# Payments for Ecosystem Services: Mechanisms to Achieve Desired Landscape Patterns

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**Abstract**

This paper evaluates the effectiveness of five payment for ecosystem service (PES) schemes at meeting conservation objectives when the spatial configuration is important in meeting desired landscape patterns. The five PES schemes are: 1) fee-simple acquisition; 2) subsidies; 3) tradable development rights (TDR) with zoning; 4) mitigation banking; and 5) purchased development rights (PDR) easements. Findings are that tradeoffs exist between PES schemes for meeting spatial conservation objectives. The appropriate PES scheme incentive mechanism for a given region will depend upon economic demand as well as the landowner and landscape characteristics of the conservation region.

## 1. Introduction

Ecosystem services are those goods and services produced by the natural environment and that are critical for sustaining life. Encompassing services such as flood prevention, natural pollination, habitat, and ecotourism, ecosystem services are interdependent and supported by one or more ecosystem functions (de Groot et al., 2002; Ruhl, 2008). The impact of human activity on our natural environments has diminished the quality and quantity of ecosystem services. Ecosystem services, in which the benefits supplied are difficult to value accurately because the benefits provided are not understood well and usually have no close substitutes (Daily et al., 1997).

Conserving and managing ecosystems is increasing in importance as anthropogenic intrusions leave larger impacts in our natural systems. Often, the landscape in developing areas is fragmented by human uses. The resulting impact is a reduction of biodiversity and a loss of ecosystem services. As private property boundaries serve to further dissect ecosystems, conservation efforts to protect and restore ecosystem services will benefit from landowner cooperation and coordination of private conservation efforts across property lines (Yaffe, 1998).

Further, experiences with environmental land use regulations from implementation of the Endangered Species Act and the Clean Water Act have illuminated the inefficiency associated with command and control approaches to protecting ecosystem services on private lands (see Brown and Shogren, 1998). When landowners are forced to incur the social costs of providing a public good, creative avoidance strategies are often employed. As a result, the social costs of providing the desired conservation object are often amplified due to a reduced opportunity set for protecting ecosystem services.

A remedy often proposed by interest groups is to implement a payment for environmental services (PES) scheme. Wunder (2007) defines a PES schemes as “a voluntary, conditional agreement between at least one “seller” and one “buyer” over a well-defined environmental service—or a land use presumed to produce that service” (also see Engel et al., 2008). Implementing a PES scheme allows landowners to voluntarily participate and compensates landowners for the costs of conservation on their land, which often mitigates avoidance strategies.

In addition, many species and ecosystem services require spatial configurations to enhance the benefits they provide to society. Recently spatially explicit models have been designed to capture the tradeoffs between spatially allocating conservation within the landscape and conservation costs (Ando et al, 1998; Dreschler and Watzold, 2001; Hartig and Drechsler, 2009; Hamaide and Sheerin, 2010). These research projects focus on the low cost landscape configuration in the absence of individual and group landowner decisions. However, these authors do not propose a method for transferring funds from government and non-government environmental organizations (NGEO) conservation coffers to landowners (Chomitz et al., 2006). Given limited agency budgets, the allocating mechanism is not a trivial matter. The assumption that compensation subsidies equivalent to foregone productive use will induce landowners to voluntarily conserve the desired configuration ignores the strategic actions of landowners as they optimize over the various land use rents, and minimize the risk associated with coordinating conservation decisions within the landscape (see Parkhurst and Shogren, 2003). Further landowners possess private information concerning the productive value of their land and can use their private information to exact information rents from the regulator (Ferraro, 2008). A simple one dimensional PES scheme will typically be insufficient to meet a voluntary spatially dependent conservation agenda.

Meeting multiple objectives requires the use of multiple incentive mechanisms—potentially one for each objective. If the regulators objective is to conserve a targeted spatial configuration voluntarily on private land, the incentive mechanism will need one component to induce voluntary participation and a second component to create the desired spatial configuration. We suggest five PES schemes for conserving spatially dependent ecosystem services: 1) Fee simple acquisition; 2) Subsidies; 3) Tradable development rights with zoning; 4) Mitigation Banking; and 5) Purchased development rights (conservation) easements (see Parkhurst and Shogren, 2003; Yamasaki et al., 2010).

## 2. PES Schemes for Conserving Spatially Dependent Ecosystems Services

### *Fee Simple Acquisition*

Fee simple acquisition is the purchase of land with all of its inherent property rights. Government agencies and nongovernment environmental organizations (NGEOs) will enter into a voluntary agreement with landowners to purchase all rights in the land including the ecosystem services. A common PES scheme employed by land trusts, fee simple acquisition is used to protect ecological services in regions particularly sensitive to damage generated by anthropogenic encroachment such as urban sprawl.

