Paying for environmental services from agricultural lands: an example from the northern Everglades

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There is growing interest in implementing market-like programs that would pay farmers and ranchers for producing environmental services (beyond those that generate food and fiber) from working agricultural lands. However, few examples exist of programs that pay directly for quantified services. Since 2005, a coalition of non-governmental environmental organizations, state and federal agencies, ranchers, and researchers has been developing a Pay-for-Environmental Services (PES) program that would compensate cattle ranchers in Florida's northern Everglades region for providing water storage and nutrient retention on private lands. We use our experience with this program to identify key challenges to PES program design, including identifying a buyer and defining the environmental services; agreeing upon credible, yet practical, approaches to quantifying the services provided; reducing programmatic costs in light of existing policies and complex regulatory issues; and maintaining an adaptive approach to program design and implementation, while satisfying the concerns of multiple stakeholders.

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Agricultural lands supply many ecosystem services desired by society, beyond merely providing food and fiber (Clay 2004). Cultivated lands and grazing systems account for nearly 50% of the global land surface (Asner *et al.* 2004; MA 2004). Although agriculture produces food and fiber often at the expense of biodiversity, water quality, and soil conservation (eg Bennett and Balvanera 2007; Kareiva *et al.* 2007), alternative policies and management of these lands could increase the provision of multiple ecosystem services (Boody *et al.* 2005; Robertson and Swinton 2005; Swinton *et al.* 2006).

In a nutshell:

- There is increasing interest in developing Pay-for-Environmental Services (PES) programs to encourage the provision of multiple ecosystem services from agricultural lands, but few examples of such programs exist
- The Florida Ranchlands Environmental Services Project (FRESP) has been designing a PES program in which state agencies pay ranchers for producing environmental services – water storage and reduced phosphorus loading – on private ranchlands in south-central Florida
- The PES concept in FRESP differs from traditional cost-share or conservation programs, in that the intent is to pay ranchers for providing documented environmental services, rather than to offer cost-sharing options for the adoption of prescribed practices
- Our experience in designing a PES program on agricultural land illustrates how such a program could work and reveals multiple challenges to program implementation

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Agri-environmental programs that are designed to increase provision of environmental services from agricultural land rarely pay directly for the documented services produced. Rather, they either offer subsidies or cost-sharing for implementing best management practices (BMPs) or taking land out of production, or use regulations to limit adverse environmental effects (Feather *et al.* 1999; Kleijn and Sutherland 2003). Government programs often provide incentives to adopt agency-prescribed management practices without determining whether the desired environmental benefits are achieved (Wunder *et al.* 2008). An alternative approach is to pay directly for environmental services produced through Pay-for-Environmental Services (PES) programs (Ferraro and Kiss 2002; Pagiola *et al.* 2004, 2007; Wunder *et al.* 2008). These programs draw from the concept of valuing ecosystem services (eg Daily *et al.* 2000; Tallis and Karieva 2005; Brown *et al.* 2007), although designing workable PES programs from this concept is a distant reality.

Of the many policy and technical requirements of PES programs, first and foremost is the need to identify environmental services valued by buyers who are willing and able to pay for them. The theory is that by focusing on environmental results and not just practices, market-like programs will encourage producer–sellers to innovate and seek cost efficiencies in providing services (Shabman and Stephenson 2007). However, insufficient understanding of the underlying ecology and environmental issues makes it difficult to quantify these services (Kremen 2005). Current PES programs pay limited attention to measuring the services produced (Wunder *et al.* 2008), in part because of the cost of documentation (Ferrano 2008). Thus, PES programs that pay for performance must face the challenge of developing cost-effective documentation that assures "buyers" that they are getting what they paid for, and "sellers" that they are getting a fair price for what they produce.

All PES programs share common elements, although the services demanded, and their evaluation, are region-specific. One common issue is the need to define and assess the current or baseline level of services being provided, and to determine the potential for increasing production. Regions most likely will vary substantially in the types and amount of baseline information available, and in the scientific or financial resources required to evaluate such information. Some types of information might be readily available (eg the area of restorable wetland habitat), whereas others might be harder to acquire (eg the number of breeding grassland birds).

In general, environmental services cannot be quantified accurately like bushels of corn, pounds of milk solids, or live weight of cattle. Consequently, many government-funded programs are based on generalized assumptions about the services produced by different management practices (Wunder *et al.* 2008). However, if a PES program is to be based on payments for actual services, then there must be some type of documented approach, so that sellers can be confident about producing the measured services, and buyers can justify different levels of payment to different producers. PES programs must also have access to reliable funding and must consider existing policies and regulations.

