



Survey

A conservation industry for sustaining natural capital and ecosystem services in agricultural landscapes

Wanhong Yang^{a,*}, Brett A. Bryan^b, Darla Hatton MacDonald^b, John R. Ward^b, Geoff Wells^c, Neville D. Crossman^b, Jeffrey D. Connor^b

^a University of Guelph, Guelph, Ontario, Canada N1G 2W1

^b CSIRO Sustainable Ecosystems, PMB 2 Glen Osmond, South Australia 5064, Australia

^c University of South Australia, North Terrace, Adelaide, South Australia, 5000, Australia

ARTICLE INFO

Article history:

Received 1 June 2009

Received in revised form 24 November 2009

Accepted 25 November 2009

Available online 12 January 2010

Keywords:

Agri-environment

Policy

Conservation industry

Market

Institutions

Society

Business

NGO

Government

Investment

ABSTRACT

Conservation investment in agricultural landscapes has evolved to take a more market-based or *business* approach. However, current levels of conservation investment are not likely to mitigate degradation to natural capital and ecosystem services. We propose the further evolution of a conservation industry to generate substantially increased investment in conservation in agricultural landscapes, particularly from the private sector. A mature conservation industry is envisaged as comprising of investors, producers, and service providers who produce conservation products and services, exchanged via market transactions. A number of requirements for a viable and effective conservation industry are identified including institutional infrastructure (conservation market institutions and regulatory systems), information provision (quantifying benefits, business models, and accounting and auditing standards), and facilitation (entrepreneurship incubation and capacity building). A conservation industry requires careful design and planning in order to operate effectively. Whilst it is not without risk, a conservation industry has the potential to increase participation and investment in conservation actions and enhance the sustainability of agricultural landscapes.

© 2009 Elsevier B.V. All rights reserved.

1. Introduction

Ecosystems can be considered as a fund of natural capital stocks generating flows of intermediate and final ecosystem goods and services through time (Millennium Ecosystem Assessment, 2005; Fisher et al., 2008, 2009; Lant et al., 2008). Natural capital stocks include renewable and non-renewable resources such as biotic, geologic, water, atmosphere, and land resources. Flows of ecosystem services are classified as supporting (e.g. nutrient cycling, primary production), regulating (e.g. natural hazard mitigation, water quality), cultural (e.g. spiritual values, recreation), and provisioning (e.g. food, fresh water) services (Millennium Ecosystem Assessment, 2005). Stocks and flows are highly interdependent. Depreciating stocks jeopardizes the future yields of flows, which, if beyond replacement rates, in turn degrade the viability of the natural capital stocks (Lant et al., 2008). In agricultural landscapes, development has generated significant economic and social benefits but these benefits have often come at high costs associated with deterioration of natural capital and ecosystem services through processes such as soil erosion,

reduced quantity and quality of fresh water, salinity, and biodiversity depletion (Tilman, 1999). From one economic perspective, degradation of natural capital and ecosystem services in agricultural landscapes is primarily a result of missing markets (i.e. the presence of externalities). Hanley et al. (1997) and Bromley (1991) argue that missing ecosystem service markets are pervasive due to a lack of fully articulated property rights assigned to common pool resources, and costly or incomplete information.

As a corollary, environmental markets have not evolved to a scale sufficient to achieve levels of natural capital and production of ecosystem services in agricultural landscapes corresponding to prevailing social values (Kroeger and Casey, 2007). Efficient markets require the absence of public goods, low transactions costs relative to benefits, and adherence to the conditions of rationality, price taking, complete information, and a complete set of markets (Ciriacy-Wantrup, 1971; Ciriacy-Wantrup and Bishop, 1975; Common, 1995). Violation of these conditions may occur due to a range of legal, cultural, and institutional factors. Markets for many natural capital and ecosystem services have not fully evolved because they breach a number of the conditions described above.

In agricultural landscapes, many provisioning services are harvested or extracted as discrete goods, meeting the excludability and rival criteria of private goods (e.g. fish, timber, water, food crops). The

* Corresponding author. Department of Geography, University of Guelph, Ontario, Canada N1G 2W1. Tel.: +1 519 824 4120x53090; fax: +1 519 937 2940.

E-mail address: wayang@uoguelph.ca (W. Yang).

values of these *marketed* services are revealed through the process of mercantile exchange and the price signals of market transfer. In contrast, flows of other *non-market* ecosystem services are generally non-excludable (or costly to exclude relative to benefits) and rival in consumption, which are attributes of common pool resources (Fisher et al., 2009). Due to the difficulty in assigning a private right to common pool resources, the price signals of markets do not accurately reveal the value of the management or production of these *non-market* goods and services. Ready access to market exchange results in managers of privately owned natural capital stocks preferentially producing marketed ecosystem services at the expense of non-market services. Over time, this results in the under-supply of the latter and the long term deterioration of the natural capital stocks and ecosystem service flows (Lant et al., 2008).

Widespread conservation measures are required to achieve socially optimal levels of natural capital and ecosystem services and hence, the sustainability of agricultural landscapes. In this study, we define conservation in agricultural landscapes as the stewardship and enhancement of privately owned natural capital stocks through management actions such as land management, weed removal, fire management, erosion control, restoration, and water quality management. Natural capital stocks enhanced through conservation can increase flows of ecosystem services. However, in many agricultural landscapes there has been an under-investment in conservation by owners of private natural capital stocks due to the high cost and loss of long term revenue from foregone extractive and production opportunities (Bryan et al., 2008). The private on-site benefits of conservation are generally regarded as insufficient compensation. The reality has been that, whilst the private owner generally incurs the costs of conservation, many of the benefits are often uncertain, realized over long time periods, and accrue predominately off site to the wider community who do not share the costs.

Measures to correct this imbalance have relied on investment by both government and non-government organizations (NGOs) as a source of compensation for private conservation actions and/or a change to property rights stipulating obligations of duty of care and stewardship. Existing conservation programs in agricultural landscapes remain largely an adjunct component of government, reliant on discriminatory administrative allocation as the dominant mechanism for conservation investment. Governments have established large-scale agricultural stewardship programs to provide financial incentives to farmers for implementing conservation practices (Heimlich and Claassen, 1998; Dobbs and Pretty, 2004; Baylis et al., 2008; Claassen et al., 2008; Hajkowitz, 2009). In parallel, NGOs have made considerable conservation investments in agricultural landscapes (Edwards and Sharp, 1990; Jepson, 2005). Market-based approaches such as auctions, tenders, taxes and subsidies, cap and trading schemes, and industry barrier removal have been increasingly used to enhance the cost-effectiveness of investment in conservation (Di Leva, 2002; Grafton, 2005; Connor et al., 2008). The primary motivation of market-based approaches is to encourage conservation through the price signals of markets rather than through explicit directives associated with regulatory control (Stavins, 2002). In theory, if environmentally appropriate behavior can be made more rewarding to land managers, then land management behavior will better align with more socially desirable alternatives.

In the absence of effective markets, achievement of socially optimal levels of natural capital and ecosystem services would require large investment of scarce public funds which are subject to competing demands. Despite advances in the design and implementation of conservation investment through market-based approaches, the scale and stability of public funding is not likely to be sufficient to achieve sustainability in agricultural landscapes (McNeely and Weatherly, 1996; Ellison and Daily, 2003; Martin, 2007). Hence, new thinking is required on the development of institutions with the potential to substantially increase investment in conservation of

natural capital and ecosystem services in agricultural landscapes (Turner and Daily, 2008; Daily et al., 2009).

In this paper, we suggest an alternative approach to prime and facilitate the further development of markets and complementary institutions towards a *conservation industry*. A conservation industry relies on market institutions to both stimulate substantially increased and persistent conservation in agricultural landscapes and sufficiently compensate the owners of private natural capital (Dietz et al., 2003; Lant et al., 2008). Existing conservation markets are largely *ad hoc*, periodic, and of limited scale and participation. The next crucial step for decision makers in governments is to establish broad-based, ongoing market institutions for the large-scale production and exchange of conservation products for enhancing natural capital and ecosystem services in agricultural landscapes.