Rissman and Merenlender (2008) identify fee simple acquisition in the San Francisco Bay area to be a PES scheme used more frequently in local government land use planning. Fee-simple parcels are smaller in size with larger perimeter to core ratios, tend to be located more in urban areas designated as open space, and owned more frequently by government agencies. The tendency towards smaller parcels is not surprising given the significant cost of acquiring land with all land use rights intact (Parkhurst and Shogren, 2003). Fee simple acquisition does allow for greatest ability to protect valuable ecosystem services in perpetuity (Davis et al., 2006; Messer, 2006). However, a tradeoff may exist between long-term control of the environmental resource and the size of the protected area.

*Implementation Issues*

Voluntary participation dictates market value be the minimum price paid for the desired land. As the land parcel becomes more critical to the desired landscape conservation pattern, landowners gain in market power; holdouts might occur in an effort to increase market value (Parkhurst and Shogren, 2003). Information rents may also be present due to landowners' private information concerning both conservation and non-conservation values (Ferraro, 2008). Conserving a spatial landscape design using a fee-simple acquisition approach may be cost prohibitive in many regions.

In addition, conservation lands acquired through fee-simple acquisition must also be managed to maintain or enhance the supply of ecosystem services. Shaffer et al. (2002) estimate the annual management costs to be about one percent of the acquisition costs and to become an increasing proportion of the total costs of conservation when fee-simple acquisition is used to meet environmental conservation goals.

***Subsidies***

Subsidies are financial assistance offered to landowners by government agencies or NGEOs to either restore ecosystem services or employ best practices for protecting existing ecosystem services. Subsidy payments can be designed to incentivize landowners to maintain their land in its natural state or to mitigate the environmental impact of development by helping the landowner meet maintenance and restoration costs of ecosystem services. The most common subsidy currently used in the United States of America is administered by the United States Department of Agriculture (USDA) through the Conservation Reserve Program (CRP). From 1992 to 2001, 15 billion dollars were awarded as short-term CRP subsidies (Lerner et al., 2007).

The CRP allocates subsidy dollars based upon an environmental benefits index. CRP subsidies are awarded to the contracts that provide the greatest benefit per dollar requested. The CRP does not necessarily target the spatial allocation of conservation to obtain the desired landscape pattern (Stoms et al., 2004). However, some states have designed programs that provide additional payments to land enrolled in the CRP to aggregate conservation efforts across landowners and to subsidize additional ecosystem improvements and restoration (OWEB, 2011)[1], proving subsidies can be designed to coordinate voluntary conservation efforts across the landscape and landowners.

Parkhurst et al (2002) propose the Agglomeration Bonus as a vector of subsidies that can conserve land voluntarily in a predetermined desired spatial configuration. The agglomeration bonus is a vector of subsidies that can be positive or negative and that attach to specific landscape characteristics. A flat subsidy induces voluntary participation while a shared border subsidy coordinates the conservation within the landscape. Positive subsidies create an explicit network externality between adjacent land parcels and neighboring landowners by paying an additional *agglomeration* bonus when they retire land adjacent to other conserved parcels, both their own and their neighbors. Negative subsidies work to repel the conservation decisions of neighboring landowners (Parkhurst, 2007), which is effective when the social benefit of ecosystem services are larger when several disjoint parcels ore conserved. Combining positive

[1] Oregon's Conservation Reserve Enhancement Program (CREP) illustrates the idea of an allied land retirement bonus scheme. The CREP pays an extra bonus to enrollees along a stream if at least 50 percent of the stream bank within a 5-mile stream segment is enrolled in the US Department of Agriculture's Conservation Reserve Program (CRP). Additional increases in the CREP payment are made when instream water leases are made available on enrolled lands (OWEB, 2011)

and negative subsidies makes the agglomeration bonus flexible to create many different spatially conserved landscape configurations.

The agglomeration bonus has been proposed as a promising PES scheme for conserving biodiversity in many environmental settings (see Smith et al., 2009; Zhang et al., 2007; Dreschler et al., 2007; Chomitz et al., 2006). However, several challenges to implementing multiple dimension subsidies including the agglomeration bonus have been recognized.