In this paper, we use our experience in trying to develop a PES program for Florida ranchlands to illustrate these various difficulties in PES program design and implementation. Our project, the Florida Ranchlands Environmental Services Project (FRESP), is a progressive coalition, composed of cattle ranchers (Table 1), environmental organizations (World Wildlife Fund [WWF]), and academic scientists (University of Florida, Archbold Biological Station), as well as state and federal agencies (South Florida Water Management District [SFWMD], Florida Department of Agriculture and Consumer Services [FDACS], Florida Department of Environmental Protection [FDEP], and US Department of Agriculture Natural Resource Conservation Service [USDA-NRCS]). The FRESP is designing a market-like PES program for Florida's northern Everglades region (WWF 2008). Our experience provides insights into the difficulties inherent in general PES program design, including agreeing on the basis of payments, data requirements and documentation of services provided, and the constraints of existing policy and regulatory frameworks. Finally, we comment on how PES programs cope with the challenges of governing complex environmental systems.

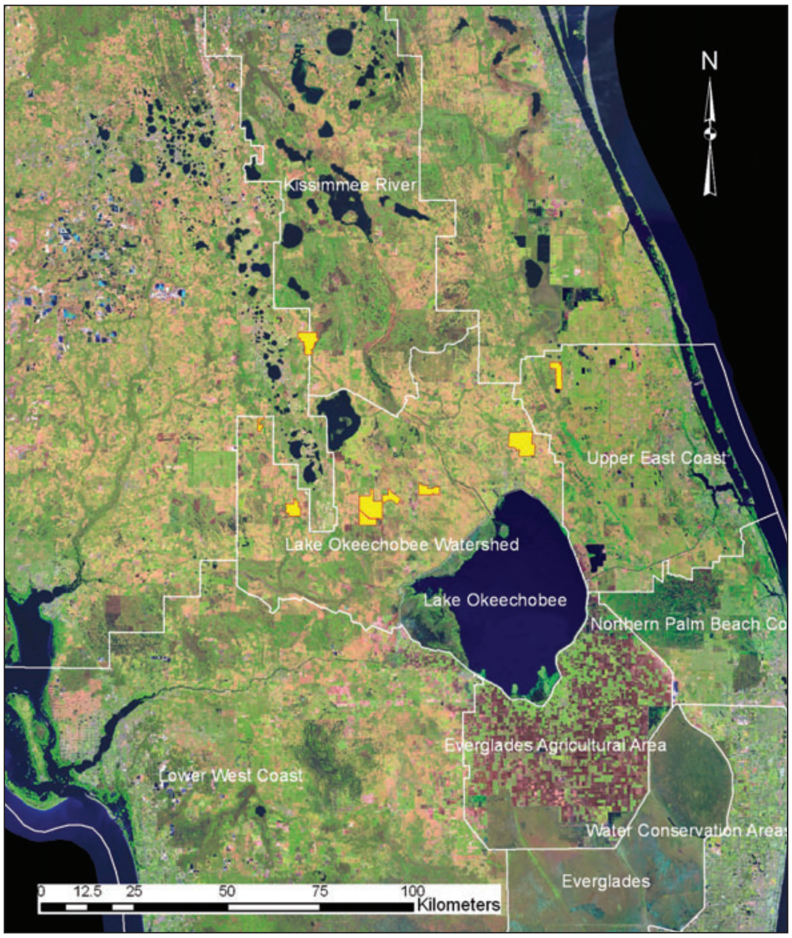

Figure 1. *Location of the eight FRESP participating ranches (yellow areas outlined in red) and boundaries of the hydrologic basins in the South Florida Water Management District. Map prepared by P Bohlen, using GIS coverages from www.sfwmd.gov, Archbold GIS Laboratory, and other sources.*

The demand for environmental services in the northern Everglades

The northern Everglades region includes the Kissimmee River, Lake Okeechobee, and adjacent coastal estuaries to the east and west (Figure 1). Beginning in the 1940s, public agencies and private land owners began to transform this region, using a vast drainage system, to facilitate agricultural production and human settlement (Aumen 1995; Steinman *et al.* 1999; Godfrey 2006). Today, the hydrologic regime of the 1.4-million-ha upstream watershed is governed by hundreds of publicly managed flow-control structures and thousands of miles of canals and ditches (SFWMD *et al.* 2007).

