REVIEW OF POLICY INSTRUMENTS FOR ECOSYSTEM SERVICES

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EXECUTIVE SUMMARY

Nearly a decade ago, in 2005, the Millennium Ecosystem Assessment (MEA) completed an unprecedented evaluation of earth's ecosystem services and found that most of these – such as water purification and pollination – were in decline, while others – food, fuel, and fibre provision – were increasing. The report highlighted how myopic policies that tend to promote provisioning services were ultimately undermining the ability of the environment to provide other services necessary for human well-being. Since the release of the MEA report, 'ecosystem services' has become a buzz phrase among policymakers, and has been seen as a way to frame policy decisions that highlight the impacts of decisions on multiple services. However, to date there has been very little thought as to how policies might be better crafted to address multiple ecosystem services and minimize some of the trade-offs that are inherent in these decisions.

This document examines the types of policy instruments that decision-makers can utilise when considering options and approaches to enhance, protect or maintain the suite of services provided by ecosystems. We use the following categories of policies and these are examined in more detail:

- **Outreach and education**—including public awareness, access to information, and environmental education.
- **Regulatory approaches**—including bans and restrictions, permits, environmental standards, and environmental limits and caps.
- **Economic instruments**—including price-based instruments like taxes, fees and levies, subsidies, tax credits, and low-interest loans, and market-based instruments such as eco-labelling, environmental markets, and auctions and tenders.
- **Ecosystem preservation and restoration**—including protected areas, ecosystem restoration, land purchases, covenants and easements, and stewardship agreements.

This document considers examples of where and how these policies have been applied, the strengths and weaknesses of the different policy approaches, and how these policies might be adapted to look more broadly at ecosystem services.

To support policies that are responsive to multiple ecosystem services and designed to minimize trade-offs, decision-makers must reinforce and increase monitoring and modelling efforts. These efforts inform policy and enhance the capacity to explore potential impacts on ecosystems, economies and society, which is necessary for good policy design.

In addition, policies cannot be effective without the appropriate institutions and authorities to implement them. Effective policy can only happen when the institutions that administer them are empowered, transparent, have the right capacity and are adequately funded and staffed.

Finally, this document provides an evaluation of the various policy instruments against ten policy-relevant factors:

- Voluntary vs regulatory
- Suitability for multiple ecosystem services
- Performance vs practice-based
- Induces behaviour change
- Provides flexibility
- Creates certainty around environmental outcomes
- Promotes innovation
- Cost burden
- New institutional capacity or infrastructure
- Enforcement costs

How the various policy instruments compare against these factors, combined with the institutional capacity, legal authorities, and the political economy, will help determine which policy or suite of policies is best suited for a particular context.

1. INTRODUCTION

> ***In the absence of intervening public legislation, we have been handed a clear set of rules from our common law … system of property rights – landowners have almost total discretion over natural capital on land they own, with strong incentives to destroy it, and they have no rights in the continued provision of ecosystem services from land owned by others. Ruhl et al. 2007, p. 109.***

Since the publication of the landmark Millennium Ecosystem Assessment in 2005, the term 'ecosystem services' is becoming a common phrase for politicians and public servants, bloggers, ecologists, and other researchers. Ecosystem services are the benefits people derive from nature, which can be in terms of a good or a service. The Millennium Ecosystem Assessment (MEA) identified and assessed a list of 29 goods and services (MEA 2005; Ranganathan et al. 2008) split across four sub-categories of services (Fig. 1). Provisioning services are the goods or products derived from ecosystems and include food and fibre, biochemicals, and freshwater. Regulating services are the benefits obtained from natural processes occurring within an ecosystem, such as erosion control and pollination. Cultural services are those services from which humans derive non-material benefits, such as recreational pleasure from a national park. Supporting services are those services necessary for the production of all other ecosystem services, such as the cycling of nutrients, formation of soils, provision of habitat, primary production, photosynthesis, and cycling of water. Supporting ecosystem services are also distinguished from the other services by the longer timeframes over which they operate.

Figure 1: **Ecosystem service classification**

PROVISIONING *Products obtained from ecosystems*	**REGULATING** *Benefits from regulation of ecosystem processes*	**CULTURAL** *Non-material benefits obtained from ecosystems*
Food & fibre Freshwater Fuel Genetic resources Ornamental resources Biochemical, natural medicines & pharmaceuticals	Air quality maintenance Biological control Climate regulation Erosion control Human disease regulation Pollination Storm protection Water purification Water regulation	Aesthetic values Cultural heritage values Cultural diversity Educational values Inspiration Knowledge systems Recreation & ecotourism Sense of place Spiritual & religious values Social relations

SUPPORTING *Services necessary for the production of all other ecosystem services*	
Nutrient & water cycling Primary production Production of atmospheric oxygen	Provisioning of habitat Soil formation & retention

Source: MEA (2005)

Our knowledge of ecosystem services is highly variable, depending on the service and location. Most is known about provisioning services as they provide tangible benefits for which a market often exists because such services are an integral part of our economy. Food provisioning services are such an example, but almost all food production relies on other ecosystem services, including regulating services, which are often degraded through the enhancement of provisioning services, and supporting services, without which life itself would not be possible. Recently, focus on regulating services has increased, in part due to the degradation of these services either through their historic neglect or through lack of knowledge of the importance of these services. For instance, the health of hives and the value of substitute pollination services that honeybees provide were highlighted in New Zealand when honeybee hives were colonized by the Varroa mite a decade ago. The introduction of the mite led to the near extinction of all non-managed (i.e. wild) exotic honeybee hives. This example also highlights how an ecosystem service may be overlooked if effective substitutes to that service exist. In this instance, honeybees had provided an effective and more efficient substitute for those services provided by native pollinators, to the point where many agro-ecosystems now rely on exotic pollinators.