*Implementation Issues*

Ferraro (2008) evaluates the differing approaches for allocating contracts for conserving biological amenities. Information rents exist in all scenarios due to landowners' private information. A common approach for allocating conservation contracts is to have landowners submit bids indicating the payment they require to conserve their land. The regulator can then compare the environmental benefits per dollar derived from each contract and choose those contracts that provide the largest benefit per dollar. Adjusting this process to satisfy a multi-dimension subsidy like the agglomeration bonus when each contract then represents a contiguous land mass and several landowners may be complicated. The market power increases to the owners of each bid as the number of bids decreases. The increasing market power could result in an increase in information rents (Ferraro, 2008). Further, creating opportunities and institutions to promote the understanding of the agglomeration bonus by the landowners and to coordinate bids could impose additional costs on the landowners and regulatory agencies (Parkhurst et al., 2002). Evidence on combinatorial auctions suggest when the items being auctioned are complements the combinatorial auction outperforms the simultaneous auction (see Tanaka, 2007). Whether this holds for the multi-dimension subsidies that target the landscape design is an open question.

Use of multi-dimensional subsidies like the Oregon CREP program and the agglomeration bonus pay an additional premium for the coordination of landowner conservation efforts into desired landscape conservation configurations. The additional premium may be useful in offsetting the transactions costs incurred with coordinating conservation efforts and the risk premium necessary to offset landowners' reliance on the actions of neighboring landowners. Contracts for contiguous multi-landowner parcels could have individual payments contingent upon the actions of all the landowners. The larger the custodial costs, the larger the number of coordinating landowners, and the longer the contract horizon, the larger the risk the landowner will need to internalize. Consequently, the coordinating premium or agglomeration bonus will need to be sufficient to compensate for the risk. Conditions may exist where an agglomeration bonus like subsidy mechanism is preferred to other payment mechanism such as heterogeneous landowner subsidies (Drechsler et al., 2007).[2]

An additional cost associated with the multi-dimensional subsidies is that the incentive structure may create multiple Nash equilibria. Each equilibrium encompasses a set of conservation actions and associated payoffs such that no landowner has an incentive to deviate from their given choice of conservation strategies. The design of multi-dimensional subsidies creates the maximize payoffs for landowners at one Nash equilibrium (the dominant Nash equilibrium) which represents the desired landscape configuration. However, in practice achieving this dominant Nash equilibrium may be challenging (Parkhurst et al., 2002; Parkhurst and Shogren, 2007, 2008). Further, if the ecosystem services are fluid and nonhomogeneous within the landscape, coordinating effort to sustain renewable resources poses additional

[2] Landowners earning a disproportionate share of the subsidy are often incentivized to coordinate group conservation efforts to insure their earnings. The agglomeration bonus can be designed to provide for landowners to earn excessive rents which could facilitate members of the group to incur the costs of collaboration. Heterogeneous payments serve to compensate landowners for lost productivity. They do not create network externalities that will promote collaborative conservation efforts (Raymond, 2006).

problems for the design of a multi-dimension subsidy to be effective within this environment (Smith et al., 2009).

***Tradable Development Rights***

Tradable development rights (TDR) programs specify a predetermined maximum level of development within a specified region, and then distribute development rights equal to the permissible total amount of development to landowners within the region. Landowners who keep their development levels below their allotted development rights level can sell their surplus development rights to other landowners, or they can use them to offset development on other properties. To ensure that development rights serve their purpose as an incentive to change development control to desired social levels, total development levels within a given region are limited such that the development rights are seen as a scarce resource, which is valuable to developers and NGEOs (Hanley, Shogren, and White, 1997; Ruhl, 2008).

TDR schemes push development towards the land with the highest developmental value. It does not, however, protect the land with the highest conservation value, nor does a TDR scheme protect the land in the desired spatial configuration. To accomplish this added objective, a TDR policy would need to be joined with an additional incentive specifically addressing the spatial configuration. Mills (1980) proposes using zoning land use restrictions in conjunction with a TDR policy. The regulator can then zone land within a specified region that is best protected for valuable ecosystem services for conservation (sending area) and provide landowners developmental rights that can be traded with landowners in areas zoned for development (receiving areas). Initially, the allowed development in a receiving area is less than the profit maximizing development level, providing receiving area landowners' incentives to purchase TDRs from sending area landowners (Ruhl, 2008).

