

Article

A Lens for Analysis of Payment for Ecosystem Services Systems: Transitioning the Working Lands Economic Sector from Extractive Industry to Regenerative System

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Abstract: Payment for Ecosystem Services (PES) systems are gaining attention worldwide. These systems are an increasingly used incentive structure for conservation, presenting a significant opportunity for science to impact and shape commerce. However, PES systems lack a unifying framework to analyze and evaluate them from multiple perspectives, including ecological revitalization alongside economic and social revitalization. In this study, I formulate a new analytical framework that accommodates both public and private PES systems, and test the framework with hypotheticals from both systems. Utilizing the framework developed, this article shows that publicly-operated PES systems function optimally, as a public system provides optimized benefits regarding societal and ecological outcomes, now and for future generations.

Keywords: payment for ecosystem services; land-use; equity; just transition; conservation



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1. Introduction

There are a multitude of stacking crises faced by society today, from the changing climate [1] and the failing rural economy [2], to the loss of biodiversity at an “unprecedented” rate [3]. Many different policies aim to alleviate the worst effects of these ongoing crises, but one has recently attracted increasing interest: payment for ecosystem services (PES) systems. A PES system, unlike other conservation frameworks, is an outcome-oriented system that looks to internalize the positive externalities associated with regenerative ecosystem management. Rather than only putting value on the goods lands can provide, a PES system also looks to value services, including the water a property retains and purifies, the carbon it can sequester, the biodiversity it can foster, and/or even the cultural experiences it can offer. The implications of the design of this type of system are immense; it could lead to a meaningful change in how we view and interact with the landscape, or it could solidify the status quo and entrench large, moneyed interests. The underlying principles and goals of a PES system will ultimately determine if the former is attained, or the latter is reinforced.

There is currently a lot of discussion surrounding the idea of “regenerative agriculture,” and what that term really means [4]. For the purposes of this article, the term “regenerative” is used to signify systems that are not extractive or exploitive, but instead aims to reestablish ecological processes and produce natural abundance. This can generally be done using Traditional Ecological Knowledge (TEK) that has developed in that place [5]. Recognition that indigenous peoples in what is now the United States utilized regenerative systems for millennia is in order, because it is those cultures and communities that hold the cultural and ancestral knowledge of place necessary to revitalize ecological processes. The intentional inclusion of indigenous peoples and their TEK in any PES system should be a central pillar of the design process.

The goal of this article is to formulate a framework to analyze PES systems, and to compare the potential benefits and detriments to pursuing a privately- or publicly-operated system. This article will provide a four-factor framework for analyzing a PES system, represented in Table 1, with the goal being a fundamental transition in how our

land-management schemes operate. First, the system will address the significant health impacts our current agriculture and food systems bring about. Secondly, and intimately related, the system will increase the ecological health of the area being used, because current conservation programs are producing questionable results [6]. Third, the system will effectively increase the economic viability of a land-based business, an issue of growing importance given the “new farm crisis” we are experiencing [7,8]. Fourth, the system will efficiently purchase services and equitably distribute financial and other benefits to land managers. Then, this article will discuss the overarching characteristics of private- and publicly-operated systems, and supply a few brief examples. Lastly, this article will utilize the framework to discuss the hypothetical advantages and disadvantages of utilizing a privately- or publicly-operated PES systems.

Table 1. Identified Factors, Metrics for Factors, and How to Quantify Metrics. This table is the result of research into different quantification methods for the factors being addressed in this proposed analytical framework.

Factor	Metrics	How to Quantify Metrics	Reference
(1). Addressing Public Health Concerns	Amount of agri-chemicals used	Total amount of pesticides, herbicides, chemical fertilizers imported and used. Total amount of agricultural antibiotics used [9]	Richardson, M., Madrigal, D. Wilkie, A., Wong, M., Roberts, E., Environmental Health Tracking Improves Pesticide Use Data to Enable Research and Inform Public Health Actions in California, <i>Journal of Public Health Management and Practice</i> : September/October 2017, Volume 23, Issue p S97–S104, doi:10.1097/PHH.0000000000000595
	Increased access to, and consumption of nutrient-dense foods	An example of a valuable analysis is what Washington County of Vermont did to better understand this issue [10,11].	http://map.ccrpcvt.org/foodretailaccess/ (accessed on 11 June 2021); Freudenberg, N., Willingham, C., Cohen, N., The Role of Metrics in Food Policy: Lessons from a Decade of Experience in New York City. <i>Journal of Agriculture, Food Systems, and Community Development</i> . (2018). 191–209, doi:10.5304/jafscd.2018.08B.009.
	Access to green space and community-building spaces	Neighbourhood[sic] Green Space Tool [12].	Christopher Gidlow, et al., Development of the Neighbourhood Green Space Tool, <i>Landscape and Urban Planning</i> 106(4):347–358 (June 2012).
(2). Increased Health of Ecosystem	Soil health measurements	Complete Assessment of Soil Health tests through Cornell Participatory Science measures like water infiltration rates and aggregation rates [13].	Franklin E., Sara Bar N., Soil Health Benchmarks: 2021 Report, PASA Sustainable Agriculture, https://pasafarming.org/wp-content/uploads/2021/03/Soil-Health-Benchmarks-Report-2021_Digital_Compressed.pdf (accessed on 11 June 2021)

Table 1. Cont.