We review the evolution of conservation investment in agricultural landscapes and establish the need for an alternative approach. A conceptual framework describing the operational elements of a conservation industry is then developed. We envisage a mature conservation industry comprising many investors, producers, and service providers. These agents exchange conservation products (e.g. hectares of habitat restored, units of water quality improvement) and services (e.g. brokerage, information provision, contractors) produced in response to price signals that conserve the functional integrity of natural capital and the production of ecosystem services. A number of requirements for the evolution of a conservation industry are then outlined. Specifically, there will need to be, institutional infrastructure including market institutions and regulatory systems; information provision including the clear quantification of environmental and social benefits and costs, development of business models, and accounting and auditing standards; and stimuli to promote entrepreneurial incubation. The lack of a naturally evolved market implies that a conservation industry is likely to require careful design and planning in order to operate effectively to minimize perverse outcomes, market distortions and degrees of market failure (Edwards, 1995; Di Leva, 2002; Gatzweiler, 2006). Extending the co-development theories of Rosenstein-Rodan (1943) and Scitovsky (1954) to missing conservation markets provides some insight into the role of governments in developing the rules of exchange, information provision and regulations to foster the development of a conservation industry. Finally, key challenges and cautions associated with a conservation industry are identified and discussed.

2. Evolution of Conservation Investment

2.1. Government Investment

Government programs including agricultural stewardship schemes and payments for ecosystem services aim to motivate conservation actions on private land generating substantial public benefits, often occurring off-farm or downstream. In the United States, government conservation programs such as the Conservation Reserve Program focus on soil conservation, water and air quality improvement, and wildlife habitat management (Claassen et al., 2008). In the European Union, agri-environmental schemes aim to improve the multifunctionality of agricultural landscapes (Dobbs and Pretty, 2004; Baylis et al., 2008). The main objectives of Australian natural resource management programs have been to reduce salinity, improve water quality, and protect biodiversity (Hajkowitz, 2009).

A countervailing view criticizes government for not taking sufficient account of cost-effectiveness in conservation investment (GAO, 2002, 2006; Kirwan et al., 2005; ANAO, 2008; Baylis et al., 2008; Hajkowitz, 2009). Whilst some improvements have been made, several dominant institutional barriers continue to limit the cost-effectiveness of government agricultural conservation programs. First, dual and often conflicting goals of producer support and environmental improvement have been common amongst conservation

programs (Baylis et al., 2008; Claassen et al., 2008). The benefits of agricultural production may trump the environmental benefits of investment when the two goals conflict. Second, limited spatial targeting of government investment in conservation programs has resulted in overpayment in some locations and underpayment in others, relative to the environmental benefits achieved (McCann and Easter, 2000; McCann et al., 2005; Baylis et al., 2008; Claassen et al., 2008). Third, limited monitoring and enforcement has also reduced the effectiveness of conservation programs due to inappropriate land management actions and non-compliance with contractual obligations (Claassen et al., 2008). Fourth, indices of program performance typically include the total number of participants, area covered, or the amount of funding spent (Heimlich and Claassen, 1998) rather than return on investment. In addition, the short term nature of funding cycles has often prioritized the timely acquittal of funds ahead of maximizing environmental benefits.

2.2. Markets for Conservation

The innovative use of market-based approaches to government investment in conservation has made substantial advances towards improved cost-effectiveness (da Motta et al., 1999; Stavins, 2002). The United States Conservation Reserve Program exemplifies an early application of a market-based instrument approach. Within the program, farmers with eligible land voluntarily submit bids for conservation contracts. These bids are screened based on an environmental benefits index (EBI) that is composed of erosion, water quality, air quality, wildlife, cost, and other factors, and contracts with EBI scores above a cutoff level are selected to be enrolled into the program (Claassen et al., 2008). These market-based programs have since expanded into other countries, including Australia (e.g. Stoneham et al., 2003; Windle and Rolfe, 2008). The most comprehensive experimentation was conducted in Australia through the National Market-Based Instruments Pilot Program. Instruments trialed included auctions, cap and trade, offsets, leverage funds, and conservation insurance. Environmental problems addressed include biodiversity conservation, salinity mitigation, wetland rehabilitation, environmental water allocation, and in-stream nutrient reduction. Market-based instruments, particularly through competitive mechanisms and measurement of environmental benefits, have led to some increases in cost-effectiveness of conservation investment despite high transaction costs (Grafton, 2005; Connor et al., 2008; Ward et al., 2008; Windle and Rolfe, 2008).

Independent environmental markets have been established for biodiversity (Stoneham et al., 2003; ten Kate et al., 2004; Carroll et al., 2007), wetlands (Robertson, 2004; Ruhl and Gregg, 2001), point and non-point source pollution (Martin, 2007), water (Bjornlund, 2003), carbon (Wara, 2007), and ecosystem services (Tallis et al., 2009). A promising opportunity for expanding and integrating these markets has emerged in compliance markets under the Kyoto protocol. Certified projects in developing countries are being established under the Clean Development Mechanism or CDM (Kirby, 2008). The primary objective of the CDM is to reduce greenhouse gas emissions with flow-on benefits to developing countries in terms of technology transfer and local economic development. In some cases, some CDM projects that include land management and reforestation efforts will produce attendant biodiversity benefits. However, the strict requirements and high transaction and compliance costs have limited the number of CDM projects (Kirby, 2008). In parallel, there has been rapid evolution of voluntary carbon markets and various carbon verification and accreditation systems, such as the Voluntary Carbon Standard that uses some CDM methodologies in its accreditation protocols. The Gold Standard, another voluntary carbon system, has an independent verification, registry and tracking of emission reductions. There is potential for the development of biodiversity accreditation systems. The Community, Conservation

and Biodiversity Alliance provides add-on accreditation to Voluntary Carbon System projects with social and environmental benefits. There is room in the carbon market for rigorous accreditation systems for complementary biodiversity and conservation efforts. Accreditation will not fully address under-investment due to the public good nature of the actions but will define a credible product for the market segments that exist. Incentives or regulation (underpinning cap and trade) will be required to achieve optimal investment from the perspective of society.

2.3. Non-Government Organizations

Non-government organizations have also made significant conservation investments in agricultural landscapes, particularly in land preservation. The Nature Conservancy, Sierra Club, and World Wildlife Fund have international reach and have developed extensive land reserves (Edwards, 1995; Jepson, 2005). These NGOs receive funding from individuals, corporations, governments, and other sources. NGOs have typically developed their own conservation investment niche that reflects the interests of donors, including special interest groups. For example, Ducks Unlimited specializes in protecting wetland habitat for waterfowl and natural values (Gabor et al., 2004). These organizations have applied business strategies and models to conservation investment such as raising funds, identifying spatial priorities for conservation investments, working with private land managers on program implementation, and monitoring and evaluating outcomes (Edwards, 1995). Conservation investment by NGOs supplements government programs and is playing an increasingly important role in the conservation of agricultural landscapes (Jepson, 2005).

2.4. Private Investment

Various forms of private investment have already contributed to conservation in agricultural landscapes. Landholders, acting either individually or in cooperatives, have invested in agricultural conservation. There has also been an increased focus on green investment by financial institutions motivated by corporate social responsibility, public image, and/or regulatory requirements (Reinhardt et al., 2008). In recent years, private enterprises have emerged with the dual aims of turning a profit and producing conservation benefits (Bishop et al., 2008). For example, the Conservation Fund in the United States provides loans specifically for conservation projects (Salafsky et al., 2002). In Hawaii, a timber extraction business was developed to profit from a portion of Koa forest with income used to protect a larger area of forest for biodiversity (Goldstein et al., 2006). These developments represent a new direction in conservation investment.

2.5. Business Approaches to Conservation

Above we describe the evolution of a business approach to conservation that places cost-effectiveness at the center of investment planning – but where to from here for conservation in agricultural landscapes? It is likely that governments will continue to be the primary investor in conservation, complemented by NGO and private investment, unless there are significant changes to national regulatory frameworks with respect to requirements for private investment. Some potential exists for the further development and application of market-based instruments and removal of institutional barriers to achieve greater environmental benefits from government conservation investments (Mulder and Coppolillo, 2005). However, it is unlikely that government investment will be able to meet the increasing societal demands for conservation (Martin, 2007) to halt the degradation of natural capital and ecosystem services in a timely manner.

An alternative approach is to refocus government conservation investment towards market evolution and the establishment of a fully-fledged conservation industry. In the long term, development of a conservation industry with the capacity to attract large-scale investment from non-governmental sources is required to ultimately secure the natural capital and ecosystem services, enhance the sustainability of agricultural landscapes, and support productivity and stability of the broader economy. Below we describe the key elements necessary for establishing a viable and effective conservation industry that increases and sustains large-scale investment in conservation.