Many applications of TDRs with zoning have been implemented over the past few decades in an effort to protect numerous ecosystem services. Florida, through the Rural Lands Stewardship Act has implemented a TDR with zoning policy to protect both natural resources and farmland (Ruhl, 2008). The Pinelands program in New Jersey employs a TDR with zoning policy to protect forest lands, species and other historical sites (Parkhurst and Shogren, 2003). Chomitz et al. (2004) apply TDRs with zoning to a spatial simulation of the Atlantic Rainforest of Brazil.[3]

Many regulators find a TDR policy to be attractive because the cost of preserving land is borne by the developer and internalized in the selling price of developed land. The cost of protecting the valuable ecosystem service is incurred by those who benefit. However, several challenges exist in implementing a TDR with zoning policy to achieve the desired landscape configuration.

*Implementation Issues*

A TDR with zoning policy is not fully voluntary. Landowners relegated to a sending area are not allowed to develop their land. Compensation for conservation is facilitated through the allocation of TDRs. Landowners may object to being forced to conserve land and as such may prematurely develop land to avoid what may be perceived as an unjust taking of their land (Parkhurst and Shogren, 2003). The zoning of conservation and development by state and local agencies potentially reduces efficiency through avoidance strategies or by expending resources lobbying the regulator to gain a favorable outcome. As such zoning detracts from the efficiency properties of a pure TDR policy.

[3] See Kaplowitz et al., (2008) for an overview of the practical uses and concerns of planning professionals regarding the implementation of TDRs.

Drechsler and Watzold (2009) designed a TDR mechanism that incorporates a biodiversity measurement algorithm that allows landowners to meet the conservation objective with greater cost efficiency by spatially allocating the conserved land parcels. The number of parcels necessary to satisfy the biodiversity requirement depends upon the spatial allocation of conservation within the landscape. Thus, biodiversity network externalities are created and traded theoretically conserving the ecosystem service with the low cost spatial conservation landscape. Their research concludes that the TDR algorithm is effective so long as the development values of the land maintain some correlation below a critical randomness measure (Dreschler and Watzold, 2009).

Both the TDR with zoning and the TDS with biodiversity algorithm require the administrating agency to establish markets to facilitate trades, track and document the available development following trades, and monitor and enforce agreements. Additional, the TDR with biodiversity algorithm will require the administrating agency to educate landowners on the impact of coordination within the landscape on the amount of biodiversity created, hence the development rights available for trade. In addition, a landowner may have a difficult time understanding the effects on biodiversity across neighboring landowners' conserved parcels, creating coordination problems impacted by landowner risk preferences. The TDR policy as proposed by Dreschler and Watzold (2009) is likely to complex to be implemented without significant and costly oversight.

For a TDR policy to be effective the demand for development must be sufficient to compensate for the opportunity cost of restricted lands. Further, the supply of TDRs must be sufficient to keep price at an attractive level for developers. Thus, the equation that determines the rate at which a TDR transfers from conservation to development is critical to the success of the policy (Ruhl, 2008; Kaplowitz et al., 2008). Implementation of a TDR policy may not be justified in some more rural areas where insufficient demand exists. In this case, one remedy is to increase the demand by increasing the size of the geographical area. However, increasing receiving areas to generate more demand creates tradeoffs between cost efficiencies and desired landscape patterns (Chomitz et al., 2004). The monetary costs of conservation may be reduced but at an expense of a less desired landscape conservation pattern and less ecosystem benefits.

***Mitigation (Conservation) Banking***

Developers undertaking a new project are often required to mitigate the adverse effects of their activities, which can be onsite or the developer can purchase development credits to satisfy the regulation off site. Development credits can be purchased as needed or the developer can purchase excess credits and bank them to fulfill mitigation requirements of future projects. Developers purchase these credits from private or publicly owned *mitigation banks;* prices are determined by supply and demand of credits. A developer purchases credits so long as the price of the credit is less than return from developing the land. New mitigation banks will enter the market if positive economic profits exist; whereas market competition will lower the price of the credits (Parkhurst and Shogren, 2003).[4]

The number and type of credits a mitigation bank can sell depends upon the quality and type of ecosystem service supplied. The regulatory agency allows for restoration and improvement of ecosystem services by awarding mitigation bank owners additional credits for the increased ecosystem benefits. In California, mitigation banks are commonly used to offset the impacts of development on endangered species and associated habitat and to mitigate impacts

[4] Creating mitigation banks in pursuit of profits has been termed entrepreneurial mitigation banking and constitutes over 300 (78% of all) wetland mitigation banks across the USA (Robertson and Hayden, 2008).

of developmental activities on wetlands (CDFG, 2011). Entrepreneurial wetland banks, mitigation banks operated for profit, are common in the Chicago area to offset the loss of wetlands due to development (Robertson and Hayden, 2008).