Factor	Metrics	How to Quantify Metrics	Reference
	Biodiversity surveys (bird, plant, insect)	Either surveys through full-time, paid monitoring personnel that visit a statistically valid sample representation of Vermont's landscape or through quality-controlled citizen science observation programs [14–16].	ERAMMP, https://erammp.wales/en (accessed on 11 June 2021); Toevs, G., Taylor, J., Spurrier, C., MacKinnon, W., Bobo, M., Assessment, Inventory and Monitoring Strategy: For Integrated Renewable Resources Management, Bureau of Land Management, https://www.blm.gov/sites/blm.gov/files/uploads/IB2012-080_att1.pdf (accessed on 11 June 2021); Sullivan, B., Aycrigg, J., Barry, J., Bonney, R., Bruns, N., Cooper, C., Damoulas, T., Dhondt, A., Dietterich, T., Farnsworth, A., et al., The eBird enterprise: An integrated approach to development and application of citizen science, <i>Biological Conservation</i> , Volume 169, 2014, 31–40, doi:10.1016/j.biocon.2013.11.003.
	Water quality measurements	Water quality observations already tracked by state, investing in remote/in situ monitoring capabilities where appropriate [17].	Behmel, S., Damour, M., Ludwig, R., Rodriguez, M., Water quality monitoring strategies—A review and future perspectives, <i>Science of The Total Environment</i> , 571, 2016, 1312–1329, doi:10.1016/j.scitotenv.2016.06.235.
	Emissions reductions and storage	Can be assessed through conservation planning as well as soil tests and increases in woody biomass on property [18].	Graves, R., Haugo, R., Holz, A., Nielsen-Pincus, M., Jones, A., Kellogg, B., Macdonald, C., Popper, K., Schindel, M., Potential greenhouse gas reductions from Natural Climate Solutions in Oregon, USA. <i>PLoS One</i> , (2020) 15(4), doi:10.1371/journal.pone.0230424.
	Modeled predictions	Utilizing modeling technology to predict, either on the farm or watershed scale, the ecosystem services provided through different conservation systems on a piece of property; ground-truthing these predictions with monitoring observations [19].	Crossman, N., Burkhard, B., Nedkov, S., Willemen, L., Petz, K., Palomo, I., Drakou, E., Martin-Lopez, B., McPhearson, T., Boyanova, K., et al, A blueprint for mapping and modelling ecosystem services, <i>Ecosystem Services</i> 4, 4–14, 5 (2013).
	Number of land operations with qualifying conservation plans	Amount of qualifying conservation plans produced and filed with the State	N/A
(3). Land Management Business Viability	Total amount of funds distributed	Amount of dollars distributed to land-based businesses; economic impact analysis of the funds investing into these rural communities [20].	Sullivan, S., McBride, W., Hellerstein, D., McGranahan, D., Hansen, L., Roberts, M., Johansson, R., Vogel, S., Koenig, S., Bu-cholstz, S., Lubowski, R., The Conservation Reserve Program: Economic Implications for Rural America, United States Department of Agriculture—Economic Research Service, Sept 2004.

Table 1. Cont.

Factor	Metrics	How to Quantify Metrics	Reference
	Incentivize and assign value to stacked production.	Increased number of acres producing multiple goods and services from same land-plot, can be assessed through participant surveys [21].	White, A., Faulkner, J., Enhancing participation in payment for ecosystem services programs: understanding farmer perspectives, The University of Vermont Extension, Sept 2019.
	Participant surveys	A mixture of quantitative questions discussing the amount of funds acquired through PES system alongside qualitative information with satisfaction with operation of system [21].	White, A., Faulkner, J., Enhancing participation in payment for ecosystem services programs: understanding farmer perspectives, The University of Vermont Extension, Sept 2019.
	Layers of entities/profit margins between purchaser and service provider	The amount of entities or individuals between the ultimate buyer of the service and the land-facilitator that supplies the service	N/A
(4). Efficient and Equitable Purchasing	Payments contingent on quantity and quality of service	Payments are tied to the quantitative metrics of ecosystem health	N/A
	Supporting funds and programs that aid land access	Establishing or partnering with a fund that allows systematically underserved populations to gain access to land [22]	Valliant, J., Freedgood, J., Land access policy incentives: Emerging approaches to transitioning farmland to a new generation. <i>Journal of Agriculture, Food Systems, and Community Development</i> , (2020) 9(3), 71–78, doi:10.5304/jafscd.2020.093.027

Ecosystem services (ES) are a function an environment provides that benefits society or humanity in some way [23]. These services can be at nearly every scale, from the hyper-local, like water retention and quality, to global, like carbon sequestration, or somewhere in between, like increasing or maintaining biodiversity [23]. These ESs are differentiated from an ecosystem good, like timber or crops, which are tangible products that can be taken from a piece of land [24]. Currently, our policies only assign economic value to goods rather than services. This is likely due to, at least in part, the historical technological limitations of monitoring and modeling techniques, an area of study that has been rapidly developing [14].

Ecosystem services will vary depending on the specific landscape or environment that is producing them; a forest will provide different services in different amounts than a field of row crops. Even within one “class” of ecosystem there can be drastic variations: a cultivated, commercial monoculture forest will drastically differ from a rewilding forest with no or highly-selective timber harvesting. Differentiating between these landscape types is crucial for the earth system models employed to predict and track the services a land can, and then does, produce [19]. Defining the limits of any natural system for legal purposes is difficult, as exemplified in the long history of discussions about what is a “wetland” for the purposes of the Clean Water Act [25]. Here, though, it may be simpler. Agricultural lands are working lands managed to produce food, fiber, or agricultural products from crops and livestock [26]. Forestry lands are also working lands, but are managed to produce raw materials for wood products and, increasingly often, recreational activities [27]. An alternative to labeling our working lands as “agricultural” or “forestry” is to accept that these uses and purposes often overlap, and include both in a title of “facilitated lands”.

A new category like this would better align our land regulatory schemes with reality, dispelling legal fictions that forested lands and agricultural land are different, and are not stackable. This slight but potentially monumental shift in terminology would allow for a systems-based regulatory and incentive scheme across the whole landscape, making it unnecessary to silo portions of land into disparate regulatory schemes. The term “facilitating” is used rather than managing working because facilitating expresses the role of emboldening natural processes to foster natural abundance rather than manufactured abundance [28]. If a goal is to facilitate natural abundance, then one plot of land will likely produce food, fiber, fuel, timber, and a variety of services; recognizing that possibility is imperative.

