Ferraro et al., *Estimating the Impacts of Conservation on Ecosystem Services and Poverty By Integrating Modeling and Evaluation*, 112 Proc. Nat'l Acad. Sci. U.S. 7420, 7421 (2015).

121. Miteva et al., *supra* note 117, at 73; Paul J. Ferraro & Merlin M. Hanauer, *Advances in Measuring the Environmental and Social Impacts of Environmental Programs*, 39 Ann. Rev. Env't Res. 495, 504 (2014).

correlate with ecosystem service provision.[122] Moreover, much of the literature has relied on case studies, introducing problems of selection bias.[123] The paragraphs below summarize effectiveness scholarship for the different types of PES schemes.

Empirical studies on the effectiveness of forest PES, largely in Costa Rica and Mexico, have reported mixed results for reduced deforestation, depending on the time period and area.[124] Researchers highlighted concerns over additionality: That PES contracts are often established on low-value lands unlikely to be converted to other uses[125]—and leakage—that avoided deforestation in the PES area leads to increased logging in other areas.[126]

Robust studies on the effectiveness of forest certification programs are also lacking. A 2016 review by Heilmayr and Lambin concluded that "[p]revious assessments generally failed to meet basic standards of rigor such as comparison to a credible control."[127] Lambin et al. similarly concluded that "few studies have tried to measure the producer-level environmental effects of eco-certification, and even fewer have overcome the methodological challenges."[128] There has been evidence, though, of localized qualitative benefits such as clarification and security of land tenure, greater levels of compliance, and increased social capital.[129]

Miteva et al. reported little causal evidence on the effectiveness of conservation instruments in developing countries.[130] Their review of PES schemes (all in Latin America) found reduced deforestation and increased reforestation, but none of the studies considered the impact on forest quality.[131] Gullison reported that forest certification generated biodiversity benefits but questioned whether they would be sufficient to protect high conservation value forests.

122. Ferraro et al., *supra* note 120, at 7420.

123. Kathy Baylis et al., *Mainstreaming Impact Evaluation in Nature Conservation*, 9 CONSERVATION LETTERS 58, 60 (2015).

124. Ferraro et al., *supra* note 120, at 7422.

125. G. Arturo Sanchez-Azofeifa et al., *Costa Rica's Payment for Environmental Services Program: Intention, Implementation, and Impact*, 21 CONSERVATION BIOLOGY 1165, 1172 (2007).

126. Jennifer M. Alix-Garcia et al., *Forest Conservation and Slippage: Evidence from Mexico's National Payments for Ecosystem Services Program*, 88 LAND ECON. 613, 613 (2012).

127. Robert Heilmayr & Eric F. Lambin, *Impacts of Nonstate, Market-Driven Governance on Chilean Forests*, 113 PROC. NAT'L ACAD. SCI. U.S. 2910, 2910 (2016).

128. Eric F. Lambin et al., *Effectiveness and Synergies of Policy Instruments For Land Use Governance in Tropical Regions*, 28 GLOBAL ENVTL. CHANGE 129, 133 (2014).

129. Michael Richards, *What Do We Know About Gender and Other Social Impacts of IWS Projects?: A Literature Review*, FOREST TRENDS 2 (May 2013), https://www.forest-trends.org/wp-content/uploads/imported/literature-review_gender-and-social-impacts_pws-projects_9-19-13-pdf.pdf [https://perma.cc/Z7K5-STDG].

130. Miteva et al., *supra* note 117, at 86.

131. *Id.* at 77–78.

There is a large literature on water PES schemes. A 2011 review of forty-seven schemes by Brouwer et al. found that 58% had been "classified as effective in reaching their environmental objectives, while 42[%] were not."[132] Reflecting the massive scale of recent Chinese watershed PES programs, an increasing number of studies have started to assess these initiatives.[133]

A small number of PES programs, such as South Africa's Work for Water Program, have explicit poverty alleviation goals.[134] Some studies of PES watershed schemes have found positive welfare impacts for PES participants, with increased household income,[135] but the overall record has not demonstrated strong positive or negative impacts on poverty.[136] Samii et al. conducted a thorough review on the link between forest PES and poverty, reporting that there is "little reason for optimism for current PES approaches to achieve both conservation and poverty reduction benefits jointly."[137]

While there is a large body of research on the social welfare impacts of the Clean Development Mechanism, most of these are not PES projects.[138] PES impacts on gender remain largely unstudied.[139]

A number of researchers have raised equity concerns created by PES programs. Bennett described problems with lack of voluntary participation in China's Sloping Land Conversion Program.[140] Rodríguez de Francisco et al. charged that PES reinforced existing social differences.[141] The most critical literature has focused on REDD initiatives, though most of these articles have been qualitative or predic-

132. Roy Brouwer et al., *supra* note 117, at 387.

133. Hau Zheng et al., *Benefits, Costs, and Livelihood Implications of a Regional Payment for Ecosystem Service Program*, 110 PROC. NAT'L ACAD. SCI. U.S. 16681, 16681 (2013).