Historically, many cultural services have also been overlooked and neglected in decision-making. This is, in part, because these benefits are largely intangible, which makes them difficult to measure, assess, and express; and to some extent the derived benefits are individually held. The importance of some cultural values in New Zealand was vehemently highlighted in 2010 with public backlash to the Government's proposal to mine on protected conservation land. The overwhelming public opinion was against the proposal because mining would erode the (cultural) value of the conservation estate; it is unlikely that the debate would have occurred if a simple existence value were enough to justify the continued protection of the land. New Zealand also has Treaty of Waitangi obligations with its indigenous Māori people about the management of natural resources. This is playing out through Treaty settlement processes that enable Māori access to and co-management of some natural resources (e.g., for the Waikato River).

In the past, the management of ecosystem services has been subsumed and assumed into the management of the environment as a whole, and this has largely been on an ecosystem-service-by-ecosystem-service basis rather than by considering multiple ecosystem services simultaneously. For example, many regional and district plans in New Zealand discuss or include various ecosystem services (water quality, erosion control) without naming them as such. However, there is a potential to create unintended negative impacts when environmental management does not consider simultaneously multiple ecosystem services.

Every action or policy will have a mix of positive and negative impacts on ecosystem services, and every decision will involve a trade-off between ecosystem services. Trade-offs often occur between regulating and provisioning services. For example, erosion-prone gullies are increasingly recognised as a problem and are stabilised using either native or exotic vegetation. Vegetation can regulate erosion, provide important habitat for pollinators and indigenous species, sequester carbon, smooth flood peaks, and, if managed correctly, be a future source of biomass fuel for the landholder. On the other hand, this vegetation may also disrupt water flows and divert water away from a stream. Other trade-offs exist between provisioning services. For example, the eroded or marginal land in our example above is now being used for timber production instead of for the production of food. Similarly, provisioning services can also interact with cultural services. There is an argument, for example, that the presence of irrigation ponds and green irrigated areas in the Waitaki Basin in the South Island of New Zealand could detract from the natural landscape of the area, which is dry and covered in tussock. Alternatively, some argue the presence of farming in other areas can enhance cultural experiences thanks to New Zealand's prominent agricultural image (Macfie 2010; New Zealand Listener 2012).

Policy approaches that explicitly consider impacts on multiple ecosystem services are more likely to be able to identify unintended and undesirable trade-offs. However, developing policies and approaches that adequately take into account the impact on multiple ecosystem services can be difficult and not always possible with all types of policy instruments.

Purpose

The purpose of this document is to provide a discussion centrepiece that explores an array of different policy instruments available for managing ecosystem services, and how and whether these instruments might be implemented to minimize the negative overall impacts and maximize the benefits of trade-offs between multiple ecosystem services. Throughout this document we use the term "policy" to refer to policy, plans, strategies, guidelines or teaching curricula that have been or could be used to maintain or enhance the condition of ecosystem services. "Instruments" refer to the method or mechanism that government or businesses can use to encourage a desired behaviour change, typically through legal or economic means,[1] such as taxes, regulations, and land covenants. Furthermore, the term "individuals" refers to broad categories that include individual homeowners and land owners, while "businesses" generically refers to companies and corporations.

This document is designed to assist decision-makers[2] in identifying the types of policy instruments to consider when evaluating options and approaches to enhance, protect or maintain the suite of ecosystem services provided by ecosystems. It also outlines some of the actions, initiatives, and information that may be needed to support policy for ecosystem services, namely monitoring, research, and evaluation and the institutional and governance structures necessary to implement policies effectively. This document is not meant to be an exhaustive assessment of all potential policy instruments. Rather, it describes a selection of available policy instruments, outlining some of the strengths and weaknesses of each policy, how each instrument could be applied to multiple ecosystem services, and some examples of where these instruments have been applied. Its aim is to provide decision-makers with insights into which approaches will be most appropriate for their own situation. While we have endeavoured to use New Zealand examples to illustrate policies where possible, in some instances we use more appropriate international examples. Similarly, in some instances the example may not relate to ecosystem services or the environment but could be used in that context. While the examples aim to provide some details on how such policies work, variations on existing instrument designs or the development of new instruments that build on the strengths of a number of existing policy instruments will often provide the innovative solutions to degradation of natural resources and loss of ecosystem services.

The document does not cover the methodologies, approaches, models, processes or tools that can be used to identify the trade-offs between ecosystem services.

[1] Adapted from Random House (1997) Webster's Unabridged Dictionary. 2nd edn. Random House, New York.

[2] The term decision-makers is used throughout this document to refer both to those developing policy and to those who do not have a formal policy-making role but make decisions on the effectiveness and efficiency policy from a stakeholder perspective (e.g. industry organisation).