3. Elements of a Conservation Industry

A conservation industry (outside box in Fig. 1) would include corporate enterprises, private landholders, NGOs, government, and the general public. As shown in Fig. 1, these agents can take on different roles including investors, producers, and service providers (internal boxes in Fig. 1). Agents are connected through markets where exchanges of conservation products and services, information, and money occur (arrows in Fig. 1).

3.1. Conservation Investors

Conservation investors, including governments, NGOs, and private investors provide funds to other agents for producing conservation products. Traditional conservation programs have invested directly in on-ground works that enhance natural capital and ecosystem services without defining tradable conservation products. It is likely that governments will continue to be a significant investor in conservation

as a substantial proportion of benefits derived from the conservation of natural resources accrues to the general public. However, it is not necessary that governments fund all conservation measures (Edwards, 1995). There needs to be a substantially increased role for private investment in order to address the large-scale degradation of natural capital and ecosystem services in agricultural landscapes.

Private conservation investments can be motivated by a range of factors including social responsibility, reputation, risk management, public image, and regulatory requirements. In particular, regulation is a key mechanism for transforming public conservation goods into private goods for which a market could form. On one hand, regulation generates demand, and therefore value, for conservation products and induces private investment in conservation. On the other hand, regulation also facilitates the development of trading rules for market transactions. Internationally, the Kyoto protocol and caps on emissions have fostered the definition of carbon credits as conservation products and related carbon trading in order to meet regulatory requirements with cost savings (Wara, 2007; Kirby, 2008). In the U.S., wetland mitigation banking as a business opportunity is possible only because of wetland mitigation requirements under the Clean Water Act (Ruhl and Gregg, 2001). Likewise, water quality trading typically involves point sources, which are regulated with respect to discharge. In a limited number of cases point sources have been allowed to meet water quality requirements through purchase of credits from diffuse sources such as farmers in the same watershed. Changes in land management are effectively translated into a water quality protection product (Ribaud et al., 2008).

Indeed, conservation investment may generate significant economic returns in addition to meeting regulatory requirements. For example, New York City's investment in upstream watersheds

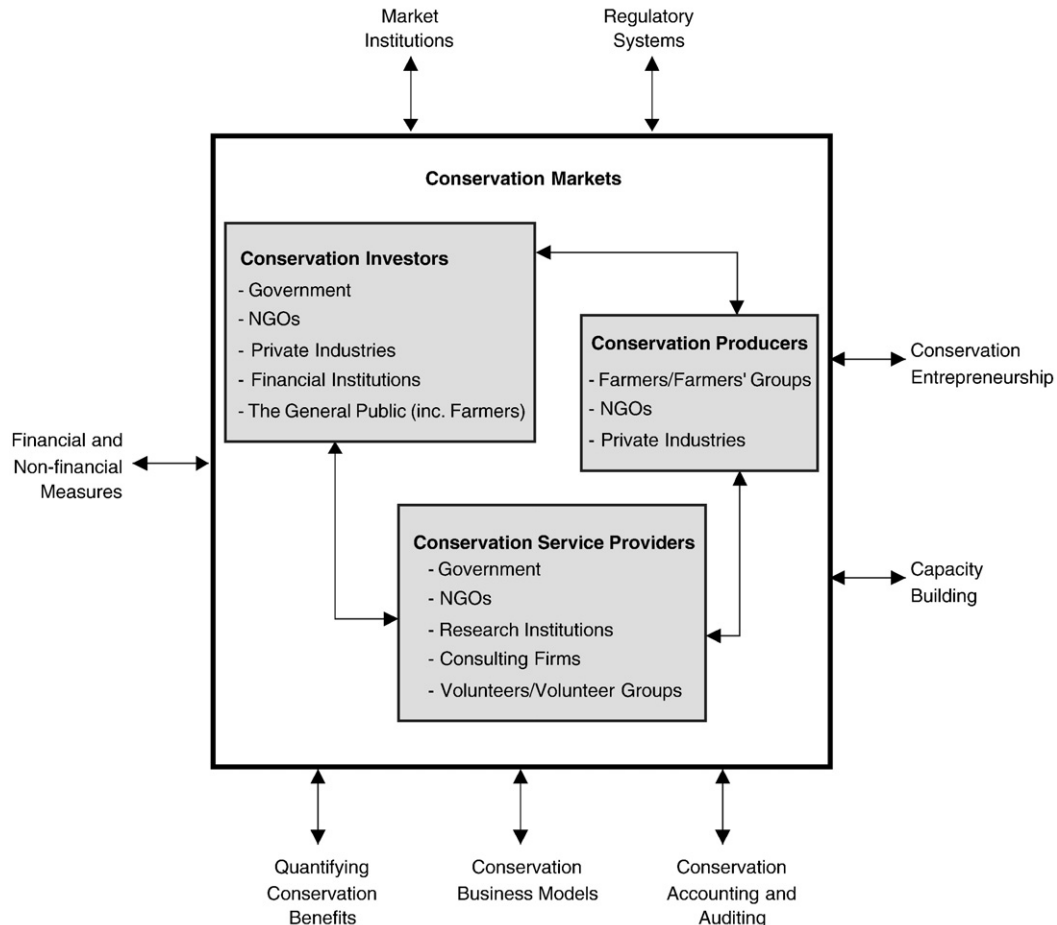


Fig. 1. A conceptual framework of a conservation industry.

exemplified the significant cost savings compared with the avoided cost of new water treatment plants (Chichilnisky and Heal, 1998). Whilst private businesses cannot fully capture the value of ecological goods and services due to their public nature, partial realization of these values through conservation markets could provide measurable incentives for private investors. In particular, regulations and institutional arrangements which allow investors to capture potential savings or capitalize on the heterogeneity of cost savings across landscapes through trade are crucial. Private conservation investment not only provides supplementary funds to costly ecosystem conservation and restoration but also helps internalize the negative externalities of production.

With further development, investment institutions, including fund managers and corporate enterprises, may increasingly conduct specialized conservation investment in agricultural landscapes with business operations similar to that of other investment enterprises. Ownership equities on conservation investments can be calculated because conservation products tradable in markets have monetary values that can enter into business balance sheets as assets and liabilities. In parallel, financial performance indicators such as return on investment and cost to benefit ratios of conservation investment can be evaluated.

Market-based conservation investments may also change the role of NGOs and governments. Traditionally conservation NGOs provide a channel for investment to meet societal demands for conservation. A conservation industry could aim to widen these investment channels to include a larger number of private agents (McQueen and McMahon, 2003; Martin, 2007). Furthermore, government funds can be used strategically to support and leverage conservation investments from private sources (Murtough et al., 2002).

3.2. Conservation Producers

Producers in a conservation industry centered on agricultural landscapes will primarily be private landholders but may include conservation enterprises and NGOs. Conservation products may be only one of multiple outputs of their business operations (Bryan et al., 2008). For example, consider a cereal crop farmer who adopted conservation tillage practices on sloping land to enhance the soil capital stock. The farmer will continue to produce agricultural products (i.e. grain – a marketed ecosystem service) but will also produce other non-market ecosystem services such as soil erosion mitigation, carbon retention, and water quality improvement as conservation products (Yang et al., 2005a). The profits of conservation producers would be defined by the margin between the revenues and production costs associated with both traditional agricultural and conservation products. With proper institutional arrangements, conservation demand for conservation products such as carbon and/or biodiversity credits can be generated. Then producers would be motivated to conduct business operations for achieving cost-effective conservation actions through minimizing production costs and maximizing revenue from enhanced ecosystem services. The profit generation mechanism created through a conservation industry is a shift from previous subsidy type of programs such as the US Conservation Reserve Program because of the financial flows generated from increased demand for conservation products. Additionally, entrepreneurial enterprises could be developed that specialize in production of conservation goods. These enterprises would develop business operations similar to other industries because they trade conservation products of value. An example is the trading of biodiversity and carbon credits generated by the ecological restoration of degraded agricultural land either purchased or leased by the entrepreneurial enterprise.

Conservation products may be considered as enhancements to natural capital which generate a suite of primarily non-marketed ecosystem services. A key challenge that producers face is to develop

innovative conservation products that are tradable in a market. Existing conservation products meet specific demand in conservation markets, including measured reductions in pollutant concentrations, carbon credits, biodiversity credits, recreational and amenity opportunities (Grafton, 2005). However, a wider set of conservation products that includes non-marketed ecosystem services with both use and non-use values are currently difficult to capture as tradable products and exchange between regions and biomes. Much work will be required to clearly define the property rights associated with the wider array of conservation products (Edwards, 1995; Murtough et al., 2002). Creative development of conservation products may induce further societal demand and attract further investment. For example, eco-labelling targets a particular market segment that is willing to pay a premium for energy efficiency or environmentally sensitive production processes (Diamantis, 1998; Bjørner et al., 2004; Sammer and Wüstenhagen, 2006).