134. J.K. Turpie et al., *The Working for Water Programme: Evolution of a Payments for Ecosystem Services Mechanism That Addresses Both Poverty and Ecosystem Service Delivery in South Africa*, 65 ECOLOGICAL ECON. 788, 794 (2008).

135. Johannes Alexeew et al., *An Analysis of the Relationship Between the Additionality of CDM Projects and Their Contribution to Sustainable Development*, 10 INT'L ENVTL. AGREEMENTS 233, 239 (2010).

136. *Id.*; Pattanayak et al., *supra* note 118, at 261.

137. Cyrus Samii et al., *Effects of Payment for Environmental Services (PES) on Deforestation and Poverty in Low and Middle Income Countries: A Systematic Review*, CAMPBELL SYSTEMATIC REVS. 7 (Dec. 19, 2014), https://campbellcollaboration.org/effects-of-payment-for-environmental-services-pes-on-deforestation-and-poverty-in-low-and-middle-income-countries-a-systematic-review/download/537_5c7e18d9f0ce44f295c745d36998793a.html [https://perma.cc/B22P-3Z6Q].

138. *See generally* Alexeew et al., *supra* note 135; Emily Boyd et al., *Reforming the CDM for Sustainable Development: Lessons Learned and Policy Futures*, 12 ENVTL. SCI. & POL'Y 820; Tracey L. Crowe, *The Potential of the CDM To Deliver Pro-Poor Benefits*, 13 CLIMATE POL'Y 58 (2013).

139. Heilmayr & Lambin, *supra* note 127, at 2913.

140. Michael Bennprat, *China's Sloping Land Conversion Program: Institutional Innovation or Business as Usual?* 65 ECOLOGICAL ECON. 699, 707 (2008).

141. Jean Carlo Rodríguez de Francisco et al., *Payment for Environmental Services and Unequal Resource Control in Pimampiro, Ecuador*, 26 SOC'Y NAT. RESOURCES 1217, 1229 (2013).

tive.[142] Empirical research has typically found little or only slightly positive social effects.[143]

Viewed overall, there has been scant impact evaluation of PES in the field. This prevents meaningful analysis of the effectiveness of PES or strategies to maximize the delivery of services and related benefits. Given the scale of current PES transactions and their likely increase, the weak state of assessment will prove problematic if program critics begin to challenge whether funds have been spent effectively. Addressing this gap will require much more intentional design of PES at the outset to collect relevant data and test hypotheses.

V. Lessons Learned

While the well-known PES success stories continue to generate enthusiasm and interest for PES approaches, a close examination of the experiences to date of the many types of PES mechanisms suggests a more nuanced picture. A small number of PES mechanisms account for the majority of growth in number, volume of transactions, size of transactions, and geographic spread. The key questions are: (1) Why have some programs grown to scale while others have not? (2) What does this tell us about the broader issue of instrument choice in environmental protection? We suggest these can be addressed through focusing on four key factors—motivated buyers, motivated sellers, metrics, and low transaction cost institutions.

A. *Motivated Buyers*

As with all exchanges, PES is driven by demand—i.e., the perceived scarcity of ecosystem services. People do not buy what they feel they do not need. In the PES arena, the scarcity may concern water quality, flood protection, climate stability, or biodiversity. If a service is not scarce (or is simply taken for granted), there is no evident need to pay for it. Many PES mechanisms are purely private—e.g., duck hunters pay farmers to keep grain on their fields or flood them, and cities pay upper-watershed land owners to keep trees standing rather than de-

142. *See, e.g.*, Patrick Bottazzi et al., *Carbon Sequestration in Community Forests: Trade-offs, Multiple Outcomes and Institutional Diversity in the Bolivian Amazon*, 45 Dev. & Change 105 (2014); Jan Börner et al., *Direct Conservation Payments in the Brazilian Amazon: Scope and Equity Implications*, 69 Ecological Econ. 1272 (2009); Michael Huettner, *Risks and Opportunities of REDD+ Implementation for Environmental Integrity and Socio-Economic Compatibility*, 15 Envtl. Sci. & Pol'y 4 (2011).