2. POLICY INSTRUMENTS

Policy instruments for improving the quality or reducing the degradation of ecosystem services are varied. The appropriateness of a policy approach depends on a number of issues such as the type of ecosystem service(s) primarily affected by an action, the existing ecosystem conditions and trend in ecosystem services, external drivers influencing decisions(e.g. climate change, peak oil, and population growth), the state of ecosystems, existing institutional and policy arrangements, the policy target (e.g. landowners, businesses), political will, and available management or technology options for improving the ecosystem service(s).

This section describes some policy instruments that could be used to improve the condition of one or more ecosystem services, including outreach and education, regulatory approaches, economic instruments, and ecosystem preservation. It outlines the strengths and weaknesses or limitations of each of the approaches and where they have been most commonly used to date. In most instances, instruments are aimed at a single ecosystem service or a type of resource use that impacts on ecosystem service(s) (e.g. energy generation). This document looks broadly at a variety of policy instruments to ensure we cover the range of instruments that utilise the science underlying an issue and influence human behaviour. In reality, a mix of policy instruments will be used to address any given issue.

2.1 Outreach and Education

The importance and role of many ecosystem services are often not well understood by policy makers, industry, and the general public. For this reason, outreach and education activities are important for highlighting the role of ecosystem services, how actions and decisions affect ecosystem services, and the trade-offs that are made between ecosystem services during decision-making. Ostrom (1999) points out that resource management policy will be most effective when the stakeholders involved in management of that resource "share an image of how the resource system operates and how their actions affect each other and the resource" (p. 281).

Outreach and education policies can take many forms. In this section we describe ways to promote access to and provision of information, establish awareness campaigns, promote or mandate environmental education, and provide technical assistance and extension services to private landowners, businesses, or homeowners.

2.1.1 Access to information

Easy access to up-to-date and credible information on ecosystem services or the data/indicators that underpin ecosystem services both nationally and locally is an important mechanism for raising the profile of ecosystem services and the trends in their condition. This information could be displayed on web portals, maps, interactive tools, or in regularly published documents. State of the Environment Reporting by the Ministry for the Environment and regional councils in New Zealand attempts to do this. However, these publications do not communicate the concept of ecosystem services, they only cover a subset of the more well-known ecosystem services (e.g. nutrient loads that may be a proxy indicator for water purification), and the indicators chosen to portray the condition of the ecosystem services are sometimes inappropriate.

Policy strengths

- Good access to information creates a robust evidence base that may enable better and more effective community participation and engagement – particularly if the information provided defines roles for multiple stakeholders.
- Access to information creates an informed public and stakeholder group. This can lead to better and more informed decisions and policies that are responsive to the needs of the community and the environment.
- Access to information on the trade-offs (if any) relating to a decision creates more robust policy and reduces the probability of unintended and unexpected consequences of policy choices and perverse outcomes.
- Good access to information may increase participation in ecosystem service markets.

Policy weaknesses

- Requires resources and processes to ensure data are updated, published regularly, and adequately maintained.
- Relies on robust research/monitoring/data collection programmes to gather, store, analyse, and report the data, which may or may not exist.
- Could result in "decision paralysis" whereby certain actors use the inherent uncertainty in current information to continually delay action until we have "enough information."

Application to multiple ecosystem services and policy design features

Access to information about multiple ecosystem services is important for making informed policy decisions that account for the potential trade-offs between services. The data and information should be good quality (including spatial and temporal data as well as data/knowledge uncertainty), with appropriate indicators/metrics used to describe the ecosystem services in the context of the decision(s) being made. The information utilised for a policy decision should include data or impacts on the condition and trends in relevant ecosystem services and the expected consequences of different policy formulations and instruments.

Applications

- National Land Resources Centre (New Zealand):[3] The virtual provides a portal to access many datasets relating to land resources collected by a number of organisations in New Zealand. As of 2014, it does not explicitly include data on the condition of ecosystem services.
- Regional Council websites (New Zealand): These are websites that contain links for the public to view regional council environmental monitoring data. For example, Horizons Regional Council conducts regular water quality and water quantity monitoring, the results of which are made available on their website. The council also monitors and reports on safe swim spots. The information experiences a lag between sampling and reporting, but is presented in a traffic light format that is easy to understand. Residents are also able to access this information by calling a local phone number.
- Climate Analysis Indicators Tool (CAIT) (United States):[4] A website that collates sets of comprehensive and comparable greenhouse gas inventories, together with other climate-relevant indicators.
- "Surf Your Watershed" website (United States): US Environmental Protection Agency website that allows users to view environmental information for the watershed in which they live. By selecting their watershed, users can view the list of impaired waters located in their watershed, water use and flow data, water monitoring data, a list of citizen-led watershed groups in the area, and a list of relevant websites.

2.1.2 Awareness campaigns and social marketing

Raising awareness can enhance people's understanding and raise the profile of ecosystem services, change the public perceptions of the importance and roles of ecosystem services, alter behaviour, and pressure governments/industry to take steps to consider more widely the impact of their decisions on ecosystems services. The concept of ecosystem services is a relatively new phenomenon and is consequently not well known or understood. Awareness campaigns and the translation of the ecosystem services concept into common language usage are therefore likely to be important aspects of mainstreaming ecosystem services. Effective campaigns with compelling messages will require robust and reliable information on the condition of ecosystems services, knowledge of how our actions can affect ecosystem services and the ecosystem services on which the action depends, as well as the knowledge of actions that can reduce our impacts and dependencies on ecosystem services. Messages need to be communicated in a way that is easily understood by decision-makers and the public.