3.3. Conservation Service Providers

Conservation service providers include governments, NGOs, research institutions, and consulting firms. Conservation service providers would specialize in roles that facilitate the exchange of conservation products. Voluntary carbon markets have demonstrated that a variety of standards can be developed by NGOs, consulting firms and others to address the problems of product verification, auditing, monitoring and accreditation. In this context, the market has identified the need for environmental products that can be clearly understood by all participants in mercantile exchange, including producers, purchasers and regulatory (or sanctioning) agencies. As an example of a conservation service provider, the Chicago Climate Exchange Inc. was established as a private carbon market clearance business to facilitate market transactions for carbon producers and investors in the voluntary carbon market (Young, 2003).

As a conservation industry evolves, service providers are likely to display an increasing number of specialized skills to support conservation producers and investors. Governments and research institutions will continue to play an important role in providing public good research such as developing more sophisticated quantitative measures of environmental benefits and value of conservation products. Increased demand for conservation products would provide many opportunities for the growth of conservation service providers. Growth may be evident in public institutions, private enterprise, and mixed public–private partnerships. For example, we may see the emergence of private enterprises that specialize in brokering and packaging conservation products for investors. Economies of scale could be gained from coordinating the actions of smaller individual producers into larger, more targeted and strategic action that achieves landscape-scale change in specific regions. As a conservation industry develops, conservation service provision may come increasingly from the private sector with a market-oriented focus in seeking business partnerships and commercial arrangements.

3.4. Conservation Markets

A well developed and functioning market is central to a viable and effective conservation industry. A conservation market provides the opportunity for producers, investors and service providers to exchange conservation products in response to information revealed as price signals. Efficient conservation markets coordinate individual actions into collective outcomes that correspond with social values. Initially, market transactions are likely to be limited to a few natural capital and ecosystem service values. New business opportunities that cover a broader range of conservation values of producers and service providers could be realized providing that there are advances in regulatory design and innovation in the development of conservation markets. A closer approximation of the economic value and a more

complete ensemble of ecosystem services may be gradually revealed and exploited through markets.

Conservation markets may develop and evolve at various spatial scales due to heterogeneities in agricultural landscapes and environmental and ecological problems. Markets may initially develop at local scales and then extend to or connect with regional, national, and international markets. In addition, single product (e.g. carbon) and multi-product (e.g. carbon, biodiversity, and water quality) markets may also develop due to the interdependencies of natural capital stocks and the flow of ecosystem services. Ultimately, conservation for enhancing natural capital stocks and the flow of ecosystem services in agricultural landscapes may contribute to several overlapping objectives at multiple scales. For example, the restoration of native habitat on a portion of farmland may be traded in local soil erosion and biodiversity markets, basin-wide river salinity, and global carbon markets.

Conservation markets should provide a competitive environment for improving cost-effectiveness of a conservation industry. With numerous conservation producers, competition will motivate investors to direct funds to projects and areas that maximize conservation benefits and hence, financial returns, within a finite budget. Competition will also motivate conservation producers to minimize costs in benefit provision in order to achieve higher net returns. As in other business sectors, a conservation industry also provides an institution for developing entrepreneurship with which innovative approaches are developed for improving cost-effectiveness of conservation investments, production, service provision, and market transactions (Schaper, 2002).

The development of a conservation industry offers opportunities for market information development. Conservation agents need to examine and learn about the price, costs and benefits of conservation products in order to make market transactions (Edwards, 1995). The price signals of conservation assets or products may be gradually established. Price signals may capture heterogeneities of conservation costs and benefits across projects, sectors, and locations and direct cost-effective conservation investments.

4. Requirements of a Conservation Industry

4.1. Institutional and Regulatory Systems

4.1.1. Market Institutions

Institutional rules need to be defined for conservation markets to operate effectively. This includes establishing trading rules, a regime of clearly defined property rights specific to natural capital and ecosystem services, and mechanisms to enforce contracts and settle ownership disputes (Di Leva, 2002; Jenkins et al., 2004). Institutional rules also determine the transaction costs of conservation (Boyd and Simpson, 1999). Past government conservation programs have been characterized by high (or informally quantified) transaction costs of participation relative to benefits (McCann and Easter, 2000). In past programs, transaction costs have been incurred in the gathering of information prior to market transaction, in the process of exchange, and in the costs of monitoring and enforcement (Connor et al., 2008). Design principles that minimize the transaction costs of participation present an opportunity for conservation service providers to develop new services and approaches (Brown and Mitchell, 2000). In traditional conservation programs, transaction costs are static which are part of the conservation investments without financial returns. Therefore those transaction costs become sunk costs associated with conservation investments. However, in a conservation industry, transaction costs become part of conservation services and become dynamic costs for generating financial benefits from conservation investments.

Complementing market development, modifications to taxation systems may be required to govern different conservation agents and

products in different market development stages (e.g. research and development) to enhance investment in conservation. In addition, legal frameworks governing the operation of conservation agents need to be modified. According to business law, a firm has no legal basis to sacrifice profits for social interests such as environmental or conservation investments without shareholder knowledge and approval (Reinhardt et al., 2008). In recent years, environmental investments of firms were justified as costs associated with promoting public image or complying with social obligations. Furthermore, there are no specified rules for conservation products such as pollution control or biodiversity credits to enter into the asset balance tables of corporations (Aretino et al., 2001). As a conservation industry develops, business law needs to evolve to formalize conservation-based decisions as part of regular business activity and establish corresponding conservation accounting standards.

4.1.2. Regulatory Systems

Governance and regulatory rules need to be defined to facilitate the development of private enterprises or public–private partnership, to establish a marketplace (virtual or physical), and support product certification, monitoring, and enforcement. Regulation will also need to be in place to prevent perverse outcomes such as the monopolization and continued degradation of natural capital and ecosystem services. Governments will need to have an ongoing watchdog role to ensure market equity in ownership of public goods and prevent land management actions that have unintended deleterious impacts to natural capital and ecosystem services. There are existing regulatory authorities that have a market watchdog role. For example, the Australian Competition and Consumer Commission administers the *Trade Practices Act 1974* that ensures individuals and organizations comply with competition, fair trading and consumer protection laws.

Regulation is essential for creating value by quantifying the scarcity of natural capital and ecosystem services and generating investment in conservation in agricultural landscapes. One regulatory mechanism for informing agents of relative scarcity and value in common pool resources has been the establishment of a cap on resource use. Generally, cap and trade schemes distribute a quantum of resource credits to scheme participants with an obligation to surrender that quantum at the end of a stipulated accounting period. Participants are able to choose to manage so as to produce a surplus, which is available to trade with those that choose to manage so as to be in deficit. Caps on use of natural capital assets and ecosystem services may be established at a range of scales. For example, Ward et al. (2008) established a cap on drainage in a small catchment in southern Australia to mitigate dryland salinity. A cap on diversions has been used to manage water resources and facilitate water trade at a large river basin scale in the Australian Murray Darling Basin (MDBMC, 1996). Trade in carbon emission reductions under the Kyoto protocol is an example of a series of national caps of Annex I countries (Annex II countries have not accepted emission targets). Minimum standards (e.g. critical natural capital, targets, minimum viable areas, etc.) have been widely established to direct conservation and natural resource management as a basis for ensuring the sustainability of agricultural landscapes (MacDonald et al., 1999; Bates, 2001; Bryan and Crossman, 2008). However, these regulatory requirements may be difficult to implement or enforce over large and heterogeneous agricultural landscapes. Minimum standards have an important ongoing role in a conservation industry in providing a basis for regulation. The identification of critical levels of natural capital given the inherent uncertainty can inform the setting of regulatory caps at safe minimum levels. This may both create scarcity and value in conservation of natural capital and non-marketed ecosystem services. Efficient market exchange is left to determine the clearance price. However, a challenge exists in capturing the spatial heterogeneity in the production and value of natural capital and ecosystem services across agricultural landscapes (e.g. Meyer and Mullinax, 1999).