The hydrological and land-use changes in the Lake

Table 1. Description of FRESP project sites

Ranch name (project status)	*Ranch size (ha)*	*Water Management Alternative (WMA) type (project area)*	*WMA design, operation, and purpose*
Alderman-Deloney Ranch (WMA operational)	1358	Wetland water retention (20 ha)	Two culverts with riser structures installed in drainage ditches to retain water at set elevation in two natural depressional wetlands. Maintain water at higher stage than was previously possible.
Buck Island Ranch (WMA operational)	4250	Pasture water retention (1500 ha)	Thirty-six culverts with riser structures installed in a network of drainage ditches to reduce P runoff and retain water in the ditches, wetland, and soil within a 1500-ha area of agriculturally improved pasture. Maintain water at higher stage than was previously possible.
CM Payne & Sons Josephine Road Ranch (WMA under construction)	317	Pasture water retention; on-site and off-site sources (195 ha)	Existing culverts and newly installed culverts and berms to retain water in pastures; water includes both on-site rainfall and runoff from upstream developments. Maintain water at higher stage than was previously possible.
Lightsey Cattle Co XL Ranch (WMA under construction)	1308	Pasture water retention (215 ha)	Install culvert riser board water-control structures and several intervening fixed plates with bleed-down holes in pasture drainage ditches to attenuate pasture runoff, maintain higher groundwater levels, and increase water storage on-site.
Lykes Bros Inc (WMA operational)	138 610	Treatment area for P removal from off-site water sources (959 ha)	Install hydraulic pump to pump water from regional public canal (C-41a) into existing 959-ha marsh/impoundment with gravity outflow at the downstream end. Nutrient removal from public water.
Rafter T Ranch Inc (WMA under construction)	2055	(a) Pasture water retention (464 ha) (b) Water impoundment (61 ha) (c) Wetland water retention (40 ha)	(a) Use existing berm along Arbuckle Creek to maintain higher water levels in pastures and drainage ditches. (b) Construct an impoundment to retain water pumped from adjacent pastures with gravity flow into creek. (c) Culvert riser board structure installed to retain more water in existing cypress swamp.
Syfrett Ranch (WMA under construction)	1240	Pasture water retention; on-site and off-site sources (113 ha)	Use existing infrastructure of pumps and ditches to retain more water on pastures planted with flood-tolerant grasses; pump water from regional canal onto flooded pasture for retention during wet periods.
Williamson Cattle Co (WMA operational)	3683	Wetland water retention (98 ha)	Install water-control structure at discharge of wetland area that was ditched and drained ~40 years ago. Maintain water stage at higher level than was previously possible to provide water retention.

Notes: At all sites, environmental performance is being monitored by a combination of flow-monitoring stations that include stage recorders, dataloggers, and automatic water samplers, as well as groundwater wells to record groundwater stage at various locations. Many of these sites are constructed with telemetry, enabling remote data access.

Okeechobee watershed have fragmented wildlife habitat and accelerated the movement of water and nutrients into regional water bodies, increasing nutrient loads into the lake and causing more extreme water-level fluctuations (Dahm *et al.* 1995; Havens *et al.* 1995). Total phosphorus (P) concentration in Lake Okeechobee has more than doubled since the 1970s, causing increases in the incidence and/or duration of algal blooms and eutrophication, mainly due to nutrient runoff from agricultural land (Steinman *et al.* 1999; Havens and Schelske 2001). When lake levels are high, nutrient-laden freshwater is pumped out of the lake through canals to the St Lucie and Caloosahatchee estuaries, which are being harmed by the combination of excess freshwater and high nutrient concentrations (Steinman and Rosen 2000).

These problems prompted the Florida state legislature to introduce the Lake Okeechobee Protection Act, which seeks to reduce annual P loads to the lake by 75% (SFWMD *et al.* 2008), and the northern Everglades and Estuaries Protection Program (NEEPP), both of which accompany the larger federal–state partnership represented by the Comprehensive Everglades Restoration Program, or CERP (USACE and SFWMD 1999; USACE 2005). These programs create a huge public demand for increased water retention and reduction of nutrient runoff within the Lake Okeechobee watershed. Plans to meet this demand include a combination of extensive public works projects, such as aboveground reservoirs and underground storage, as well as alternative water storage projects on public and private lands, and cost sharing for agricultural BMPs (SFWMD *et al.* 2008). These plans call for nearly one million acre-feet (123 348 hectare-meters [ha-m]) of new water storage north of Lake Okeechobee. Recognizing that this storage capacity will be difficult to obtain solely through public works projects or land acquisition, state agencies are considering options for retaining water on private lands (including ranches) throughout the region.

The focus on retaining water north of the lake created a window of opportunity (eg Olsson *et al.* 2006) for garnering agency support for a program that would pay ranchers for storing and filtering water on their lands (ie the FRESP program). There is a clear public demand for these water-related environmental services, and that demand is matched by government agencies with the authority and the available budget to purchase these services from private land owners. The demand by the buyers (Florida state agencies) for obtaining these environmental services on private ranches is evidenced by the inclusion of FRESP in the northern Everglades plan (SFWMD *et al.* 2008), and by the state's commitment of over $3 million to FRESP, in addition to more than $3 million from federal and private sources (USDA-NRCS and the WK Kellogg Foundation).