In addition to traditional methods of communication, maps, animations, and interactive tools can be effective ways to engage and educate the public on issues, e.g. Carbon Footprint Calculators[5] can educate and raise awareness about how individual actions impact our climate; and websites like Naturewatch,[6] allow individuals to record their sightings of native species.

Policy strengths

- Targeted campaigns can engage local residents who then take ownership of issues in their area.
- Awareness campaigns often have high levels of political support because they are non-prescriptive and do not require coercive force (Kemkes et al. 2010).
- Social media is becoming a cost-effective and powerful tool for engaging with large numbers of people on issues, particularly with youth and young professionals.

Policy weaknesses

- Public campaigns run the risk of involving only those participants who are already motivated to improve the condition of ecosystem services. For example, a call for volunteers is more likely to be answered by someone who is already aware of the issues.
- There is no certainty the awareness campaign will have the desired impact on behaviour.
- Awareness campaigns have generally been most effective where they target specific behaviour that also had links to human health or safety (e.g., do not start forest fires, wear seat belts, and use designated drivers campaigns).

Application to multiple ecosystem services and policy design features

To support a multiple ecosystem services approach, awareness campaigns could be used to introduce the public and stakeholders to the concept of ecosystem services either directly or indirectly. Many recent awareness campaigns make the link between ecosystems and the services they provide. For instance, the US Forest Service's "Forests to Faucet" campaign highlights the importance of forests in maintaining the quality and quantity of freshwater. The challenge with awareness campaigns is the balance between maintaining simplicity with messaging while conveying complex issues involving multiple ecosystem services. In some instances, identifying and focusing on the 'hot' issues for stakeholders or the public will be successful, provided the underpinning assessment of the impacts and dependencies on all relevant ecosystem services has been carried out and any trade-offs between services are transparent.

[3] www.nlrc.org.nz

[4] www.cait.wri.org

[5] Kids carbon calculator www.cooltheworld.com/kidscarboncalculator.php; link to a series of calculators for different users www.carbonzero.co.nz/calculators/

[6] Naturewatch.co.nz

Applications

- The Drains to Harbour programme (Whangarei, New Zealand):[7] This program involves a classroom introduction to stormwater pollution sources, field trips to assess stream water quality, visits to wastewater treatment plants, and the marking of drains in their local communities to raise awareness of where the drains flow. This also acts as a means of educating the public on these issues.
- Recycling symbol (global): The recycling symbol is placed on containers to indicate that they are recyclable, and is also used to indicate products made from recycled materials. This universal symbol for recycling was designed in the 1960s by Gary Anderson and was the winner of a contest sponsored by a Chicago-based recycled paperboard company. The purpose of the contest was to raise environmental awareness among high schools and colleges/universities across the US. Since then, the symbol has been linked with the "reduce, reuse, recycle" waste hierarchy and features on recycling bins and products worldwide. The symbol has become important as a way to raise awareness and inform the public about recycling.
- Carbon Footprint calculators (many regions): These calculators help users estimate their individual carbon footprint based on energy use, car use, air travel, public transportation, and eating and spending habits. Such tools help raise awareness of how individual behaviour and activities have the potential to impact on greenhouse gas emissions. In addition, users can compare themselves with others and see how changing their behaviours and activities might lead to a lower carbon footprint.
- Storm drain labelling (Chesapeake Bay, United States): The label, which is placed on each storm drain, indicates "No Dumping" and also identifies the water body to which the water (and pollutants) drains (e.g., Potomac River). It has been used by many districts in the Chesapeake Bay region (US) as a cheap and effective method of educating citizens about water quality problems in streams, lakes, rivers, and the Bay. In this manner, citizens are made more aware of the impact of their actions on local water quality.

Figure 2: The Drains to Harbour programme symbol on roadways, Whangarei, New Zealand

2.1.3 Environmental education

Environmental education helps shape values and raises awareness of the role of ecosystem services from an early age into adulthood. It focuses on teaching the inherent value of the ecosystems, ecosystem services, and the environment; the relationship between human well-being, ecosystems, and the services they provide; and how human actions affect ecosystem services. Environmental education may be the most important avenue for addressing many indirect drivers of the degradation of ecosystem services. It informs people about how the choices they make ultimately impact services provided by ecosystems and how they depend on ecosystem services for their well-being, and may influence individuals to change behaviour and lifestyles to reduce their impact on ecosystem services (Selman & Greenhalgh 2009).

Although education opportunities exist for all age groups, the predominant form of education on ecosystem services in New Zealand is through the school system. Although rarely taught as a unified concept, individual ecosystem services are discussed, and their importance emphasised. Adult environmental education can be part of general awareness campaigns (above), a distinct and discrete learning event, or learned through the use of tools and specialist software.

Policy strengths

- Environmental education is non-prescriptive, yet promotes understanding and awareness, allowing individuals to make informed choices.
- Environmental education, particularly at a school level or for young leaders, is an excellent conduit for exposing the younger generation to environmental issues and building understanding of the importance of ecosystem services as well as enhancing leadership and cooperative working skills, and entrepreneurship.
- Environmental education in schools provides valuable interactions between schools and local communities, to the benefit of both.
- Readily available internet resources enable landholders and interested citizens to learn about and engage with the concept of ecosystem services without specialist or expensive training.