4.2. Information Provision

4.2.1. Quantifying Benefits

Information and uncertainty remain large potential barriers to the successful evolution of environmental markets. Demand for conservation products will be severely diminished if there is uncertainty about the key characteristics of the product, such as the certainty surrounding the environmental outcome. Insufficient information as a cause of market failure may represent fundamental scientific uncertainty, or the limits of individual knowledge in a complex and dynamic world. Rapid and accurate quantification of the benefits of conservation for natural capital and ecosystem services is a fundamental requirement of a viable and effective conservation industry (Carpenter et al., 2009; Daily et al., 2009). This information provides the foundation of a conservation industry supporting market transactions, product definition, cost-effective investment and production decision-making, performance evaluation, and accounting and auditing processes. However, producing robust information of this kind is challenging because of the temporally dynamic, multi-scale and interdependent nature of ecosystem processes (Kroeger and Casey, 2007). Uncertainty and risk associated with conservation information are likely to be persistent. This is common to other markets (e.g. financial markets). It is imperative that this uncertainty does not delay the development of a conservation industry. Rather, uncertainty in conservation information needs to be built into product definition and trading. Tools and strategies from other risky markets (e.g. options, hedging) may also be developed to manage uncertainty in a conservation industry.

Science underpinning the quantification of the benefits of conservation for enhancing natural capital assets and ecosystem services will require further development to support a conservation industry (Carpenter et al., 2009; Daily et al., 2009). Government conservation programs have used simplified and indirect measures to target investment (Hajkowicz et al., 2009). For example, the allocation of funds in European Union agri-environment policy is based on the potential to generate environmental benefits from changes in land management (Baylis et al., 2008). The United States Conservation Reserve Program targets investment using the Environmental Benefits Index. This index employs an array of indicators including wildlife, water quality, erosion, and air quality to directly link land management to the provision of conservation benefits (Claassen et al., 2008). In Australia, the National Market-Based Instruments Pilot Program has developed methodologies and indicators for defining environmental benefits of conservation actions for non-point source pollution, salinity, biodiversity and other objectives (Grafton, 2005). However, access to information on conservation outcomes may become necessary for the development of a conservation industry.

The importance of outcome-based information in agricultural conservation programs has been recognized. The United States Conservation Effects Assessment Program was established in 2004 to examine conservation effects with an extensive network of 48 watersheds. Both monitoring and modeling efforts were conducted to better understand the efficacy of land management actions for conservation. The Canadian Watershed Evaluation of Best Management Practices program was established in 2004 with a network of seven watersheds across the country. The purpose of this program was to set up monitoring stations, implementing best management practices, and evaluating both economic and environmental effects of best management practices (Yang et al., 2007). New modeling techniques have recently been presented which enable increased sophistication in quantifying natural capital and ecosystem service benefits (Crossman and Bryan, 2009; Nelson et al., 2009). However, a major problem with outcome-based assessment that must be managed is that conservation occurs now but outcomes arise well into the future.

A key issue that will need to be addressed is who provides this information. In environmental markets characterized by dynamic and complex processes, government provision and dissemination of information at economies of scale may be the least cost solution (Perman et al., 2003). That is, without government underwriting, the cost to individuals of obtaining accurate information to complete market transactions may be prohibitive. The incentives for unregulated markets to provide sufficient information may be too weak or diffuse, introducing the opportunity for governments to catalyze natural resource markets in a co-development role as proposed by Scitovsky (1954).

4.2.2. Conservation Business Models

For conservation investors, a typical scenario may be to direct investments to projects that maximize the value of conservation products or financial returns. An investment decision model similar to that of non-conservation businesses may be followed. The basic steps include specifying investment objectives and constraints, listing possible options, evaluating and prioritizing options, identifying the optimal portfolio of investment options, and evaluating investment outcomes (Possingham, 2001). Spatial targeting is recognized as a way to improve the cost-effectiveness of conservation investments in agricultural landscapes (Wünscher et al., 2008; Crossman and Bryan, 2009). Spatial targeting based on maximizing benefit to cost ratios have been found to be more cost-effective than both benefit maximization and cost minimization approaches due to heterogeneity of landscape conditions (Babcock et al., 1996; Yang et al., 2005b; Bryan and Crossman, 2008). The prioritization of investment based on high benefit–cost ratios may achieve greater environmental benefits and profits for investors.

For conservation producers, business models need to be developed to guide production processes involving conservation measures, input costs, technology, and outputs in order to maximize net returns from conservation. For example, net returns of switching from cropping to tree planting needs to consider opportunity costs (forgone cropping returns), plantation costs, time period for tree growth, returns from tree cutting, conservation products as measured by water savings, water quality improvement, and carbon credits (Bryan et al., 2008). Also, business models involve developing marketable conservation products for profit making. For example, an ecotourism business can define visiting opportunities as a conservation product to attract customers (Diamantis, 1998).

For conservation service providers, business models need to be developed that define specialization and expertise for serving conservation investors, producers, and markets. For example, services could be developed for data provision, decision support, monitoring, enforcement, certification, market clearance, advertising, and others (Edwards, 1995).

Translation of the principles, structure, and elements of a conservation industry into business practice is likely to generate a diversity of business models which incorporate, to varying degrees, trading in a conservation market. Some business models will be directed to value creation (Martin and Petty, 2000). Firms may purchase conservation products as inputs to the business such as a downstream user of water paying upstream watershed custodians for maintaining water quality. Firms may also develop alliances with conservation providers to protect their resource base, as in seafood manufacturers working with sustainable fisheries. Other business models may be directed to building investment portfolios (Damo-daran, 2006). For example, firms may invest in conservation providers where projected demand and cash flows indicate an undervalued stock. Companies which have secured their resource base through investment and alliances may well attract direct investment because of their reduced risks and costs, and increased opportunities. Where conservation markets are brought into existence by government regulation, similar incentives may apply. For example, firms

generating value through biodiversity credits where scarcity is signaled by government policy, may attract investment if they are seen as undervalued as a well-managed repository of biodiversity credits is likely to increase in value over time. We note that all these models, properly defined, enter business analysis through the normal tools of corporate strategy and finance (Peirson et al., 2006). A full taxonomy and analysis of conservation business models will be a key task of subsequent work, informed by the general principles laid out in this paper.

4.2.3. Conservation Accounting and Auditing

Financial accounting, auditing, and reporting are standard practices for firms (Bottom, 1998). However, accounting and auditing of conservation agents may be challenging due to the difficulties in quantifying conservation products related to natural capital and ecosystem service values (Burritt and Cummings, 2002). As a result, conservation programs have commonly been evaluated by simple measures such as area under conservation, the amount of money invested, or the number of participants (Christensen, 2003; Claassen et al., 2008). In recent years, calls for standard practices for accounting, auditing, and evaluation of conservation of natural capital stock and ecosystem services have been made (Salafsky and Margoluis, 2003; Jepson, 2005; Stem et al., 2005; Boyd and Banzhaf, 2007). The emergence of voluntary environmental reporting in corporate businesses represents a relatively new direction in conservation accounting and auditing. An example is the new initiative to have large corporations report on their perceived corporate risk and exposure to climate change and the carbon economy. Efforts to standardize the auditing, reporting and management options of these risks are central to the aspirations of the Global Reporting Initiative and Carbon Disclosure Project (CDP, 2009) and development of tradable environmental goods.

Low cost, robust, and compulsory accounting and auditing systems will need to be developed for measuring and reporting the performance of conservation investors, producers, and service providers. The values of conservation products can be assessed and entered into asset balance tables of conservation enterprises. Financial reports or investment reports may be developed to document the processes of conservation investment, production or service provision such as input and output relationships and intermediate steps. An adaptive process to gradually refine accounting and auditing processes may be needed to overcome early difficulties in book-keeping (Speckbacher, 2003).

4.3. Facilitation

4.3.1. Incubation of Conservation Entrepreneurship

Entrepreneurship is a concept associated with profit making, early adoption, and risk taking in business development. Recently, the concept has been extended to characterize those endeavors that maximize the social benefits from limited resources as social entrepreneurship (Schaper, 2002) and ecopreneurship in the context of green businesses (Isaak, 2002). Innovative business approaches to conservation in agricultural landscapes have also been characterized as conservation entrepreneurship (Rinehart and Pompe, 1997). In a conservation industry, entrepreneurs and entrepreneurial enterprises seek new business opportunities, assemble resources, conduct conservation investments, production or service provision, and achieve both financial and public benefit goals.