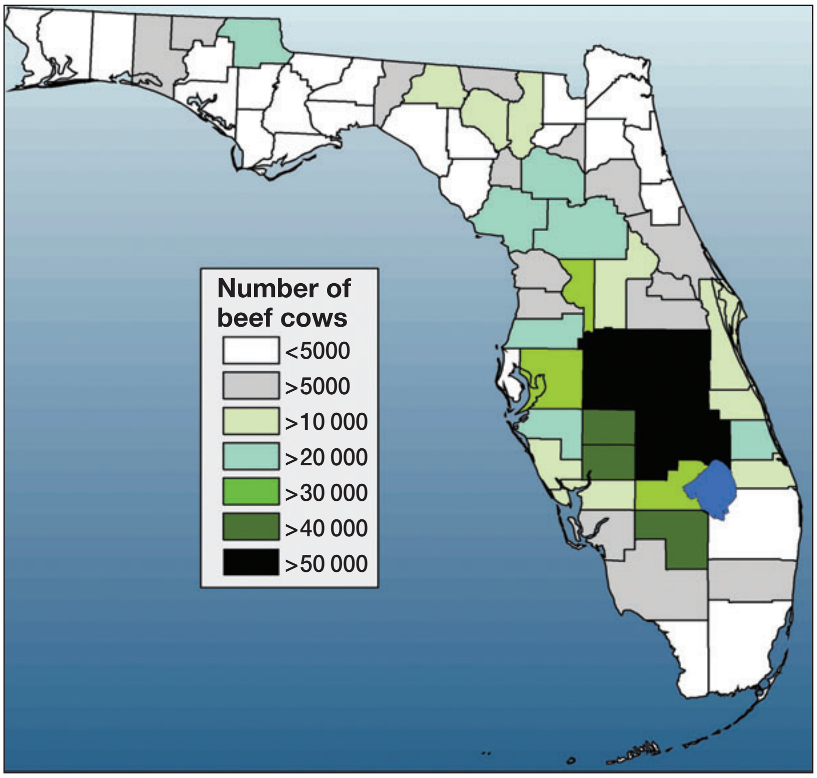

Figure 2. *Map of the state of Florida showing the major areas of beef cattle production by county. Numbers of breeding cows are from the 2007 Agricultural Statistics. Map produced by R Pickert, Archbold GIS Laboratory.*

Identifying ranchers as potential sellers of environmental services

Cattle ranches in the Lake Okeechobee watershed provide valued ecosystem services. Ranches north of the lake, which are mainly cow–calf operations, are the dominant land use in the watershed and contribute to Florida's national ranking of 12th–13th in the production of cattle (USDA-NASS 2008; Figure 2). These ranches represent about 0.5 million ha of agronomically improved pastures, and also include pastures with native rangeland vegetation, on land parcels varying from 500–5000 ha, with several in excess of 50 000 ha (Figure 3). These large ranches encompass extensive natural communities, provide corridors that are critical to wildlife movement, support water recharge and storage, and harbor common wildlife species as well as several federally threatened and endangered species (eg woodstork [*Mycteria americana*], indigo snake [*Drymarchon corais couperi*], crested caracara [*Caracara cheriway*], Florida grasshopper sparrow [*Ammodramus savannarum floridanus*], and Florida panther [*Puma concolor coryi*]; Figure 4).

These attractive environmental features of south-central Florida cattle ranches convinced program staff at WWF, as well as colleagues at other environmental groups (eg The Audubon Society, The Nature Conservancy), that cattle ranching is a preferred land use in the northern Everglades from an environmental perspective. However, narrow economic margins generate pressure to convert ranches to more intensive agriculture, which would likely result in less water storage and higher P loads (Hiscock *et al.* 2003; Lynch and Shabman 2007; Swain *et al.* 2007). Florida's rapid population growth provides powerful incentives for selling ranchlands for development; from a conservation standpoint, current projections that Florida will lose an additional 2 813 886 ha of rural land to residential or urban development by 2060 are alarming (Zwick and Carr 2006). In order to explore ways to enhance both the ecological value and the economic viability of cattle ranches, WWF formed an ad hoc group – including several ranchers, independent scientists, and state-level water management, agriculture, and environmental agencies – in 2003 to identify opportunities for generating revenue from the production of environmental services.

A study conducted by WWF and partners concluded that ranchers – with appropriate incentive – could harness the extensive canals and ditches, berms, and water-control structures, which were originally designed for

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Figure 3. *(a) Agronomically improved pasture and (b) native wet prairie pasture typical of south-central Florida.*

drainage and irrigation, to retain more water, rehydrate drained wetlands, and reduce P loads. Most importantly, the assessment concluded that state agencies could buy these ecosystem services from ranchers at a cost that was lower than, or competitive with, the cost of securing the services through large public works projects. This stimulated interest among the partners in exploring the development of a program that would pay ranchers willing to provide environmental services on their land, as a complement to publically funded projects being proposed for Greater Everglades restoration. Because programs were already in place to encourage ranchers to voluntarily adopt water quality BMPs, it was understood from the outset that a PES program needed to be based on the concept of "additionality"; that is, ranchers would be paid only for services that went "above and beyond" the water retention and P-load reduction that would result from existing and anticipated management practices. Given that there are a half million hectares of ranchland in the region, such a PES program potentially could provide a substantial amount of water storage and nutrient retention if adopted on a wide scale; one goal of FRESP is to conduct a more-detailed analysis of the water storage that could be achieved by a scaled-up program on ranchlands throughout the watershed.