Policy weaknesses

- Environmental education is not explicitly included in the school curriculum and not always financially supported.
- There is no comprehensive and holistic teaching resource available on ecosystem services concepts. As a result ecosystem services are generally discussed in isolation of other types of natural resource policy issues.
- There is no certainty that an environmental education programme or initiative will have the desired impact on behaviour.

[7] www.emr.org.nz/information.php?info_id=30

Application to multiple ecosystem services and policy design features

Environmental education is an important component of broadening the knowledge, acceptance, and use of the ecosystem services concept – especially to embed holistic environmental decision-making in the next generation of policymakers, landowners, and businesses. Without a thorough understanding of our impacts and dependence on ecosystems and the trade-offs between them, it will be difficult to build and sustain policies that consider multiple ecosystem services.

Applications

- Enviroschools programme (New Zealand): A programme where schools are actively able to teach environmental education. It is run by the Enviroschools Foundation and has flourished despite a lack of policy or research and development by the government. Activities undertaken during the programme are not prescribed and therefore are subject to wide variation. For example, schools can explore any aspect of "water" they chose such as one school in Northland conducted water quality monitoring tests in a local stream.[8]
- Sustainable Business Council's Future Leaders Programme (New Zealand): In 2012, the focus of this programme was ecosystem services, and was aimed at informing and training the next generation of business leaders about the importance of ecosystem services and how to incorporate them into business thinking. The World Business Council for Sustainable Development runs similar programmes.[9]
- New Zealand Association for Environmental Education (NZAEE) (New Zealand): A national, non-profit organisation that promotes and supports lifelong learning and encourages behaviour that leads to sustainability for New Zealand/Aotearoa. NZAEE is an independent voice for environmental education, empowering people to respect and nurture the environment, recognising its link with the social, cultural, and economic aspects of sustainability. Seaweek 2012,[10] hosted by the NZAEE, focused on learning from the sea and comprised a wide range of events, activities, opportunities, competitions, and calls to action.
- Starker Family lecture series (United States): An adult education event hosted by Oregon State University, Corvallis. It comprises four, free lectures and a weekday fieldtrip, funded by a prominent Oregon forester family, as an educational bequest. The lecture series is forestry themed and runs every year. In 2010, the theme was ecosystem services from forests. The educational component covered definitions of an ecosystem service, how rehabilitation projects in forests have improved the provision of these services, and the mechanics and realities of a market for these services (R. Admiral, Oregon State University, pers. comm., 7 July 2010).

2.1.4 Technical assistance

Technical assistance can promote the adoption of technologies or practices that reduce or help avoid the degradation or improve the quality of ecosystem services. Individuals and landowners may not be aware of the negative impacts of their actions on the broader array of ecosystem services and even less aware of the technologies or practices they could apply to reduce their impact. Similarly, they may not be aware of the ecosystem services on which their actions or decisions depend. Technical assistance can play an important role in the success or adoption of policies or strategies to improve ecosystem services. The success of outreach and technical assistance will vary depending on the effectiveness of the outreach strategy, the suitability of the technology or practice being promoted to address community or business needs, the ease of adoption, and a willingness to change on the part of the targeted community (Selman & Greenhalgh 2009).

Technical assistance is often provided to key land managers by their industry representatives, either informally or formally such as levies (e.g., Sustainable Winegrowing, DairyNZ or Horticulture NZ); by local, state or central government bodies or universities through outreach and extension. It is most successful for small, inexpensive changes in practices that also increase profitability (Feather & Cooper 1995).

Policy strengths

- Some solutions that are management- rather than technology-based can be relatively low cost and have low resistance to change, meaning that uptake can be rapid and widespread.
- Technical assistance can be an effective supplementary instrument to assist communication, adopt lasting behavioural changes, and ease the burden or impact of the main policy instrument being used to address a problem.

Policy weaknesses

- Adoption of new technologies/practices can be limited in cases where technologies/practices are relatively expensive to implement, and therefore should be combined with other policies instruments, e.g. subsidies, tax credits, loans.
- People are often resistant to changing the way they operate their business or how they do things. Therefore, innovative approaches to technical assistance are often needed to achieve widespread changes, such as influencing social networks and public debates.
- Dedicated funding is needed to pay technical assistance providers. A lack of funding may limit the effectiveness of technical assistance programmes if there is insufficient staff to provide outreach to the targeted communities.

[8] www.horahora.school.nz/documents/MicrosoftWord-T1-Week05.pdf
[9] www.wbcsd.org/work-program/ecosystems.aspx
[10] www.seaweek.org.nz

Application to multiple ecosystem services and policy design features

Technical assistance programmes can be powerful vehicles for increasing understanding and demonstrating how decisions and actions can affect multiple ecosystem services. Such programmes can be used to provide the information that allows communities, businesses, and individuals to compare actions and approaches that limit their negative impacts on ecosystem services and to make informed decisions on any trade-offs associated with their decisions and actions. Again, most of the examples below tend to focus on single ecosystem services or a small suite of services rather than looking comprehensively across ecosystem services. However, programmes can be designed to be more comprehensive.