2. Materials and Methods

The sources utilized in this article range from social and natural scientific publications, government documents and policy summaries, to discussions with practitioners in these fields. There were no new studies or measurements that took place in the research presented. The research fell into two primary buckets: (1) the Analytical Framework for PES Systems [21,29–35] and (2) the factors proposed to differentiate public and private PES system operators [36–43]. This article’s research relies heavily on the scientific literature regarding ecological health, specifically from a Western Science perspective. These studies aim to understand discrete pieces of the ecological system [14,31–33,44], be they soil carbon, biodiversity, or water-related services, and then integrate that discrete understanding into a larger narrative of ecological health. Along with this Western Science perspective, I aim to highlight the need to integrate TEK into our understanding of natural systems [5]. Bridging these two pools of knowledge and ways to view the world is essential to create a robust understanding of the operation of ecological systems, as well as how they interact with human systems.

The limits to the presented research are important to highlight, as the study and development of PES systems is still a forming body of work. The goal of this article is not to be the sole, comprehensive discussion of PES systems. This article aims to add to the growing discussion and ensure that PES systems are discussed holistically and systematically, not focusing on one sole aspect of the potential benefits, be it ecological or societal. This is reflected in the research for this article, as it attempts to touch on natural sciences, health sciences, social sciences, economic systems, and legal structures. Since this research is so significantly broad, there are likely pieces of fresh research that have been overlooked.

3. Results

3.1. *Mode of Analysis for a Payment for Ecosystem Services Program*

When designing and implementing a payment for ecosystem services system, there are certain over-arching factors and goals that should be taken into account. First, a PES system must address the public health impacts associated with our agricultural system and the food it produces. Second, the health and wellbeing of the ecosystem being facilitated must be a piece of any analysis. For a PES system to succeed, the overall vitality of the landscape must be improved, and those improvements tracked and accounted for. Third, the economic viability of diversified operations must be increased. In other words, these systems should increase the streams of revenue of a land-facilitating business, rather than compensate for assumed income lost because of conservation techniques. Lastly, there must be measures put in place to both efficiently and equitably administer this system. These factors, metrics, and applicable references have been collected and are provided in the Table 1.

At the outset, though, the system’s purpose must be oriented towards bringing about a transition in how we interact with our landscape. The system should signal a transformational change in our relationship with the landscape, brought about by changing the economics of land-based businesses. Our current regulatory framework surrounding

agriculture and forestry is focused on mandating compliance with a mix of regulatory benchmarks and best management practices including tillage practices [45], when fertilizers can be applied to the field, and when trees can or cannot be harvested for lumber [46]. How our greater agricultural markets operate also reinforces the extractive status quo, offering a premium for crops as an incentive to comply with certain conservation practices or programs [47]. Current programs aim to make up the difference in income a land manager may forego and the costs they incur by using conservation practices, or rewilding portions of their property [48].

In contrast, a system that provides a framework to proactively transition a land manager's relationship with land to that of a land facilitator is based off of a systems-analysis of the ecosystem, providing opportunities to land-based businesses to maximize ecological health of the property alongside the economic health of the business. This type of system allows for the purchasing of a variety of goods and services lands may produce, and each individual operation would be able to tailor their outputs to best fit the land and ecosystems they find themselves inhabiting. Rather than compensating a land manager for the loss of income, this system directly compensates for services provided to a buyer [49]. Aptly named an outcomes-based compensation for conservation framework, these systems aim to tie the compensation for the quality of service being provided, either through on-the-ground monitoring, or advanced modeling tools [11]. These systems also increase the amount of choice made by the land facilitator of what to produce and how to produce it. Land facilitators may choose an industrial system that aims to maximize goods produced and minimizes services, a regenerative system that aims to maximize services and minimize goods, or most likely somewhere in between. Put simply, rather than only accounting for the goods a land-based business produces, an outcomes-based system incentivizes stacked production of multiple goods and services from the same plot of land.

3.2. The Spectrum and Qualities of Private Markets to Public Programs for Ecosystem Services

There are a growing number of iterations of PES systems [50]. They range from a purely-market driven approach, to ones that operate simply as a public program recognizing a farm's "environmental excellence" to allow for price premiums on the goods they produce [36]. However, most fall somewhere in between purely-private and purely-public, requiring a discussion of different characteristics that influence how a program operates. The characteristics discussed are: (1) who owns, operates, and/or manages the system; (2) what transparency requirements are applicable to the operation of the system; (3) if a profit-motive exists; (4) mandatory or voluntary purchasing/payment structures; and (5) excludability from the benefit of the ecosystem service.

First, the operators of that system inherently impact how a system operates, as reflected by the recent popularity of the phrase "personnel is policy" [37]. This is to say, the operator—be it a group of investors or government officials—will be reflected by the operational policies and agendas that they pursue. This factor is also vitally important regarding the input that a system receives from its participants, i.e., the democratic, and in the alternative technocratic, tendencies of a system. Next, the transparency requirements that a system utilizes will fundamentally impact the operation of a system [38]. Transparency surrounding the decision makers, how decisions are made, the data that decisions are based off of, and the finances of a system are vital, not only for an efficient purchase of ESs, but also the participant's faith that they are being treated and compensated fairly. Thirdly, the existence or non-existence of a profit motive in a PES system reflects some level of the program's efficacy, as discussed above, but also in the design and operation of that program. If there is a direct motivation to ensure the lowest cost to benefit ratio possible, this will naturally affect the operation of the system. Fourth, if a PES system operates as voluntary market or a mandatory compliance program will fundamentally alter its operations. If voluntary, then it will need to make the case to and attract participants that might be willing to bear any operational or administrative burdens that come with convincing

buyers to purchase services that are often used for free. However, if participation is instead mandatory, then investment will likely be geared towards benefitting the participating land facilitators. Lastly, the ability for the beneficiaries of a system to exclude others from the benefit of ecosystem service will impact the scale and scope of a system. Put another way, if it is possible for an individual, or group of individuals, to purchase the service and thereby exclude the ability of others from gaining access to that service, that will influence how a system will operate.