Governments have a role in supporting the development of conservation entrepreneurs, entrepreneurial enterprises, and entrepreneurship (Seidl et al., 2003). Public resources may be used to develop incubators that foster innovation in conservation business enterprises (Friedman, 2000). Government investment may also be redirected to develop entrepreneurial conservation enterprises through start-up grants, leverage and venture funds. The conservation

entrepreneurs may be evaluated on their projected financial performance and the conservation of natural capital and ecosystem services.

4.3.2. Capacity Building

Capacity building is important for facilitating a viable and effective conservation industry. It involves equipping investors, producers, and service providers with the necessary skills for conducting transactions in a conservation market. Governments have had a long history in investing in capacity building. Mechanisms such as information centers and extension networks provide information and other services to improve private landowners' skills in implementing conservation practices (Jänicke and Weidner, 1997). NGOs have also undertaken capacity building activities to help partners implement conservation projects (Edwards, 1995; Corso et al., 2004). A strong capacity building program should underpin all aspects of a conservation industry including securing funds, developing business models, investment decision support, communication, monitoring, accounting and auditing. Capacity building mechanisms such as extension, training, support networks, and knowledge brokering need to be established on national, regional and local levels (Salafsky et al., 2002). Capacity building may become part of a business sector of conservation service provision with the maturing of a conservation industry.

5. Cautionary Notes

Much existing conservation is voluntary and undertaken irrespective of economic incentives. Typically labor is the major volunteering contribution, compared to other potential inputs such as materials and equipment. Caution is required to ensure a conservation industry does not crowd out, discourage or jeopardize the voluntary conservation efforts of many private landholders in agricultural landscapes (Reeson and Tisdell, 2008). For example, over 4,000 community groups involving over 120,000 farmers and other community members, participated in the Australian Landcare Program for sustaining farmland and biodiversity (Curtis and Van Nouhuys, 1999). Experiences in Australia's Landcare programs have shown that inadequate resourcing of information, support and materials can also significantly discourage conservation volunteering and eventually cause failure in volunteer contribution (Byron et al., 2001; Byron and Curtis, 2002). A conservation industry has the potential to provide non-governmental financing of the infrastructure of voluntary conservation without crowding out labor contributions. The wider volunteer sector is also a large and important contributor to conservation programs (Latteier, 2001; Pattengill-Semmens and Semmens, 2003).

Certification and training is one complementary approach to encourage involvement of volunteers in data collection, water sampling, and monitoring of landscape changes. The sequencing of both financial and non-financial incentives (e.g. through group payments, social recognition in the community) will need to be encouraged to maintain existing social cohesion in communities and prevent crowding out (Ward et al., 2008; Reeson and Tisdell, 2008). These innovative incentive combinations introduce both pecuniary and non-pecuniary rewards to private landholders who undertake substantially more conservation than is required or stipulated as contractual obligations.

6. Conclusion

Government investment in conservation in agricultural landscapes has evolved to incorporate market-based approaches that when well designed and implemented, have the potential to increase scheme cost-effectiveness. The air of confrontation and conflict that characterized previous attitudes of environmental and non-government groups towards markets has begun to recede. In parallel with private

enterprises, many involved in environmental activities have come to realize that markets can be harnessed and channeled towards the achievement of environmental goals. The noted change in attitude culminated in widespread recognition that carefully designed markets can be turned into a powerful ally and paradoxically correct past market failures. Subject to controversy and debate a decade ago (Keohane et al., 1998), markets for conservation have evolved to the point of becoming received wisdom in many environmental policy circles (Stavins, 2003). As a result, leading environmental groups and regulators have more widely endorsed and implemented business approaches to increase investment in conservation. Whilst these developments have demonstrated the potential of markets and business approaches, they have not resulted in conservation investment on the scale required to mitigate the degradation of natural capital stocks and flows of ecosystem services, and achieve sustainability in agricultural landscapes.

A conservation industry provides an alternative for increasing and sustaining investments in agricultural landscapes to meet societal demand for conservation. A conservation industry has the potential to engage governments, firms, and the general public to materialize conservation demand into investment that enhances natural capital assets and improves the provision of ecosystem services. A conservation industry consisting of investors, producers, and service providers needs to be supported by institutional and regulatory systems, information provision, entrepreneurship, business models, accounting and auditing standards, and facilitation. The novelty of the proposed conservation industry is to develop a market institution for conservation investment. Traditional conservation investment from government and/or NGOs generates public benefits but these benefits have limited monetary values because property rights are not defined. Previous and existing market-based approaches have explored ways to define conservation products, trading rules, regulatory support, and others. However, these experiments are limited in scale and time. Extending from these developments, the proposed conservation industry is an established and evolving market institution for exchanging conservation products and services. The increased generation of conservation products not only fulfils regulatory requirements for conserving natural capital stocks and flows of ecosystem services, but also generating financial returns for continuing investment in conservation.

Whilst the conservation industry is business oriented, we do not suggest that this is a free market institution due to the uniqueness of conservation goods and the complexity of landscape processes. Rather, a conservation industry will need to be tightly regulated and planned with governments acting as investors, facilitators and regulators with rights of enforcement and escalating coercion. This needs to be paired with significant advances in the science and technology supporting rapid, inexpensive, and accurate quantification of the benefits of conservation for natural capital and ecosystem services to support trade. A conservation industry has the potential to increase participation and investment in conservation actions and enhance the sustainability of agricultural landscapes but its development could be a risky path. However, this may be a pragmatic approach as the cost of delayed response by waiting for better alternatives could be even higher.