Applications

- Horizon Regional Council's Sustainable Land Use Initiative (SLUI): The initiative provides whole-farm management plans and suggestions for improvement through best practice management for landholders on highly erodible lands (Horizons Regional Council 2013).
- Cooperative Extension Services (United States): A network operated by the US Department of Agriculture that provides "useful, practical, and research-based information to agricultural producers, small business owners, youth, consumers, and others in rural areas and communities of all sizes."[11]
- Dairy Extension Center (Australia): A virtual forum for discussion and dissemination of ideas as well as a vehicle through which to administer technical assistance. An example of the types of technical assistance is the "Feeding Pastures for Profit" workshop series and field days where experts assist registered dairy farmers to manage their herd towards the goal of "profitable feeding" (i.e. good rotation and appropriate supplements). It was established and is co-managed by an industry-funded body, Dairy Australia, and the Victorian government (Dairy Extension Centre, no date).
- Private Forests Tasmania toolbox (Australia): Technical assistance is offered to non-foresters who wish to enhance forestry plantings on their land through a free toolbox. The toolbox contains several easy-to-use computer programs on a single CD that help with the planning and management of trees in an agricultural setting. The toolbox was developed by Private Forests Tasmania with funding provided through a variety of government departments (Joint Venture Agroforestry Program run by the Rural Industries Research and Development Cooperation) and with technical contributions from government and non-government sources (School of Forest and Ecosystem Science at the University of Melbourne, Ensis, Forestry Tasmania, and the Australian Co-operative Research Centre for Forestry).

[11] http://www.csrees.usda.gov/Extension/

2.2 Regulatory Approaches

Regulatory or command-and-control approaches operate on the premise that a penalty will be incurred if a source of ecosystem harm (e.g. factories, farms, other companies, organisations or individuals) fails to comply with prescribed levels of pollution, abatement, or ecosystem quality, or fails to adopt the prescribed means of reducing damage to ecosystem services (Opschoor et al. 1994).

As regulatory approaches mostly impact on or are applied to a single ecosystem service, there may be unintended consequences or trade-offs when a number of regulatory approaches impact on the same ecosystem service, or one regulatory instrument has unintended consequences on other ecosystem services. For example, the installation by a wastewater treatment plant of technology to reduce its nutrient losses (to enhance water purification services) may increase the plant's energy use, which negatively impacts on climate regulating services.

The following sections explore a number of regulatory approaches, including environmental bans and restrictions, environmental standards, and environmental caps. While protected areas could also be considered as a regulatory approach we have chosen to include them in a section that deals with the preservation of ecosystems rather than this section which is more focused on policies to influence actions and the flow of ecosystem services.

2.2.1 Environmental bans and restrictions

Environmental bans and restrictions are policies that prohibit:

- activities[12] (e.g. closed fishing and hunting seasons; bans on harvest of indigenous forest; zoning regulations that restrict uses of land in certain areas such as no industrial facilities in a residential zone).
- products (e.g. polycholorinated biphenyl or PCB was banned because of its accumulation in water and aquatic organisms, which negatively impacted on freshwater and food provisioning services with subsequent health impacts such as cancer in humans and other species).
- technologies (e.g. bottom trawl fishing has been banned in a number of countries or fisheries).

Bans and restrictions are not based on performance or achieving a specific environmental outcome, rather they target specific activities, products or technologies that may have a negative impact on an ecosystem service.

[12] While protected areas could also be considered a subset of environmental bans and restrictions, they have, instead, been considered in the section on ecosystem preservation and restoration.

Policy strengths

- Bans and restrictions are most appropriate to use where activities, products or technologies have negative implications for the wider public, e.g. where they are known to have severe human health or ecosystem impacts.
- Generally provide clarity and are equitable.
- Some bans and restrictions may be easy to monitor, as it is relatively straightforward to determine if an activity is or is not taking place or a product or technology is or is not being used.
- Change in activities (or products) can encourage innovation, e.g. replacing ozone-depleting CFCs by less harmful substances.

Policy weaknesses

- Bans and restrictions are relatively inflexible and inefficient mechanisms to achieve a desired outcome because while they prohibit specific activities, products or technologies, they do not cover all activities, products, and technologies that may have similar adverse impacts.
- Depending on the spatial extent of the ban, there can be leakage of that activity, product or technology to other areas that do not have the same restrictions. Therefore, they may not be sufficiently effective and their use may move to countries or areas where there is less ability to monitor and enforce the use of these activities, products, and technologies.
- Depending on what is being banned, these regulations can be costly to enforce. For example, bans on tropical timber products are challenging because of the difficulty of differentiating between some plantation grown and primary forest timber.
- They may be cost ineffective, as they are based on controlling activities rather than outcomes. Over-regulation may occur.
- As they are mandatory there may be resistance to the implementation of these regulations.
- Bans impose a cost to change activities, products or technology for those affected by the bans and restrictions.
- While unsustainable technologies, activities or products are banned, in themselves they do not promote or provide incentives for the use of other preferred or more sustainable technologies, activities or products.

Application to multiple ecosystem services and policy design features

Bans and restrictions tend to target a single activity, product or technology, which may lead to potentially conflicting impacts on ecosystem services. Some bans or restrictions may target an ecosystem such as primary forest or deep-sea ecosystems and as a consequence protect the suite of ecosystem services that the ecosystem provides. For example, protecting a primary forest will preserve the regulating services such as climate regulation, water purification and water regulation, and any spiritual and aesthetic cultural values that the forest provides.