4. Discussion

In the following discussion, this article elaborates on the analytical framework that is identified in the Table above. The framework provided has four factors, each consisting of a number of metrics that can be used to judge the progress towards the goal of bringing about a different economic system regarding our land-based businesses. Then, this article provides a discussion of the qualities of publicly- and privately-operated PES systems and provides a brief discussion of some examples of each. Lastly, this article presents a discussion utilizing the provided analytical framework in conjunction with the qualities of publicly- and privately-operated PES systems in a hypothetical prediction of the likely success of each. Publicly-operated PES systems are predicted to be most influential when utilizing this systems-view framework, leading to a deeper transition of system rather than the private sector working alone.

4.1. The Analytical Framework

The four factors and the associated metrics aim to give the most complete picture of programmatic success available. First, addressing the public health concerns related with agriculture and our food system in general. Second, the economic viability of the land-based business can be accounted through the number of qualifying conservation plans that are filed, how much capital is distributed to these businesses, a survey that mixes both quantitative and qualitative information, and incentivizing stacked levels of production. Third, a PES system can only be as successful if the ecosystem it is employed in experiences an increase in health and quality. This regeneration of natural systems can be monitored through soil health assessments, biodiversity surveys of flora and fauna, water quality measurements, and emissions reductions and storage. Another key piece to this ecological regeneration is the ability to model and predict the work that must be done. Fourth, the equitable and efficient payment of monies to land-based businesses is vital for any PES system, and must account for: the amount of layers of administrative bodies and/or profit margins between the purchaser of the service and the land-business that provides the service; have the payments contingent on the quality and quantity of the service; and must support systematically underserved communities in their access to land to take advantage of these programs.

First, the public health concerns related to the food we produce and how we produce it are monumental, from the environmental effects associated with large-scale animal agriculture [51] and monoculture commodity-crops [52], to the increased risk of diet-related disease, including obesity, diabetes, and a myriad of cancers [53]. Even worse, these issues are not going away, and are instead generally trending in the wrong direction [54]. Addressing these public health concerns must be a driving factor in the consideration of the success of a PES system. The causes of these problems are many, from the incentive structure around how we produce food, to our public food purchasing and dietary guidelines.

To better-understand these dynamics and interrelation of the policies surrounding both the production of the food we produce, and the health effects it causes, this article suggests the use of three primary metrics identified in the Table above. First, from the production perspective, the total amount of agri-chemicals used should be tracked; including all pesticides, herbicides, artificial fertilizers, as well as antibiotics used in agricultural businesses. This would not be a mandate or regulation to decrease use, but simply a consideration of how much of these chemicals are used on the landscape. The second

metric should aim to track changes in the access to, but more so the consumption of fresh, nutrient-dense foods. Increased consumption of nutrient-dense foods can lead to a myriad of health benefits [29], but the ability to buy and then eat that food is a significant hurdle for many [55]. The societal constraints when it comes to eating healthier cannot be ignored, and have not been solvable through education campaigns, but needs to be addressed at a systemic level. The final metric regarding PES system's contribution to addressing public health concerns related to our food system is access to high-quality greenspaces. There are a variety of benefits associated with access to high quality green space [56], and the recent COVID pandemic has reinforced the importance of greenspace in all human environments [30].

Second, alongside and deeply connected with addressing public health concerns is the necessary healing of the land that has been systematically and historically extracted of nutrients, calories, and materials for generations. Luckily, ecosystem health is a concrete and easily graspable consideration when designing a PES system. There are a number of ways to account for the health of an ecosystem, but no single factor is a perfect proxy. Metrics like soil health indicators [31], quantifications of biodiversity [32], and the amount and quality of any water runoff [33], can give insight to ecological health; however, should none of these should be used alone to assess ecosystem health. The metrics identified in the Table above aim to combine these metrics, as well as emissions reductions, carbon storage, and effective modeling. When viewed in conjunction with one another, these indicators can represent a more-complete picture of ecosystem health.

Land facilitators may also wish to establish a monitoring framework or process on their own land, to better account for the services they may provide but also to gain a better picture of the health of their land. These could take the form of innovative participatory community science methods that could be both cost effective and informative at a granular, field-scale [13]. These participatory programs could use more-qualitative measurements that have been shown to consistently represent quantitative metrics [57]. This process would not only significantly increase the transparency of any monitoring program, but also bring a significant co-benefit of training our land managers to think more-like land facilitators, recognizing and understanding changes in the landscape they interact with.

Depending on the scale being considered, the type of monitoring program will differ. For a single property, a robust monitoring program would likely be cost efficient [44]. For a program designed for a watershed, state, or national scope, though, a combination of monitoring and modeling is likely the most efficient way to account for ecosystem health at the outset [14]. Assuring this model can utilize the data sets described above, and be flexible enough to be easily modified to accept new data sets as they become available, is imperative. Ultimately, the goal of the modeling program would be to compliment the monitoring one, utilizing the monitoring data to calibrate and ground-truth the model against real-world observations. However, the model's initial role is a crucial one: efficiently calculate payments for enrolled working lands while robust monitoring systems are established [58].