References

- ANAO, 2008. Regional Delivery Model for the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality. Audit Report No. 21 2007–08. The Australian National Audit Office, Canberra.
- Aretino, B., Holland, P., Matysek, A., Peterson, D., 2001. Cost sharing for biodiversity conservation: a conceptual framework. Productivity Commission Staff Research Paper. AusInfo, Canberra.
- Babcock, B.A., Lakshminarayan, P.G., Wu, J.J., Zilberman, D., 1996. The economics of a public fund for environmental amenities. *American Journal of Agricultural Economics* 78 (4), 961–971.
- Bates, G., 2001. A duty of care for the protection of biodiversity on land. Consultancy Report, Report to the Productivity Commission. AusInfo, Canberra.
- Baylis, K., Peplow, S., Rausser, G., Simon, L., 2008. Agri-environmental policies in the EU and United States: a comparison. *Ecological Economics* 65, 753–764.
- Bishop, J., Kapila, S., Hicks, F., Mitchell, P., Vorhies, F., 2008. Building Biodiversity Business. Shell International Limited and IUCN, London, UK and Gland, Switzerland.
- Björner, T., Hansen, L., Russell, C., 2004. Environmental labeling and consumer choice – an empirical analysis of the effect of the Nordic Swan. *Journal of Environmental Economics and Management* 47, 411–434.
- Bjornlund, H., 2003. Farmer participation in markets for temporary and permanent water in southeastern Australia. *Agricultural Water Management* 63 (1), 57–76.
- Bottom, E., 1998. Is accounting a value-adding function? Examining financial reporting and auditing with respect to capital markets. *Journal of Accounting Education* 16 (2), 373–380.
- Boyd, J., Simpson, R.D., 1999. Economics and biodiversity conservation options: an argument for continued experimentation and measured expectations. *The Science of the Total Environment* 240, 91–105.
- Boyd, J., Banzhaf, S., 2007. What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics* 63, 616–626.
- Bromley, D., 1991. *Environment and Economy: Property Rights and Public Policy*. Blackwell, MA.
- Brown, J., Mitchell, B., 2000. The conservation approach and its relevance for protected landscapes. *The George Wright Forum* 17 (1), 70–79.
- Bryan, B.A., Crossman, N.D., 2008. Systematic regional planning for multiple objective natural resource management. *Journal of Environmental Management* 88 (4), 1175–1189.
- Bryan, B.A., Ward, J., Hobbs, T., 2008. An assessment of the economic and environmental potential of biomass production in an agricultural region. *Land Use Policy* 25, 533–549.
- Burritt, R.L., Cummings, L.S., 2002. Accounting for biological assets – the experience of an Australian conservation company. *Asian Review of Accounting* 20, 17–42.
- Byron, I., Curtis, A., 2002. Maintaining volunteer commitment to local watershed initiatives. *Environmental Management* 30 (1), 59–67.
- Byron, I., Curtis, A., Lockwood, M., 2001. Exploring burnout in Australia's Landcare program: a case study in the Shepparton Region. *Society and Natural Resources* 14, 901–910.
- Carpenter, S.R., Mooney, H.A., Agard, J., Capistrano, D., DeFries, R.S., Diaz, S., Dietz, T., Duraipappah, A.K., Oteng-Yeboah, A., Pereira, H.M., Perrings, C., Reid, W.V., Sarukhan, J., Scholes, R.J., Whyte, A., 2009. Science for Managing Ecosystem Services, Beyond the Millennium Ecosystem Assessment. *Proceedings of the National Academy of Sciences of the United States of America* 106, 1305–1312.
- Carroll, N., Fox, J., Bayon, R. (Eds.), 2007. *Conservation and Biodiversity Banking: A Guide to Setting Up and Running Biodiversity Credit Trading Systems*. Earthscan.
- CDP 2009. Carbon Disclosure Project website. <http://www.cdproject.net/reports.asp>. Accessed April 2009.
- Chichilinsky, G., Heal, G., 1998. Economic returns from the bio-sphere. *Nature* 391, 629–630.
- Christensen, J., 2003. Auditing conservation in an age of accountability. *Conservation in Practice* 4 (3), 12–19.
- Ciriacy-Wantrup, S., 1971. The economics of environmental policy. *Land Economics* 47, 36–45.
- Ciriacy-Wantrup, S., Bishop, C., 1975. Common property as a concept in natural resources. *Natural Resources Journal* 15, 713–727.
- Claassen, R., Cattaneo, A., Johansson, R., 2008. Cost-effective design of agri-environmental payment programs: U.S. experience in theory and practice. *Ecological Economics* 65, 737–752.
- Common, M., 1995. *Sustainability and Policy: Limits to Economics*. Cambridge University Press, Cambridge.
- Connor, J.D., Ward, J.R., Bryan, B.A., 2008. Exploring the cost effectiveness of land conservation auctions and payment policies. *Australian Journal of Agricultural and Resource Economics* 52 (3), 303–319.
- Corso, A., Holsen, T.J., Pater, J., 2004. Building capacity for watershed stewardship. *Proceedings of the Water Environment Federation*, pp. 1322–1326.
- Crossman, N.D., Bryan, B.A., 2009. Identifying cost-effective hotspots for restoring natural capital and enhancing landscape multi-functionality. *Ecological Economics* 68, 654–668.
- Curtis, A., Van Nouhuys, M., 1999. Landcare participation in Australia: the volunteer perspective. *Sustainable Development* 7 (2), 98–111.
- Da Motta, R.S., Huber, R.M., Ruitenbeek, H.J., 1999. Market based instruments for environmental policymaking in Latin America and the Caribbean: lessons from eleven countries. *Environment and Development Economics* 4, 177–201.
- Daily, G.C., Polasky, P., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., Ricketts, T.H., Salzman, J., Shallenberger, R., 2009. Ecosystem services in decision making: time to deliver. *Frontiers in Ecology and the Environment* 7 (1), 21–28.
- Damodaran, A., 2006. *Damodaran on Valuation: Security Analysis for Investment and Corporate Finance*, 2nd edn. John Wiley & Sons, New Jersey.
- Di Leva, C.E., 2002. The conservation of nature and natural resources through legal and market-based instruments. *Review of European Community and International Environment* 11 (1), 84–95.
- Diamantis, D., 1998. Environmental auditing: a tool in ecotourism development. *Eco-Management and Auditing* 5, 15–21.
- Dietz, T., Ostrom, E., Stern, P.C., 2003. The struggle to govern the commons. *Science* 302, 1907–1912.
- Dobbs, T.L., Pretty, J.N., 2004. Agri-environmental conservation schemes and multi-functionality. *Review of Agricultural Economics* 26 (2), 220–237.
- Edwards, V.M., 1995. *Dealing in Diversity: America's Market for Nature Conservation*. Cambridge University Press.