■ The FRESP pilot program

In 2005, FRESP was launched as a pilot program. Its aim was to: field test credible, yet cost-effective, methods for producing and documenting the environmental services of water storage and nutrient load reduction; design a comprehensive program, including the contracting processes; and facilitate negotiation between buyers and sellers to determine a price for services. In the pilot phase, participating ranchers are being paid for the total costs of installing and operating different Water Management Alternatives (WMAs) on their land. They are given a fixed annual "participation payment" for 3 years, with an option to renew; ultimately, the intent is to develop a full-scale program that would tie payments to the amount of service provided, once agreed-upon documentation procedures are in place.

FRESP includes WMA projects on eight ranches, to evaluate the possible water retention and nutrient load reduction services under real-world conditions (Figure 5; see WebPanels 1 and 2 for two additional constructed sites). The WMAs include rehydrating previously drained wetlands, managing pasture drainage to increase water retention, pumping water from regional canals into a treatment wetland for nutrient removal, and building impoundments to store more water on the ranch (Table 1). Four ranches constructed fully operational WMAs in 2007, and an additional four ranches began constructing their projects in 2008.

The challenges encountered while designing and implementing these projects illustrate some of the difficulties of translating the PES concept into a workable program. Some of these are discussed in the following three sections, which focus on factors that affect "transaction costs", which in the case of market-based PES programs are the costs associated with making payments in exchange for environmental services. These costs are associated with (1) documenting the services, whether it be by data collection and analysis, third-party verification, or required record keeping; (2) negotiating and executing contracts, which could include the cost of determining eligibility, estimating the environmental service potential, and administering payment; and (3) dealing with regulatory issues, including permitting, threatened and endangered species issues, and reconciling with other state or federal programs.

Cost-effective, practical documentation

Documentation of services is central to the operation of a market-like program. However, methods for documenting services in a PES program must be practical, low-cost, transparent, and acceptable to both buyers and sellers (Cook *et al.* 2004). The FRESP team has implemented instrumentation and procedures for evaluating water storage and P-load reduction on the pilot projects to determine the cost of obtaining credible documentation, and to test how much information on environmental services is lost as each layer of data or monitoring is stripped away. In addition, extensive hydrological modeling of two of the WMAs is underway, which will enable a comparison between predicted and actual performance.

The purchasing agencies' need for documentation – and, to some extent, the way they want the services defined – depend upon the documentation costs and capabilities. In any PES program, the incremental knowledge gained from more measurements, greater accuracy, and higher precision needs to be weighed against the increased cost of collecting, analyzing, and managing data.