Given the potentially high level of leakage with some types of bans and restrictions, decision-makers should ensure that the restrictions in one area do not result in those activities, products or technologies moving to another area without equivalent policies that achieve the same outcome as the bans or restriction.

To use bans and restrictions to enhance the protection of ecosystem services, the differing impacts of existing and proposed bans and restrictions on all relevant ecosystem services, the potential for leakage, and, most importantly, what types of alternative activities, products or technologies could emerge and their impact on ecosystem services, need to be assessed.

Applications

- Zoning bans (New Zealand): This is where governments use zoning to restrict where people can build houses. Following the 2011/12 earthquakes in Christchurch the local government used zoning to restrict where people can build new houses or rebuild existing ones.
- Controlled Fishery Licence (New Zealand): New Zealand requires that fishing only occurs in some parts of the country and at certain times. In some instances the public is required to obtain licenses for access and these are also time restricted. For example, a Backcountry Licence as well as a Controlled Fishery Licence is needed to fish on the Upper Greenstone River (and its tributary streams) between 1 February and 31 March. The aim of the restriction is to preserve the quality of angling by limiting angler density.[13]
- The Montreal Protocol on Substances that Deplete the Ozone Layer (global): This is an international treaty designed to protect the ozone layer by phasing out several groups of halogenated hydrocarbons believed to be responsible for ozone depletion. Since the Montreal Protocol came into effect, the atmospheric concentrations of the most important chlorofluorocarbons and related chlorinated hydrocarbons are reported either to have levelled off or decreased.
- Tropical timber bans (many nations): These are restrictions placed on tropical timber product imports or selective restrictions on products that are not sustainably produced. A number of industrial countries have tropical timber bans. In the United Sates, for example, both the States of Arizona and New York prohibit the use of tropical timber in public construction projects (FAO 1994).
- Timber production bans (China): These are timber production bans to slow the destruction of China's forests implemented in 1998. This also meant Chinese industry increased timber imports from other countries in the region. Watchdog groups estimate that much of the demand from China was supplied through illegal logging in nearby countries such as Russia, Indonesia, Myanmar, and Cambodia, where conservation laws and enforcement are weak (Lague 2004).

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[13] http://www.fishandgame.org.nz/

- Drought response plan (Australia): This plan was developed to coordinate water supply and reduce drought impacts implemented in 1997 when Melbourne experienced its longest drought on record. Actions include water restrictions and permanent water-saving rules. For instance, under Stage 1 water restrictions watering systems (manual, automatic, spray, and dripper) can only be used to water gardens and lawns on restricted days and within restricted hours.

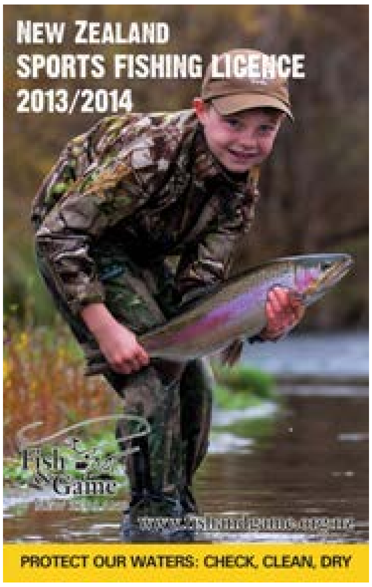

Figure 3: New Zealand's sport fishing licence

2.2.2 Environmental standards

There are many forms and classifications for environmental standards. For this document, we have chosen to classify standards based on the manner in which they specify requirements; either through performance or through design specifications (Box 1 outlines standards based on their purpose). Performance standards specify the level of ecosystem service degradation or the level of performance specified that technologies, products, processes or actions must achieve. For example, US law includes NOx emission standards for vehicles sold in the United States. Vehicles must be designed in such a way that they do not exceed maximum NOx emission thresholds.

On the other hand, design standards are prescriptive, and may specify design requirements, such as materials to be used (e.g. standards that specify the amount of copper in a pipe), how a requirement is to be achieved (e.g. standards that specify type of technology to use or how it is operated), or how an item is to be fabricated, constructed or installed (e.g. building standards).

Box 1: Standards differentiated based on purpose of the standard

While this document describes standards based on the manner in which they are applied, standards may also be categorized according to their purpose. The different 'purpose-based' standards most relevant to ecosystem services include:

- Product standards – standards that establish specifications that must be adhered to in the manufacture or performance of a product or specify the properties or characteristics of product design or ways in which the product is used.
- Process standards – standards that specify requirements that must be met by a process to function effectively, such as an assembly line operation, building construction, and site design. Low impact design (LID) standards are an example of an installation standard meant to mitigate the ecosystem service degradation from urban development or in some cases restore or replicate ecosystem services.
- Technology standards – standards that prescribe the type of technology that must be used or the practices that must be implemented to achieve the desired environmental outcome or level of impact on ecosystem services. For example, in Maryland (US), major wastewater treatment plants are required to install enhanced nutrient removal technology (ENR) to reduce their nitrogen losses to waterways.
- Environmental standards – standards that specify a set of quality conditions that must be achieved to maintain a particular ecosystem function or protect a particular component of an ecosystem. They can specify a desired state (e.g., pH of a lake) or limit the extent of an activity (e.g., harvest no more than a certain percentage of a forest).