Third, when building a system to compensate land facilitators for the ecosystem services they may produce, assuring participation is economically worthwhile is crucial [21]. If the benefit is only negligible in comparison to their existing income streams, then participation will likely be low. [21] Transitioning from a monoculture system with intensive inputs, to a regenerative system that attempts to facilitate the natural processes already ongoing on the land to maximize the ecological health is a radical one and must take place at scale. This is not to say that monoculture and large-scale commodity operations will cease to exist, but rather they will become one of many business model options a land-based business can take. A meaningful transition in business model reflects a significant change in the methods of farming and forestry, and therefore may result in stranded assets and the need for public investment in these land-based businesses [21,59] or creative use of debt restructuring tools available to farmers [34]. Moving away from the current extractive paradigm that surrounds agriculture through diversifying income streams outside of the

traditional goods would allow land facilitators to select the goods and the services that would be viable for the specific piece of land they facilitate.

Unlike income-foregone conservation frameworks, a PES program is not attempting to replace the income lost by conserving land, but to compensate for the positive externalities that may be produced through land facilitation. Historically, only negative externalities have been accounted for regarding the regulation of our environment. Rather than only utilizing one financial tool in the regulatory tool box, penalties, a PES program would also use incentives to transition business models. There is a recent example of how agricultural operations can change their business models when a new income stream becomes available: agritourism. In response to the changing economics of farming businesses, Vermont enacted H.663, prohibiting municipalities from barring a farm from starting an “accessory on-farm business.” In response to this law, many agricultural operations changed their business model to take full advantage of this new revenue stream in a sector that already has thin and thinning margins [60]. This example represents the ability of land-based businesses to react and adapt to new income streams that suit the property operated on.

The four metrics identified for the third factor in the table above attempt to gain a picture of the effectiveness of these programs at changing the economic relationship with the landscape. First, the number of qualifying conservation plans that have been produced and filed with the state can give an idea of the depth of this change. Second, and relatedly, the total amount of funds distributed to land facilitators, and an economic impact analysis of those funds, can show if these systems actually do affect economic viability. Third, the ability to track the increased number of acres utilizing stacked production systems, where more than one good or service is produced by a single plot of land, will be crucial. An example might be multi-species cover-cropping, which reduces runoff, purifies runoff that does leave, sequesters carbon, and provides food for pollinators and the greater ecosystem. Lastly, there must be a survey that mixes quantitative and qualitative analyses regarding participant’s attitudes towards participation in these programs.

One critical issue that is beyond the scope of this article is the much-needed discussion on how to effectively and accurately value ecosystem services [61]. This has been an ongoing debate and area of controversy since the first comprehensive discussions of PES systems [61]. As it stands, ecosystem service evaluation is inherently anthropocentric, as reflected by the provided definition of ecosystem services [23]. There is also a significant issue in the valuation scheme, as it is primarily based on willingness to pay, which in the case of many regulating and indirect life-supporting services, is generally zero because individuals enjoy these services for “free” [35]. This valuation scheme does not take into account either the intrinsic value of ecosystem components that do not benefit human society [62]. Another critique of these valuation schemes is they do not, and cannot, consider the biophysical [63] and thermodynamic [64] constraints that exist on our economic systems, justifying a closer, detailed look at the fundamentals of neoclassical economic theory in light of developing literature of ecological economics in the PES context [64].

Lastly, a consideration that touches all those above is how efficient and equitable the program or the “end-user” is in purchasing the services from the landowners. The ESs “end-users” utilize range from the hyper-local (water quantity and quality) to global scales (carbon sequestration), creating an issue regarding who is considered a “buyer” of this service [35]. A system that efficiently pays the land facilitator a meaningful amount is integral to meeting the previously discussed considerations [21].

To distribute the funds equitably, a program must account for: (1) the possibility of multiple entities seeking profits through the administration of the program; (2) the quantity and quality the service provided; and (3) significant historic and social factors that manifest in who owns what land. The first metric aims to keep the seller and the purchaser close together in the chain of administering the program. The second is directly tied to the quality of the monitoring/modeling programs and the economic viability of land facilitators, and require an intentional design that will equitably account and compensate for ecosystem services. The last metric is difficult, as a new compensation scheme for

land managers necessitates ownership of land, which was not equitably achievable by all persons in the United States until the enactment of the Fair Housing act of 1968 [65]. This is an important fact that must not be ignored, because to effectuate a Just Transition, all peoples and communities must be able to participate in these programs. One consideration might also be a graduated or progressive scale of payment, i.e. a smaller operation might be granted a higher per-acre payment than a larger one.

4.2. Attributes Applied to, and Examples of, Publicly and Privately Administered Payment for Ecosystem Services Systems

This article, when discussing Publicly Administered Programs (PAP), is referring to any PES system that involves the government, on behalf of society, procuring ecosystem services from land facilitators. First, when considering who owns, operates, and/or manages the system, a PAP is by definition operated by government officials and owned by the public. A government official, in general, is going to be required to be responsive to public pressure and take public comment and input into account when considering both the design as well as administration of any PAP [39]. Operation of a PES system by government officials also directly influences the transparency of this program, as government bodies and officials generally have robust transparency requirements alongside the public comment aspects of program design [39]. In a PAP, unless utilizing some private contractors for administration, there is generally no profit-motive to consider. With no profit motive, the likely result is more financial benefit going directly to the land facilitator.

PAPs can operate either as a mandatory regulatory scheme, or as a voluntary program. The choice between these two will of course impact how the system operates. A voluntary program will need to operate through market-incentives as to provide motivation to promote good land facilitation systems of production [36], whereas a mandatory regulatory scheme incentivizes participation through penalties and enforcement actions against those that do not comply with the applicable standards. The voluntary or mandatory nature of a PAP will also impact the excludability of the benefit from the ecosystem service. Depending on the structure of a voluntary program, mainly the agreement for payment between the government and the land facilitator, the benefit of the service may still be owned, and therefore sold, by the land facilitator. If the language regarding these voluntary programs, though, is procuring the services as part of a larger compliance program, then this benefit from the service will be owned by the government as part of that program [36]. Relatedly, if the PAP itself is a mandatory regulatory system, then the benefits from the provided services will be owned by the government, barring any attempts to sell those services on a market.