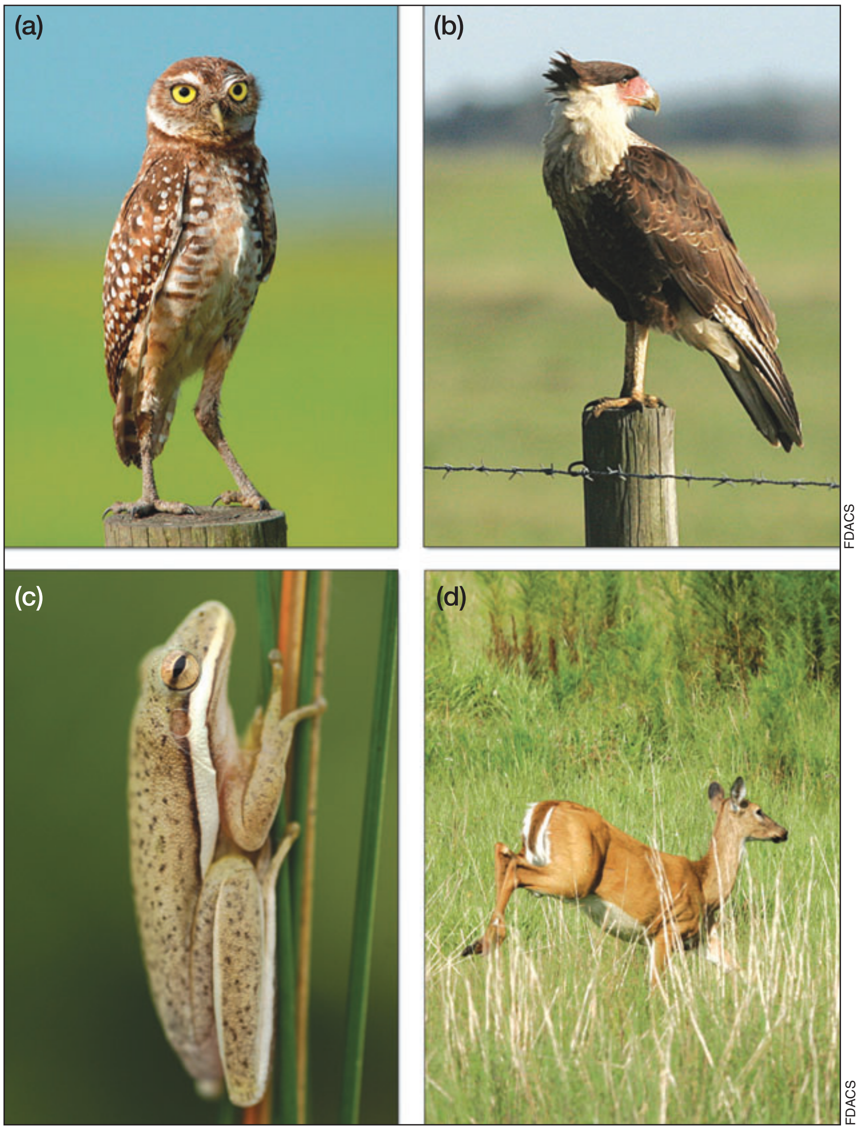

Figure 4. *Florida ranches provide important habitat for wildlife, including threatened species such as (a) the burrowing owl (*Athene cunicularia*) and (b) crested caracara. They also support important wetland habitat for species such as (c) the green treefrog (*Hyla cineria*), as well as game species such as (d) the white-tailed deer (*Odocoileus virginianus*), which can provide supplementary income to ranches through private hunting leases.*

The way that P-load reduction is quantified is an example of the influence of documentation costs and practicality on program design. Our previous experience, a review of existing scientific literature, and consultation with hydrologists confirmed that quantifying increases in water retention, though difficult, could be done more easily and with more certainty than quantifying reductions in P runoff, except in cases where water enters the site by pumping or channeling through a limited number of points. Therefore, a scaled-up program should recognize that, in some cases, accurate quantification of P-load reduction would be too costly to justify, even in cases where theory predicted that this service was being provided. Thus, both buyers and sellers would have to accept that any agreed-upon documentation was likely to provide less information about P-load reduction than water retention. All performance-based PES programs will need to deal with such cost tradeoffs and negotiations when considering the documentation of environmental services.

Contract design

The experience of implementing complex pilot projects on eight ranches has provided valuable insight into contract design for a scaled-up PES program. In the specific case of FRESP, contracts need to account for the fact that ranchers are unlikely to provide water retention in low rainfall years. A payment structure was required that would ensure that payments were received in all years in order to offset the financial risk for ranchers, who might need to make substantial investments in designing, constructing, and operating WMAs. A proposed solution was