*Implementation Issues*

Mitigation banking aggregates ecosystem services into larger preservation reserves; however, often times more dispersal of the environmental amenity is preferred (see Saunders et al., 1991). Aggregating ecosystem services that provide more benefits when dispersed throughout the landscape (or watershed) into one large reserve could decrease the social benefits. Entrepreneurial interest into mitigation banking creates even larger reserves to capture scale economies (Robertson and Hayden, 2008).[5] The economic cost of mitigation is reduced but at a decrease in the derived ecosystem benefits.

Mitigation banking also serves to reallocate wetlands from urban areas to more rural areas, disadvantaging people in urban areas as critical wetland services are lost (Boyd and Wainger, et al., 2002; Ruhl and Salzman, 2006). Shifting the benefits from a high value area to a low value area reduces the cost of mitigation. Regulating the size of the region in which a bank is located and can sell credits serves to keep ecosystem services local where benefits may be larger (Parkhurst and Shogren, 2003).

Further, restored ecosystem services often have temporal requirements before the benefits derived from the restored ecosystem service can be ascertained. However, regulatory agencies will often allow the bank owners to sell credits prior to the time where restoration can be fully assessed. Mitigation banks may sell credits for expected benefits that never materialize resulting in a loss in ecosystem services. Also, measurable proxies (such as counting acres) implemented by regulatory agencies to determine functional value of the restored ecosystem services have

[5] See Ruhl and Salzman (2006).

assessment inefficiencies. Mitigation banks rarely meet their mitigation objectives; the value of the ecosystem services lost to development is not fully replaced (Ruhl and Gregg, 2001).

***Purchased Development Rights (PDR) Easements***

Ownership of land provides the landowner certain rights regarding how the land can be used, which include the right to exclude others from using the land, the right to develop the land, the right to produce commodities, and the right to employ other legal rent-seeking activities. A *conventional easement* is a legal instrument that serves to separate specific rights in the land and transfer those rights from the landowner to another entity. A PDR easement severs the developmental rights of the land (any actions that are non-compatible to conservation) which can then be sold to a separate party for a specified period of time for a cash payment, usually at the fair market value of the easement—the difference between the easement-free value and the easement-encumbered value of the property (Parkhurst and Shogren. 2003).

The concept of an easement is captured by Coase (1960) in his seminal article *The problems of social cost.* Coase argued social costs could be mitigated through bargaining as opposed to more aggressive government intervention. PDR easements allow a buyer(s) and seller(s) to interact in the market to make a voluntary transaction. Transactions only occur if both parties are able to benefit from the arrangement.

PDR easements are commonly used by NGEO and government agencies as a PES scheme for protecting ecosystem services. In Maryland, a PDR scheme is used to retire the developmental rights from agricultural lands while leaving the landowner on the property. The land selection process selects parcels based on the bid easement value ratio but does not have a mechanism for coordinating conservation within the landscape (Horowitz et al., 2009). Liu and Lynch (2011) show PDR policies have had a significant impact in slowing the conversion of farm lands into more developed regions. Stoms et al. (2011) show that acquiring more information regarding cost and benefits allows for a more effective targeting of a conservation landscape design.

*Implementation Issues*

Reverse auction mechanisms which are commonly employed to choose lands for PDR as a PES scheme typically rank order a benefit cost ratio and then choose those contracts with the largest ratio. By choosing contracts simultaneously, the regulator loses the opportunity to capture network externalities that result when conserved parcels share common borders. Alternatively, allowing for sequential choice of contracts would more readily capture coordinated conservation network externalities, but would do so with higher costs. Landowners may realize the increased value of their parcel to the landscape conservation design and act strategically. Further, information rents may be more extensive (Ferraro, 2008). Reverse auctions that recalibrate contract rankings each round tend to protect more ecosystem services for a fixed budget (Horowitz et al., 2009). The larger the opportunity set, the better able the regulator is to satisfy optimal landscape designs.

**Discussion and Conclusion**

Two goals that are inherent in government and NGEO conservation efforts are to meet the conservation objective and to do so at the minimum possible cost. Meeting these goals is a trivial matter for a government regulator armed with perfect information regarding the minimum cost landscape design that meets the conservation objective and who can induce all landowners to participate voluntarily for compensation equivalent to the lost value of their land in non-conservation activities. However, this situation does not exist.