Several PES systems have utilized the public program approach, including the Welsh Glastir program, New York City's Land Acquisition Program (LAP), and the United States Department of Agriculture National Resource Conservation Service's (USDA-NRCS). To date, there has yet to be a comprehensive PES program that directly compensates a land facilitator for the services that will result in general ecological health. However, there is reason to believe that many systems similar to Glastir are moving in that direction [66]. During the ongoing debates on how to restructure Glastir given Brexit, the Welsh Assembly has begun to discuss how these frameworks fail to "fairly reward the environmental outcomes produced on farms and gives insufficient incentive for farmer participation" [66].

Glastir is an "income-foregone" or "costs-incurred" framework, "designed to improve the Welsh Government's support for environmental improvement in Wales's farms" [66]. Given the current events surrounding Britain exiting the European Union, the funding for this program is currently being debated, but is funded through EU funds until December 2023 [67]. Glastir operates through a tiered and ecosystem-focused approach. After initial qualification through verifying certain practices and conservation measures, an entire farm enrolled in Glastir Entry is paid a flat fee per hectare through a contractual agreement with the Welsh Government [68]. Alongside this entry-level program, there are elements focused on: producing specific services, including soil carbon, water quality, and biodiversity; a woodlands element aiming to increase the vitality of Wales's limited forests; and a common

land element geared towards the enrollment of community-owned lands [68]. Glastir has had mixed success; a 2014 audit of the program found it was periled by low enrollment and administrative issues that lingered from previous iterations of the program [69]. However, a recent update to the program's initial national survey shows that the ecological health indicators chosen have been trending, generally, in the right direction [70].

A crucial piece to Glastir is their monitoring and modelling programs, where a statistically representative sample of the landscape is first selected [14]. Then, a robust, rotating monitoring program should take place on each selected parcel [10]. The monitoring program is designed to survey on the selected land plots in varying weather conditions and seasons as to get as complete data sets as possible [14]. The parcels of land are repeatedly visited over the course of a four-year cycle, collecting extensive and valuable data that offers a more-complete picture into the health of the overall landscape [14]. These observations then directly feed into the modeling framework used to predict and value the services that a land manager in the system can contract for [14].

New York City is the largest city in the United States, with over 18 million people living there, and the entirety of its water source is unfiltered [71]. New York City's LAP is working to assure that the watershed stays healthy enough to continue producing clean, potable water. The LAP aims to either purchase development rights on property or the property itself to conserve the property's ecosystem services associated with clean water. Again, this is not an example of an outcomes-based program to purchase ecosystem services, but rather a conservation program that aims to secure ecosystem services related to maintaining a watershed that can produce potable water in the amounts needed in a cost-effective manner [71]. This is done through purchasing either conservation easements on property, or property in fee simple [72].

CSP has been increasingly successful since its first iteration in 2009, when the budget to provide both technical assistance as well as direct payments was initially set at \$9.4 million, now, in 2020 the budget totaled over \$2.2 billion [73]. Based on acreage, it is now the largest conservation program operated by the USDA-NRCS [73]. Unlike all other USDA-NRCS conservation programs that require a natural resource problem in existence that must be addressed for qualification, CSP allows for the proactive maintenance and improvement of already-existing conservation systems in place on a farm. CSP operates on a five-year contract basis, with options to renew at the end of the term. The application process considers the traditional factors of costs-incurred and income-foregone, but also considers the expected benefits that will result [73]. Applicants are then ranked using model-based programs that consider two primary factors: (1) the conservation benefits on applicable priority resource concerns when applying for enrollment; and (2) how much improvement to these benefits that would result from the proposed conservation activities [73]. Alongside these two considerations, eligibility is premised on meeting specific thresholds for natural resource priority concerns, and then meet/exceed a threshold for an additional concern by the end of the five-year contract [73]. Payments to a farm operation on an annual basis range from the minimum of \$1500 to the maximum of \$40,000 [73]. Some have criticized CSP as not going far enough, and not attracting enough farmers to conservation systems of management [74]. CSP is closer to a true-PES, as it conditions payments to landowners on their ability to show that a certain threshold of ecological health exists, but still operates on the income-foregone framework [73].

For the purposes of this article, a private system is anything that does not fit the definition of a public system provided above. Private, market-based systems can take many forms, from a non-profit entity administering or creating a market, to a for-profit corporation seeking to aggregate and buy or sell services on existing markets, and everything in between. Regarding who operates the system, the management schemes of private entities generally focus on charter, shareholder, and board direction; and often there is a direct intent on generating profits. A management scheme comprised of a closed group of individuals making decisions for the entity or program with no meaningful public input is inherently undemocratic, and can lead to profit-maximizing inefficiencies in a market [40].

Directly related to the small decision making group of a private entity is the general lack of meaningful transparency and public input in decision making. The lack of public input makes fundamental sense when considering private entities common purpose: generating profits and returns on investment for its shareholders.

However, not all private entities share the sole purpose of profit generation, non-profits and the newer Benefit Corporation offer avenues to expand the purpose of corporate bodies. However, these businesses are still that, a business that ultimately must provide some return on investment to the shareholders and funders of the operation, limiting the amount of financial benefit that the land facilitator will see from providing ecosystem services. Even with an entity earning the title “non-profit,” it is still able to generate significant amounts of capital [41]. Private entities may play a role in mandatory compliance programs that take the form of markets, like the Regional Greenhouse Gas Initiative aggregators, contractors, or market managers, but the strong majority of activity by private entities in the ecosystem services sector is in voluntary markets [42]. These voluntary markets have had a mixture of successes and failures and should be utilized to advance the capabilities of mandatory programs [43]. Lastly, when considering the excludability of the ecosystem service, any private market-mechanism to sell the benefits will result in absolute excludability from the benefits sold on the market place. Put simply, if a buyer purchases the ecosystem service of carbon sequestration to offset their emissions, or purchases water quality enhancement services to save money regarding infrastructure investment, then that ecosystem service cannot be built into any government program, to avoid double-counting [43].