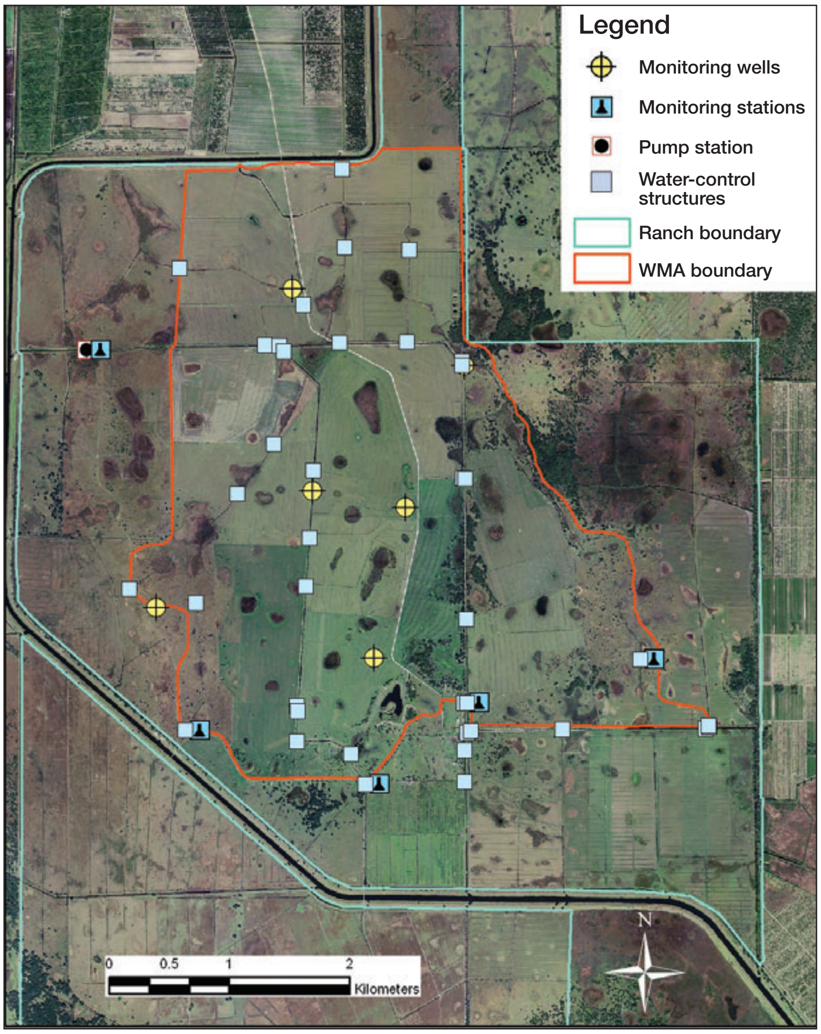

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Figure 5. *The Water Management Alternative (WMA) at Buck Island Ranch is a pasture water retention WMA, in which 37 dilapidated water-control structures were replaced with new aluminum culvert/riser-board structures, which will be managed to retain water in a 1500-ha (3700-acre) area of improved pasture, while continuing to maintain cattle grazing on these pastures. The WMA monitoring system includes flow measurement systems at five gravity discharge culvert sites; three groundwater wells in pastures; two surface water wells in drainage ditches; and a pump monitoring system.*

for agencies to pay for the option of retaining a model-predicted amount of water for an "average" rainfall year, regardless of actual rainfall. In dry (or wet) years, ranchers would get paid more (or less) than the value of the water retained, but there would be a certain payment each year. A similar logic would apply to ranchers who could provide documented P-load reduction services, as the ability to provide that service may also vary with weather conditions.

There would also need to be an assessment of the water retention and P-load reduction potential of a specific site and WMA design before contracts could be signed. Contracts would be written and terms of payment established, in part on the basis of such a pre-assessment. The FRESP team is developing a relatively simple Potential Water Retention Model and a Potential P Load Reduction Model that will allow for pre-assessment of these potential water services, and will use data from the existing pilot project to test these models. However, models and other analyses used to assess potential run the risk of over- or under-predicting the extent of the actual services provided. Because of these uncertainties, a scaled-up PES program must have an adaptive management plan for post-contract model refinement and site reassessment, including monitoring design, model error analysis, and management practice audits. In any PES program, the buyer assumes the risk of not receiving the service that was paid for, and the seller assumes the risk of not making a profit; these risks can be minimized through effective design, management, and documentation.

The intersection between PES and environmental regulatory programs

Designing a PES program like FRESP requires navigating through a complex regulatory maze created by multiple state and federal agencies responsible for environmental regulations, policies, and programs. Clarifying the relationships between these entities is essential to PES program design. For example, any program in the US that proposes to alter hydrology and wetland habitat on agricultural land, especially if federal funds are involved, immediately engages multiple federal agencies, including the USDA-NRCS, the US Environmental Protection Agency (EPA), the US Fish and Wildlife Service (USFWS), and the US Army Corps of Engineers (USACE), as well as state agriculture, natural resource, and water management agencies. Each agency has its own regulatory mission, and none include the design of novel, market-like solutions to environmental problems.

In PES programs such as FRESP (unlike permanent conservation easement programs), projects are based on fixed-length contracts, and the land owners want some assurance that they could return the land to its pre-existing condition after the contract period ends. In the case of FRESP, regulatory agencies were engaged up-front to assure this kind of post-contract flexibility. First, FRESP negotiated a Nationwide 27 Permit (Section 404 of the Clean Water Act) and a Memorandum of Understanding between FDEP, SFWMD, and FDACS, that would allow ranchers to return their lands to the pre-WMA wetland conditions after contracts expired. Second, FRESP obtained a letter of concurrence on the Nationwide 27 Permit from the USFWS, agreeing to the provision that sites could revert to pre-WMA status, and affirming that the WMA would have "No Effect" on or "May Affect, Not Likely to Adversely Affect" six federally threatened and endangered species. In each case, negotiating the agreements was both time consuming and sufficiently complicated that it required technical support from Environmental Defense, a conservation organization with expertise in the US Endangered Species Act.

Finding a way through this kind of regulatory maze is essential to reduce the risks (and paperwork) for both the agencies and land owners, reduce transaction costs, and ensure broad participation in any PES program. A major emphasis of the next phase of FRESP is to identify alternatives for efficient PES program administration and to incorporate these features into existing or newly created institutions, processes, or agencies. For example, we are reviewing programmatic alternatives to a project-based letter of concurrence from USFWS for endangered species, including a Safe Harbor Agreement, a General Conservation Plan, or a Section 7 agreement with USDA-NRCS.