143. Rohit Jindal et al., *Reducing Poverty Through Carbon Forestry? Impacts of the N'hambita Community Carbon Project in Mozambique*, 40 World Dev. 2123, 2123 (2012); Mohan Poudel et al., *Social Equity and Livelihood Implications of REDD+ in Rural Communities—A Case Study from Nepal*, 9 Int'l J. Commons 177, 177 (2015); T.N. Maraseni et al., *An Assessment of the Impacts of the REDD+ Pilot Project on Community Forests User Groups (CFUGs) and Their Community Forests in Nepal*, 136 J. Envtl. Mgmt. 37, 37 (2014).

velop. Landholders can choose to enter into these transactions or not. The challenge is that many ecosystem services are public goods whose benefits cannot easily be captured by discrete parties. As a result, complete reliance on private PES transactions will prove insufficient in many settings to ensure the socially optimal level of service provision.

We currently see this challenge playing out in the domain of climate change. Private markets do not internalize the negative costs of greenhouse gas emissions (also known as the social cost of carbon[144]) that result indirectly in harms such as the extended droughts in California or more frequent and powerful hurricanes in the Atlantic.[145]

PES instrument design addresses this issue by stimulating transactions through regulation that creates demand. This prevents free-riding and overcomes the collective action costs of organizing diffuse beneficiaries. It is thus no surprise that many of the largest PES programs are all based on transactions mandated by compliance PES, such as mitigation banking. This also explains why the PES mechanisms of compliance biodiversity, instream flow, and water quality markets remain limited to a small number of countries. The necessary governance capacity of laws and institutions to create regulatory demand is absent in most countries.

B. *Motivated Sellers*

If PES payments are to provide services, then landowners must be paid, and their behavior must be sufficient to provide the desired service. Moreover, the amount paid to landowners must be competitive with the opportunity costs. Put another way, PES on its own will make trees more valuable standing than cut down only if the service payments to economically-motivated landowners are as attractive as the value of timber. But in many settings, the revenue streams from PES will not change landowners' behavior and may need to be bolstered by regulation or other strategies.

This, too, suggests limits to purely private markets. If a significant part of the service's value lies outside the transaction (or the collective action costs of organizing payments from beneficiaries are high), then we should not expect to see large and growing PES markets. The data supports this. Wetlands provide important protection against flooding and storm surges. This was evident recently in Houston but more dra-

144. *The Social Cost of Carbon: Estimating the Benefits of Reducing Greenhouse Gas Emissions*, U.S. ENVTL. PROTECTION AGENCY, https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html (last visited Sept. 7, 2018) [https://perma.cc/7BP6-5CCU].

145. Scott Waldman, *Global Warming Tied to Hurricane Harvey*, SCI. AM. (Dec. 14, 2017), https://www.scientificamerican.com/article/global-warming-tied-to-hurricane-harvey/ [https://perma.cc/EU33-KDF4].

matically with Hurricane Katrina.[146] In neither case, however, did private markets emerge to conserve wetlands for their flood protection services. The most important instruments for wetlands conservation are regulatory, most notably the Section 404 program under the Clean Water Act.[147] This has spurred the growth of mitigation bankers who now provide credits for wetlands habitat. Even here, though, there is often a mismatch between where the mitigation takes place (generally far from the development impact) and where the service provision would be most valuable.[148]

One can also stimulate service provision with subsidies such as watershed PES financed through water utility bills or government payments. A key practical challenge for subsidy programs, though, lies in identifying those landholders that are most important for service provision. This requires an assessment mechanism to ensure the funds are spent most efficiently. There is no real benefit in paying everyone to conserve wetlands. The focus should be on wetlands with the potential to provide the greatest level of storm water protection. Most subsidy programs, however, do not condition payments on service provision capacity, either because of the transaction costs or concern over achieving the dual goal of poverty alleviation.[149]

C. *Metrics*

Because PES is, by definition, an exchange of value for services, how the service should be measured is of prime importance.[150] Most PES transactions do not resemble markets in the sense of competing buyers and sellers.[151] True PES markets only occur in the shadow of regulation: They are only feasible where metrics are easily obtained and services are fungible, like the carbon compliance market in California, which trades in offset credits equivalent to one ton of carbon dioxide equivalent emissions.[152] Wetland and stream mitigation programs also provide low-cost metrics, defining credits in terms of wetland area and linear stream habitat lost or restored, often with additional quality weightings.[153] These are proxies, however, and it remains contested how accurately they capture service provision.[154]