Some examples of market-based, privately operated programs to administer a form of a PES system include offset markets, offset aggregators, and direct payments for ecosystem services by private entities. Offset markets are systems that allow for an entity, from a natural person to a multinational corporation, to purchase credits that will offset some amount of environmental harm they cause. Examples of offset markets include RGGI and the no longer operating Chicago Climate Exchange (CCX). RGGI operates as a cap and trade program specifically for electricity production in member-states, allowing emitters to offset a certain portion of their GHG emissions through purchasing credits created by projects operating outside of the power-generation sector [75]. RGGI is not exactly an offset market but allows for offsets in their cap and trade scheme. Due to the rigorous requirements associated with RGGI’s offsets, there has only been one offset certified for sale, and that was for a reduction in the amount of methane a landfill produced [76]. The CCX was an example of a voluntary carbon market. Put simply, it was a transactional platform for emitters and offset producers and aggregators to exchange capital for the ability to claim a reduction in emissions. Ultimately, though, the CCX failed, and in 2010 trading was officially ended for a variety of reasons, including oversupply of—and low demand for—offsets and lack of meaningful government backing [77].

For offset markets to operate effectively, there must be entities that offer offsets on the market. Due to the rigorous requirements associated with gaining access to offset markets, individual land owners, generally, are not able to financially meet the demands [78]. Offset aggregators identified this gap in the carbon market and have been working to aggregate small parcels of land or projects into an offset that is comprised of multiple projects [78]. The United Nation’s Reducing Emissions from Deforestation and forest Degradation (REDD+) and the recently created Indigo Ag are examples of offset aggregators. Both of these offset aggregators limit their programs solely to carbon credits. Although REDD+ is a program of the UN, it operates as a medium between private capital and developing nations creating sanctioned offset projects. However, outside of the airline industry, a demand for these credits has not manifested, as recent reports conclude that nearly 90% of the funds used in REDD+ have been from public coffers [79]. The intensity of questioning the effectiveness of REDD+ has been increasing in recent years, especially as the Paris Accord framework has come into effect [79].

Indigo Ag is a recently created private, for-profit corporation that aims to aggregate the sequestration potential of agricultural soils and offer that as an offset credit on a

market place [80]. The company has generated intense excitement in the financial world, translating to over one billion in financing to date, and receiving a valuation of up to ten billion USD [80]. The offset credit cleared an important hurdle in 2020, being verified by the Climate Action Reserve and therefore gaining access to carbon market trades. Shortly after this verification, commitments from a range of multi-national corporate entities came in to purchase these credits. Ultimately, though, offset aggregators can only operate if there is demand for credits in offset markets, which has not come to fruition in any meaningful capacity without government involvement.

A private entity, be it non-profit or for-profit, can also organize a payment structure to acquire specific ecosystem services. A novel example of this is the Audubon's Bobolink Project. A voluntary program farmers must apply for, the Project aims to pay farmers that change their mowing or haying schedules to allow grassland nesting birds, like the bobolink, to have a successful brood [81]. In effect, the Bobolink Project is purchasing the improved service of biodiversity, potentially making it more financially attractive for a farmer to support a different conservation and harvesting calendar. Significant issues with this variety of project exist, mainly the small scale and dependence on private philanthropic donations. After operating for over seven years, the Bobolink Project still enrolls under 1000 acres a year across four New England states [81].

4.3. Application of Analytical Framework

Private, market-based approaches or publicly administered, programmatic approaches to implementing a PES system can produce vastly different results. The following is a discussion attempting to apply the modes of analysis identified in this article, comparing and contrasting the two approaches. If the goal of a PES system is indeed to facilitate a transition in how we view and utilize our landscapes, than careful design of either a privately- or publicly-operated system can provide this result. In a privately-operated system, though, there would still be a need for substantial government or public-sector involvement, mainly the creation of a compliance market for these services [49]. Without exerting some pressure to stimulate demand in the markets for ecosystem services, the ultimate user can generally continue to utilize many of the benefits of the ecosystem services free-of-charge [49].

First, addressing public health concerns regarding our food and how it has been produced is imperative to creating a truly just food system. Privately-operated PES systems generally haven't made public health a primary goal. Although there are not any privately-operated programs that are looking to specifically increase the healthiness of, access to, or consumption of healthier foods, labeling programs may be seen as a private attempt at doing so. These labels often try to signify to potential food buyers that a food was produced a certain way or does not include certain artificial chemicals. However, the producer utilizing these labels is doing so to charge a price premium for the food, directly limiting access to the healthier food by less-affluent communities, which are generally the ones in need of increased access to these foods. These programs also don't address the need for increased access to high-quality green spaces.

On the other hand, public programs are able to create coordinating positions, offices, agencies, and/or statutory mandates to consider public health impacts. This is to say, a public PES system could be intentionally designed to take into account not only the quality of the food being produced by landowners, but also to ensure that the food is accessible to less-affluent communities. Many states and governments already track the amount of agrichemicals are used in the state, and this can be easily integrated into a public program. The program could also compensate farmers who open up their land as high-quality greenspaces, and provide a clearinghouse of all properties that have outdoor recreational or community-building spaces available to local communities.

Second, and correlated with addressing public health concerns, helping reinvigorate the health and viability of the landscape is vital for the success of a PES system. The privately-operated models of PES systems, mainly carbon offset markets, have come into

question regarding their present effectiveness, but even more-so in the future [43]. Another significant limitation of offset markets is that they are generally focused on one service. This severely limits the amount of information regarding the health of an ecosystem is available, reflecting an imperfect picture of ecological health. The most successful private-operated systems, from an ecological health perspective, are likely those that are similar in design to NYC's LAP, where land is put into permanent conservation [71].