In the real world regulators are forced to make tradeoffs between the strengths and weaknesses of PES schemes as they relate to the attributes of the targeted landscape.   We identify three key attributes for determining which mechanism would be most effective at meeting the desired conservation landscape pattern: 1) Developmental Pressure; 2) Landowner Attitudes and Values; and 3) landscape needs for ecosystem services. We address each in turn.

*Development Pressure*

When development pressure is strong market forces will increase the costs of conservation.  PES schemes that harness the market and internalize the costs of protecting valuable ecosystem into the value of the development—development is forced to "pay its own way", will provide greater ecosystem services.  TDRs with zoning and Mitigation Banking will be better able to protect the desired ecosystem configuration when market demand is thick.  Fee-simple acquisition, the agglomeration bonus, and PDR easements will be cost prohibitive. Government coffers will likely be insufficient to conserve the lands necessary to meet the landscape design.

In a weak development market, implementing a TDR with zoning or Mitigation Banking PES scheme may require the regulator to make the market too large allowing the magnitude of the local losses in ecosystem services to outweigh the gains as ecosystem services are aggregated to a remote location (Boyd and Wainger, et al., 2002; Ruhl and Salzman, 2006).  When developmental pressure is weak, the value of non-conservation activities is lower making PDR easements, the agglomeration bonus, and fee-simple purchase more attractive.

*Landowner Attitudes and Values*

Landowners may view their role as a steward of the land and their autonomy in managing their land as necessary and sufficient for protecting the vast ecosystem services provided on their land. Government intervention in land uses, no matter how innocuous, may be viewed as untenable. Even a gentle nudge in the form of a subsidy may violate this sense of autonomy and good stewardship. The least intrusive PES scheme is fee-simple acquisition; a voluntary agreement between parties to sell all rights in the land at the market value. The most intrusive PES scheme would be TDR with zoning, particularly for those landowners in a sending area. When attitudes toward autonomy are strong for landowners within the conservation landscape, government should seek less intrusive PES schemes to meet landscape designs, or work in partnership with NGEOs to satisfy the provision of ecosystem services within the landscape.

Attitudes and values towards conservation may also be present within the targeted conservation area. Targeting landowners with high conservation values may reduce the costs of implementing PES schemes to meet the targeted landscape design. The compensation necessary to enroll lands may be less because the market price is offset by the landowner's conservation value. In addition, landowners whose land use decisions are already in alignment with the provision of desired ecosystem services if left to steward the land will have lower costs of maintenance. Here, PDR easements and the agglomeration bonus would be most effective at meeting desired landscape patterns. However, the mechanisms that are often used to capture individual values, such as reverse auctions, are subject to rent seeking as landowner's benefit from their private information (Ferraro, 2008).

*Landscape Needs for Ecosystem Services*

The provision of each ecosystem service requires specific conservation efforts and spatial landscape designs. Within the targeted landscape many ecosystem services are available. In addition the regulator may have competing objectives (Nelson et al., 2008). Whether several small or a single large conservation patch is necessary will depend on the ecosystem services being protected (Parkhurst and Shogren, 2008). PES schemes such as the agglomeration bonus, PDR easements, and fee simple acquisition are relatively flexible and can be used to meet diverse goals and objectives. TDR with zoning and mitigation banking may be less flexible due to the necessary government oversight to create markets, record transactions and monitor and enforce land use restrictions. The tendency for entrepreneurial mitigation banking to create larger contiguous ecosystem service to capture economies of scale decrease the flexibility for mitigation banking to meet landscape designs requiring several small preserves.

If developmental demand is high, social values for autonomy are high, and requirements for ecosystem services are to aggregate demand into one large contiguous conservation reserve, mitigation banking would be the best PES scheme. Alternatively, where development demand is high, social values for autonomy are high, but ecosystem services require a landscape pattern that allows for several small conservation reserves, the TDR policy with zoning is the better PES scheme.

For areas where developmental pressure is low, conservation values are high, and the desired landscape design requires one large area, the agglomeration bonus will likely be more efficient. Where objectives can be met with several small reserves, tradeoffs exist between the agglomeration bonus and the PDR easement PES scheme, depending on whether a combinatorial auction or a reverse auction for heterogeneous values is more efficient (Ferraro, 2008; Tanaka, 2007).

Designing PES schemes to satisfy desired landscape designs will depend upon the underlying natural, social, and economic characteristics of the targeted conservation region. There is not a one size fits all approach to designing PES schemes for conserving desired landscape patterns. The good news, with thoughtful reflection regulators can capture significant economic gains by designing the PES scheme to adhere to socioeconomic and bioeconomic characteristics of the targeted landscape.

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