146. Edward B. Barbier, *Hurricane Katrina's Lessons for the World*, 524 NATURE 285, 285 (2015).
147. 33 U.S.C. § 1344 (2012).
148. J.B. Ruhl & James Salzman, *The Effects of Wetland Mitigation Banking on People,* 28 NATL. WETLANDS NEWSL. 1, 1, 8 (2006).
149. Stefanie Engel, *The Devil in the Detail: A Practical Guide on Designing Payments for Environmental Services*, 9 INT'L R. ENVTL. & RESOURCE ECON. 131, 151 (2016).
150. Salzman et al., *supra* note 19, at 140.
151. *Id.*
152. *Id.*
153. *Id.*
154. *Id*.

Metrics present more definition and exchange problems once one moves to biodiversity and habitat, as seen by the difficulty in practically defining "no net loss."[155]

The choice of metrics presents a tension—easily assessed metrics reduce transaction costs and facilitate exchanges, but they risk missing what really matters and may not actually align with conservation goals.[156] More rigorous metrics, by contrast, may accurately capture service values but be so unwieldy that transaction costs become prohibitive.[157]

D. *Low-Transaction Cost Institutions*

As a practical matter, a PES program requires a group of discrete buyers to buy a service and a set of discrete sellers to be paid.[158] Thus, there must be an efficient way to collect and distribute funds.[159] This is fundamental to the success of many watershed PES programs.[160] Water utilities already collect fees from those to whom they provide water.[161] Because no individual negotiation is necessary, the transaction costs are small.[162]

Aside from services with clear and localized benefits, such as water purification and flood protection, two institutional problems remain.[163] First, ecosystem services are often subject to the domains of different agencies and political jurisdictions. This creates high transaction costs, as the different regimes must be mediated.[164] Second, there is a problem of diffuse beneficiaries.[165] If everyone benefits from a public good, such as biodiversity or carbon sequestration, then effectively no one can be charged.[166] Philanthropic institutions such as the World Wildlife Fund or the Norwegian government's foreign aid for REDD help overcome these hurdles by aggregating demand on behalf of the public, but freeriding remains a problem.[167]

With these factors in mind, it is obvious why the scaling up of subsidy watershed PES has been a successful strategy in terms of value, growth, and geographic reach.[168] Buyers are motivated to protect watershed because of the clear relationship between watershed protec-

155. *Id.*
156. *Id.*
157. *Id.*
158. *Id.*
159. *Id.*
160. *Id.*
161. *Id.*
162. *Id.*
163. *Id.* at 140–41.
164. *Id.* at 141.
165. *Id.*
166. *Id.*
167. *Id.*
168. *Id.*

tion and water quality.[169] It is easy to identify upper-watershed landowners and pay them to change their management practices.[170] The clear metrics for implementation are based on restrictions on development and can be monitored at a low cost.[171] Additionally, water utilities already collect fees from beneficiaries and pay suppliers.[172] Voluntary biodiversity PES, at the other extreme, generally lacks all of these attributes.[173]

VI. Conclusion

Taken together, PES programs in water, carbon and habitat/biodiversity represent significant policy instruments across the globe, with total transaction value in each sector in the billions of dollars. While there is significant heterogeneity, a small number of PES approaches account for the majority of growth in each sector. Water PES dominates in terms of transaction value, number of programs, and geographic spread. Forest carbon PES continues to grow, but biodiversity PES has remained small in terms of value and diffusion. Certification for the major agricultural commodities that drive deforestation represents the greatest emerging opportunity for new and significant PES growth, but credibility and transparency present major challenges.

Simply because certain types of PES are unlikely to scale up does not mean they should be regarded as failures. In many parts of the world where conservation is most under threat, alternatives to PES may be infeasible and the preconditions for large-scale PES absent. As a result of weak governance capacity, regulation and credible enforcement may not be options. In those settings, PES mechanisms, even if operating at small scale, may represent the most promising "second-best" conservation strategy.

In practice, PES represents a rich blend of carrots and sticks and of private transactions and regulation. Those services that are primarily public goods, where private benefits cannot be captured easily, regulation and subsidy instruments dominate. In settings where service provision provides significant private benefit or where consumers view service provision as an important aspect of the social license to operate, then purely private and non-governmental transactions dominate.

169. *Id.*
170. *Id.*
171. *Id.*
172. *Id.*
173. *Id.*