In contrast, publicly-operated programs can account for stacked production, putting value on many different indicators of ecological health rather than relying on one. The Welsh Glastir program has been seeing results with most of the indicators trending in the right direction, even with lower-than-expected enrollment in the program. Another example of public, programmatic action that is directly related is the federal government's work conserving wetlands. Once the United States, through its democratically elected institutions, decided to put a priority on wetland conservation and mandate certain compliance-oriented programs as well as income-foregone programs, there have been meaningful decreases in the amount of wetlands destroyed or degraded [82]. These programs are still inadequate, though, as it still allows for the drainage or degradation of wetlands if certain offset requirements are met [82]. A publicly-operated program that aims to significantly increase the health of an ecosystem should do more than mandate the non-use of that land, but compensate for the services that are provided from the land that the citizens of the nation enjoy.

Compensating land-facilitators for the quantity and quality of the ecosystem services they can produce will likely redefine the land-based business model. This is, again, premised on the assumption that a PES system is intended to bring about a transition in our relationship with landscapes. From an extractive model based on minimizing inputs (agri-chemicals) and maximizing outputs (calories and other goods) to one that allows a land-based business owner to balance the need to produce goods with the need to produce services. No longer will the business model that puts a sole-priority on the amount of bushels or board-feet produced be the only option. Rather, new business models will include the consideration of additional revenue streams compensating for services provided given certain systems of production are established on the land. This shift in business model will likely significantly increase the chances that land-based businesses will transition to a land facilitator role rather than that of a land manager, bringing about the associated benefits discussed above.

Third, the ability to help bolster the economic viability of land-based businesses requires not just repaying land facilitators for the income they may have foregone due to, or the amount of money spent on implementing a conservation project. Instead, for payments to be truly "worth it" for land businesses, recognition of the value of the services being performed would better allow for a true diversification of income streams outside of traditional ones like crops, livestock, or lumber. Generally, current PES systems in the United States, both public and private, operate with only one service in mind. The service is usually water purification [83], water retention [84], or carbon sequestration [85]. These income streams, alone and disparate, do not add up to an amount that has convinced land-based businesses to significantly alter their business model. A privately-operated system would have to operate at an immense scale and complexity to match buyers with sellers in a marketplace while trying to control for likely price fluctuations. Where a publicly-operated system could, in theory, decouple the purchase of the service from the ultimate end-user, and replace it with society-at-large acting through government action. This simple, yet fundamental, difference between private- and public-operated systems allows for the stacking of benefits and productions, rather than relying on one single service or good. Allowing—and incentivizing—stacked productions inherently increases business viability, as it increases the amount of streams of income that can stem from a single practice or crop.

Lastly, the differences between private- and public-operated PES systems is most stark in the efficiency and equity associated with purchasing ecosystem services. As discussed

above, privately-operated systems are inherently undemocratic, and generally aim increase the welfare of their shareholders, not the general population. Privately-operated systems also run into an issue of multiple layers of profits. An offset market, an offset aggregator, and any intermediaries all may seek some level of profit through administering the system. Another level of complexity, and inefficiency, are the additionality and permanency requirements associated with offset programs [86]. These requirements represent a significant burden, and have led to many systems failing [86].

Public programs, on the other hand, are more likely to be oriented towards the general welfare of society. There are no profit-considerations when a government decides to implement a program or not, but rather a balancing of the effectiveness of the program with the political will to enact such a program. This, of course, brings different concerns including who has access to the legislative and regulatory process. However, the decision makers at the helm of a public program are, by design, beholden to the will of the people and thus, can be removed. A public program can source its funds from federal coffers, and allow the states and tribal nations to distribute the funds according to certain parameters that fit the needs and characteristics of the locality. This could be seen as an inefficient system with multiple layers between the buyer (the U.S. Government) and the seller (landowner), but because there are no profit margins associated with each level of bureaucracy, it is still likely more efficient than a private-operated system. The inefficiencies related with the additionality and permanency reporting requirements associated with offset markets could be replaced with stewardship payments, similar to those in the CSP, supporting the transition of land managers to land facilitators.

5. Conclusions

Payment for Ecosystem Services systems are being discussed as a legitimate possibility now more than ever before. The adoption of PES systems could act as a catalyst transitioning our land-based business sector from an extractive industry to a regenerative system, or it could simply tweak, and entrench the current paradigm. In this article a new analytical framework to evaluate the effectiveness of PES systems is presented. This framework is compatible with both private- and publicly-operated PES systems. The framework attempts to provide a systems-based evaluation of the program, taking into account social and ecological processes. The impact of this framework is intended to ensure that PES systems help bring about a paradigm shift regarding the relationship society has with the landscape.

Utilizing this framework, this article concludes that when the goal of a PES system is to truly transition how our land-based businesses perceive, interact with, and ultimately value lands, then a publicly-operated system is the most likely candidate to do so. Publicly-operated systems are best-positioned to help support businesses financially while transitioning business models through the already-extensive public conservation programming. Land-based businesses, both farms and forests, already see a significant amount of public capital that helps them maintain an economically viable business [87–89]. It is also, arguably, in the best interest of our government, on behalf of society, to ensure that we have a food system that can produce high-quality foods at economical levels while also not degrading our environment. The government's agricultural conservation programs have some track record of being ineffective at helping ecological viability. A publicly-administered outcomes-based program would likely alleviate these concerns, as payments are based on real, tangible ecological outcomes rather than on hoped-for outcomes associated with specific practices. Lastly, publicly-operated programs can have strict equity considerations applicable to answer the systematic discrimination that is still felt today. In sum, a publicly-operated PES system could possibly catalyze a Just Transition in our land-based economic sectors, and help usher in a new era of economic and conservation policy. Put simply, a publicly-operated system can be designed to take into account local knowledge and characteristics, compensate land facilitators directly for outcomes—both

actual and modeled—and allow the land-facilitator to still be the primary decision-maker for the operation.

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