- Edwards, V.M., Sharp, B.M.H., 1990. Institutional arrangements for conservation on private land in New Zealand. *Journal of Environmental Management* 31, 313–326.
- Ellison, K., Daily, G.C., 2003. Making conservation profitable. *Conservation in Practice* 4 (2), 12–20.
- Fisher, B., Turner, K., Zylstra, M., Brouwer, R., de Groot, R., Farber, S., Ferraro, P., Green, R., Hadley, D., Harlow, J., Jefferiss, P., Kirkby, C., Morling, P., Mowatt, S., Naidoo, R., Paavola, J., Strassburg, B., Yu, D., Balmford, A., 2008. Ecosystem services and economic theory, integration for policy-relevant research. *Ecological Applications* 18, 2050–2067.
- Fisher, B., Turner, R.K., Morling, P., 2009. Defining and classifying ecosystem services for decision making. *Ecological Economics* 68 (3), 643–653.
- Friedman, V.J., 2000. The incubator for social entrepreneurship: creating partnership for second order social change. Paper presented at the Annual Conference of the International Society for Third-Sector Research, Dublin, Ireland.
- Gabor, T.S., North, A.K., Ross, L.C.M., Murkin, H.R., Anderson, J.S., Raven, M., 2004. Natural Values: The Importance of Wetlands and Upland Conservation Practices in Watershed Management. Ducks Unlimited Canada publication. 57 pp.
- GAO, 2002. Agricultural Conservation: State Advisory Committee Views on How USDA Programs Could Better Address Environmental Concerns. United States General Accounting Office, Washington D.C.
- GAO, 2006. USDA Should Improve Its Process for Allocating Funds to States for the Environmental Quality Incentive Program. United States General Accounting Office, Washington DC.
- Gatzweiler, F.W., 2006. Organizing a public ecosystem service economy for sustaining biodiversity. *Ecological Economics* 59 (3), 296–304.
- Goldstein, J.H., Daily, G.C., Friday, J.B., Matson, P.A., Naylor, R.L., Vitousek, P., 2006. Business strategies for conservation on private lands: Koa forestry as a case study. Proceedings of the National Academy of Sciences of the United States of America 103 (26), 10140–10145.
- Grafton, 2005. Evaluation of Round One of Market Based Instrument Pilot Program. The Australian National University, Asian Pacific School of Economics and Government.
- Hajkowicz, S., 2009. The evolution of Australia's natural resource management programs, towards improved targeting and evaluation of investments. *Land Use Policy* 26 (2), 471–478.
- Hajkowicz, S., Collins, K., Cattaneo, A., 2009. Review of agri-environment indexes and conservation payments. *Environmental Management* 43 (2), 221–236.
- Hanley, N., Shogren, J.F., White, B., 1997. *Environmental Economics: In Theory and Practice*. Macmillan Press, London.
- Heimlich, R.E., Claassen, R., 1998. Agricultural conservation policy at a crossroads. *Agricultural and Resource Economics Review* 27, 95–107 April.
- Isaak, R., 2002. The making of ecopreneur. *Green Management International* 38, 81–91.
- Jänicke, M., Weidner, H., 1997. *National Environmental Policies: A Comparative Study of Capacity-Building*. Springer-Verlag Publisher.
- Jenkins, M., Scherr, S.J., Inbar, M., 2004. Markets for biodiversity services: potential roles and challenges. *Environment* 46, 33–42.
- Jepson, P., 2005. Governance and accountability of environmental NGOs. *Environmental Science & Policy* 8 (5), 515–524.
- Keohane, N., Revesz, R., Stavins, R., 1998. The choice of regulatory instruments in environmental policy. *Harvard Environmental Law Review* 22 (2), 313–367.
- Kirby, A., 2008. CCC Kick the Habit: UN Guide to Carbon neutrality. Progress Press Malta, UNEP.
- Kirwan, B., Lubowski, R.N., Roberts, M.J., 2005. How cost-effective are land retirement auctions? Estimating the difference between payments and willingness to accept in the Conservation Reserve Program. *American Journal of Agricultural Economics* 87 (50), 1239–1247.
- Kroeger, T., Casey, F., 2007. An assessment of market-based approaches to providing ecosystem services on agricultural lands. *Ecological Economics* 64 (2), 321–332.
- Lant, C.L., Ruhl, J.B., Kraft, S.E., 2008. The tragedy of ecosystem services. *BioScience* 58 (10), 969–974.
- Latteier, C., 2001. Linking citizens with scientists: how Illinois EcoWatch uses volunteers to collect ecological data. *Conservation in Practice* 2 (2), 31–36.
- Martin, P., 2007. Concepts for private sector funded conservation using tax-effective instruments. Land and water Australia project report UNE57.
- Martin, J., Petty, J., 2000. *Value Based Management*. Harvard Business School Press, Boston, MA.
- MacDonald, D.V., Hanley, N., Moffat, N., 1999. Applying the concept of natural capital criticality to regional resource management. *Ecological Economics* 29, 73–87.
- McCann, L., Easter, K.W., 2000. Estimates of public sector transaction costs in NRCS programs. *Journal of Agricultural and Applied Economics* 32 (3), 555–563.
- McCann, L., Colby, B., Easter, K.W., Kasterine, A., Kuperan, K.V., 2005. Transaction cost measurement related to environmental and natural resource policies. *Ecological Economics* 52, 527–542.
- McNeely, J.A., Weatherly, W.P., 1996. Innovative funding to support biodiversity conservation. *International Journal of Social Economics* 23 (4/5/6), 98–124.
- McQueen, M., McMahon, E., 2003. *Land Conservation Financing*. Island Press.
- MDBMC, 1996. *Setting the Cap: Report of the Independent Audit Group*. Murray-Darling Basin Ministerial Council, Canberra.
- Meyer, D., Mullinax, D.D., 1999. Livestock nutrient management concerns: regulatory and legislative overview. *Journal of Animal Science* 77, 51–62.
- Millennium Ecosystem Assessment, 2005. *Ecosystems and human well-being: synthesis*. Millennium Ecosystem Assessment. Island Press, Washington DC.
- Mulder, M.B., Coppolillo, P., 2005. *Conservation: Linking Ecology, Economics, and Culture*. Princeton University Press.
- Murtough, G., Aretino, B., Matysek, A., 2002. Creating markets for ecosystem services. Productivity Commission Staff Research Paper. AusInfo, Canberra.
- Nelson, E., Mendoza, G., Regetz, J., Polasky, S., Tallis, H., Cameron, D.R., Chan, K.M., Daily, G.C., Goldstein, J., Kareiva, P.M., Lonsdorf, E., Naidoo, R., Ricketts, T.H., Shaw, M.R., 2009. Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales. *Frontiers in Ecology and the Environment* 7 (1), 4–11.
- Pattengill-Semmens, C.V., Semmens, B.X., 2003. Conservation and management applications of the reef volunteer fish monitoring program. *Environmental Monitoring and Assessment* 81 (1–3), 43–50.
- Peirson, G., Brown, R., Easton, S., Howard, P., 2006. *Business Finance*, 9th edn. McGraw-Hill, North Ryde, NSW.
- Perman, R., Ma, Y., McGilvray, J., Common, M., 2003. *Natural Resource and Environmental Economics*. Longman, UK.
- Possingham, H.P., 2001. The business of biodiversity: applying decision theory principles to natural conservation. *TELA: Environment, Economy and Society Issue* 9.
- Reeson, A.F., Tisdell, J.G., 2008. Institutions, motivations and public goods: an experimental test of motivational crowding. *Journal of Economic Behavior & Organization* 68 (1), 273–281.
- Reinhardt, F.L., Stavins, R.N., Vietor, R.H.K., 2008. Corporate social responsibility through an economic lens. *Review of Environmental Economics and Policy* 2 (2), 219–239.
- Ribaudo, M., Hansen, L., Hellerstein, D., Greene, C., 2008. The Use of Private Markets to Increase Private Investment in Environmental Stewardship. *Agricultural Economic Report Number 64*, U.S. Dept. Agr. Econ. Res. Serv.
- Rinehart, J.R., Pompe, J.J., 1997. *Entrepreneurship and coastal resource management*. The Independent Review 1 (4), 543–559.
- Robertson, M.M., 2004. The neoliberalization of ecosystem services: wetland mitigation banking and problems in environmental governance. *Geoforum* 35 (30), 361–373.
- Rosenstein-Rodan, P.N., 1943. Problems of industrialization of eastern and south-eastern Europe. *Economic Journal* 53 (210/211), 202–211.
- Ruhl, J.B., Gregg, R.J., 2001. Integrating ecosystem services into environmental law: a case study of Wetlands mitigation banking. *Stanford Environmental Law Journal* 20, 365–392.
- Salafsky, N., Margoluis, R., 2003. What conservation can learn from other fields about monitoring and evaluation. *BioScience* 53 (2), 120–122.
- Salafsky, N., Margoluis, R., Redford, K.H., Robinson, K.H., 2002. Improving the practice of conservation: a conceptual framework and research agenda for conservation science. *Conservation Biology* 16 (6), 1469–1479.
- Sammer, K., Wüstenhagen, R., 2006. The influence of eco-labelling on consumer behaviour – results of a discrete choice analysis for washing machines. *Business Strategy and the Environment* 15, 185–199.
- Schaper, M., 2002. The essence of ecopreneurship. *Green Management International* 38, 26–30.
- Scitovsky, T., 1954. Two concepts of external economies. *Journal of Political Economy* 67 (2), 143–151.
- Seidl, I., Schelske, O., Joshi, J., Jenny, M., 2003. Entrepreneurship in biodiversity conservation and regional development. *Entrepreneurship & Regional Development* 15 (4), 333–350.
- Speckbacher, G., 2003. The economics of performance management in nonprofit organizations. *Nonprofit Management & Leadership* 13(9), 267–281.
- Stavins, R., 2002. Lessons from the American experiments with market-based instruments. Faculty Research Working Papers Series RWP01-032, John F. Kennedy School of Government, Harvard University.
- Stavins, R., 2003. Market based instrument policies: what can we learn from U.S. experience (and related research). Presented at “Twenty years of Market based instruments for environmental protection: has the promise been realised”: Donald Bren School of Environmental Science and Management, University of California, Santa Barbara. August 23–24, 2003.
- Stem, C., Margoluis, R., Salafsky, N., Brown, M., 2005. Monitoring and evaluation in conservation: a review of trends and approaches. *Conservation Biology* 19 (2), 295–309.
- Stoneham, G., Chaudhri, V., Ha, A., Strappazzon, L., 2003. Auctions for conservation contracts: an empirical examination of Victoria's BushTender trial. *Australian Journal of Agricultural and Resource Economics* 47 (4), 477–500.
- Tallis, H., Goldman, R., Uhl, M., Brosi, B., 2009. Integrating conservation and development in the field: implementing ecosystem service projects. *Frontiers in Ecology and the Environment* 7 (1), 12–20.
- ten Kate, K., Bishop, J., Bayon, R., 2004. *Biodiversity Offsets: Views, Experience and the Business Case*. IUCN, Gland, Switzerland and Cambridge, UK and Insight Investment, London, UK.
- Tilman, D., 1999. Global environmental impacts of agricultural expansion: the need for sustainable and efficient practices. Proceedings of the National Academy of Sciences of the United States of America 96, 5995–6000.
- Turner, R.K., Daily, G.C., 2008. The ecosystem services framework and natural capital conservation. *Environmental and Resource Economics* 39, 25–35.
- Wara, M., 2007. Is the global carbon market working? *Nature* 445, 595–596.
- Ward, J., Connor, J.D., Hatton MacDonald, D., 2008. Designing tradable credit policy for diffuse source salinity *ex ante*. *Society and Natural Resources* 21 (10), 930–943.
- Windle, J., Rolfe, J., 2008. Exploring the efficiencies of using competitive tenders over fixed price grants to protect biodiversity in Australian rangelands. *Land Use Policy* 25 (3), 388–398.
- Wünscher, T., Engel, S., Wunder, S., 2008. Spatial targeting of payments for environmental services: a tool for boosting conservation benefits. *Ecological Economics* 65, 822–833.
- Yang, W., Sheng, C., Voroney, P., 2005a. Spatial targeting of conservation tillage to improve water quality and carbon retention benefits. *Canadian Journal of Agricultural Economics* 53, 477–500.
- Yang, W., Khanna, M., Farnsworth, R., Onal, H., 2005b. Is geographical targeting cost-effective? The case of the Conservation Reserve Enhancement Program. *Review of Agricultural Economics* 27 (1), 70–88.
- Yang, W., Rousseau, A.N., Boxall, P., 2007. An integrated economic–hydrologic modeling framework for the watershed evaluation of beneficial management practices. *Journal of Soil and Water Conservation* 62 (6), 423–432.
- Young, L., 2003. Carbon sequestration in agriculture: the U.S. policy context. *American Journal of Agricultural Economics* 85 (5), 1164–1170.