■ The role of stakeholder coalitions in designing PES programs

Maintaining the needed collaborations to address the PES design issues requires a shared vision and a sense of trust among the various partners (Olsson *et al.* 2006; Asquith *et al.* 2008). Because market-like PES programs do not fit neatly into existing markets or policy frameworks, they require the leadership of entrepreneurs who are willing to build diverse coalitions of stakeholders, to work through difficult policy and regulatory obstacles, and to sustain political goodwill and consistent financial support to promote change (Olsson *et al.* 2006). Such coalitions require organizational skills and persistence in order to hold together a diverse array of institutional, disciplinary, and cultural perspectives.

Designing PES programs based on performance is as much a socioeconomic challenge as it is a scientific or technical one. In the case of FRESP, WWF was the *social entrepreneur*, who encouraged diverse partners to step outside their traditional roles and boundaries and embrace novel approaches for meeting mutually agreed-upon goals (Olsson *et al.* 2004). The ranchers were environmental pioneers who shared an environmental ethic and were looking for common sense approaches that would enable them to profit from producing environmental services. The forward-thinking leaders within state agencies, without whom the project could not have been launched, were willing to stretch their agency mission, regulatory framework, and budgets to support a true PES program design. The scientists working on FRESP needed to step outside of traditional academic reward structures to contribute toward policy alternatives by applying scientific information in the face of uncertainty and acting as "honest brokers" (Pielke 2007). They also had to consider how their scientific expertise fit within the broader policy context of a complex environmental issue and to identify ways that they could work with policy makers and other stakeholders to contribute to sound, science-based environmental governance (Lackey 2007; Steyaert and Jiggins 2007).

■ Broader implications for PES programs

Although the concept of applying market-based programs to environmental services has broad appeal, there are many challenges in moving from concept to reality (Shabman and Stevenson 2007; Wunder *et al.* 2008). Even though south-central Florida offers an ideal setting for designing and implementing a PES program, and despite tremendous support for the FRESP program across a broad stakeholder coalition, there are still considerable hurdles, both technical and institutional, to making such a program work. FRESP has benefited from substantial resources to support both an in-depth analysis of difficult-to-measure environmental services and an assessment of program design and policy options that could minimize transaction costs in a scaled-up program. Such resources are rarely available under normal circumstances.

Whether the service of interest is water storage and water quality improvements, carbon sequestration, or enhancement of wildlife or biodiversity, a central challenge to any PES program is documenting environmental performance on sites that differ in their physical and ecological characteristics, management history, and connection to the surrounding landscape. Market-like programs need to focus on the costs and benefits of different documentation methods, and it is possible that these programs will foster such methods (Stephenson *et al.* 1998). Technical advances in ecological sensor networks may help reduce the costs of monitoring certain environmental services over broad areas, which – in combination with the development of simplified models – may lower documentation costs, while increasing accuracy.

Existing regulatory and policy obstacles add costs and bureaucracy, undermining the desired market-like efficiency sought by PES programs. These costs could be reduced by programmatic solutions, such as streamlined permitting, program-specific exemptions for wetland or wildlife impacts, and mechanisms to facilitate interagency collaboration. A related issue is the need to create a flexible policy environment that achieves regional or national goals in a more coordinated way, by allowing complementary programs to work together or for single projects to be included within multiple programs.

Finally, PES programs require dedicated funding streams that link those who demand environmental services with those who can supply them. Many farmers and ranchers are willing and able to provide environmental services beyond food and fiber, but they need incentives to do so. As Aldo Leopold wrote, "it…goes without saying that economic feasibility limits what can or cannot be done for the land" (Leopold 1949). The advantage of PES programs is that they offer direct payment to farmers and ranchers for providing specified environmental services, which should stimulate innovation and efficiencies in their provision. However, such programs must compete with other programs and mechanisms that fund environmental improvements on agricultural lands, such as existing cost-share programs and conservation easements, which are already oversubscribed (Batie in press). More examples of successful PES programs are needed to determine how they compare with other, complementary approaches in terms of cost efficiency, targeting, and environmental outcomes.

Even with dedicated funding streams, programs such as FRESP require sustained investment of social capital if they are to succeed. There are many moving parts that must operate in unison with multiple stakeholder involvement if such a project is to move from a pilot phase to a full-blown program. Currently, the prospects for continued goodwill among parties to stay engaged in the process, negotiate in good faith, and work through programmatic issues appear promising. Much of this goodwill arises from a shared vision among stakeholders that paying private land owners to provide environmental services makes good sense. There are encouraging signs that such a program, in one form or another, will be among the range of available options for managing complex environmental issues in the northern Everglades.

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