Adapted from NIST (standards.gov site); Sands (2003); and other sources

Policy strengths[14]

General

- Standards are a widely understood form of policy.
- While the implementation costs can be high, the political costs of standards are generally lower compared with economic instruments such as taxes and subsidies, as setting standards does not incur direct budgetary implications for the administering agency.

[14] Some of these policy strengths and weakness were adapted from UN ESCAP Virtual Conference 2003.

Design standard

- In general, design standards are easier to monitor and enforce than performance standards as they are based on the use of a certain technology or process. Certification standards often accompany design standards and are used to validate the implementation/application of the design standard.

Performance standard

- Performance standards provide more flexibility in how a standard can be achieved and are therefore likely to be more cost-effective than design standards for those affected by the standard.
- These standards encourage innovation to meet the requirements of the standard.

Policy weaknesses

General

- To set an economically efficient standard, both the demand for environmental improvement as well as the supply of actions to improve the environment must be known. However, these are not directly observable, making it challenging to set the optimum standard.
- Standards provide no incentive to reduce or improve ecosystem services beyond the standard because they tend to discourage the development of technologies that might otherwise result in greater levels of ecosystem service improvement. Instead, they focus on the service affected by the standard.
- In some cases, monitoring, enforcement and penalties for violating standards may be too weak.
- Financial costs may be high for those affected by the standard and for the administrator to implement, monitor, and enforce.
- Standards may be politically unpalatable if they are stringent and businesses are adversely impacted.

Design standard

- Design standards may be considered inflexible and inefficient as they are uniformly applied to all firms and regions and, as a result, do not acknowledge firm variability making them less cost-effective.
- To be effective, design standards need to be revised frequently in response to rapidly changing circumstances. In general, legislation does not keep up with the pace of change.
- Design standards may not promote innovation as they specify the actions, processes, design or technologies that must be used.

Application to multiple ecosystem services and policy design features

As with bans and restrictions, standards tend to target a single activity, product, technology or pollutant. There is potential for various standards to lead to conflicting impacts on ecosystem services. Also similar to bans and restrictions, standards may result in leakage that could shift the undesirable impact or process to another location that is not subject to that standard. Therefore, both the unintended impacts of multiple standards and the leakage potential should be assessed when implementing standards that impact on multiple ecosystem services.

Applications

Performance standards

- National Environmental Standards (NES)[15] (New Zealand): NESs are national standards or regulations that prescribe technical standards, methods or other requirements for environmental matters. NESs not only protects people and the environment, they also secure a consistent approach and decision-making process throughout the whole country. These standards have been used to protect air quality and sources of water intended for human consumption. The NES for sources of human drinking water require regional councils to consider potential impacts of proposed activities on drinking water in their decision-making process. For example, under the standard councils are only allowed to issue water discharge permits for activities that will not violate health quality standards and aesthetic determinants after treatment (Government of New Zealand 2007). NESs can be used where a single issue is present at multiple locations or where issues cross multiple, jurisdictional boundaries. While many of the NESs are performance standards, some are design standards.
- National Environmental Standard on Ecological Flows and Water Levels (New Zealand): The government is developing a proposed NES, defined as "the flows and water levels required in a water body to provide for the ecological function of the flora and fauna present within that water body and its margins". This proposed standard is intended to complement and enhance the existing Resource Management Act 1991 (RMA) process for establishing ecological flows and water levels through regional plans. The proposed standard aims to promote consistency in the way regional councils decide whether the variability and quantity of water flowing in rivers, groundwater systems, lakes, and wetlands is sufficient. The proposed standard would do this by:
    - setting interim limits on the alteration to flows and/or water levels for rivers, wetlands, and groundwater systems that do not have limits imposed through regional plans, and

[15] http://www.mfe.govt.nz/laws/standards/

- o establishing a process for selecting the appropriate technical methods for evaluating ecological flows and water levels in rivers, lakes, wetlands, and groundwater systems.
- Car Emission Standards (New Zealand): This requires that cars entering the country meet approved car emission standards aimed at achieving improvements in air quality by reducing the levels of harmful emissions from motor vehicles. Currently, New Zealand recognises approved emissions standards from Japan, USA, Australia, and Europe. Requirements are different for each vehicle type, i.e. 'new' versus 'used' vehicles.[16]
- Minimum Energy Performance Standards (New Zealand): Part of the role of the Energy Efficiency and Conservation Authority (EECA) is to work with international organisations to set New Zealand energy efficiency standards for product performance and energy use. Many products are covered by the Energy Efficiency (Energy Using Products) Regulations 2002. General requirements are set out, and specific details for each product type – like Minimum Energy Performance Standards (MEPS) levels and/or energy rating labelling details – are described.[17]

Design standards

- Building Rules (South Australia): South Australia is the driest state in the driest continent, and because water is a valuable resource, state building rules require that new dwellings, and some extensions or alterations, have an additional water supply to supplement mains water. The most common way to meet the additional water supply requirement is to install plumbed, minimum-sized rainwater tanks. Other options include a recycled water scheme, or a connection to a community rainwater storage tank.[18]
- Flood and Water Management Act of 2010 (England and Wales): The UK government responded to the 2007 summer floods by passing this Act, which requires new development and redevelopment to have water drainage plans for surface runoff. Subsequent national standards issued in December 2011 established standards for design, maintenance and operation of Sustainable Urban Drainage Systems (SUDS).[19]
- Best Available Technology (Maryland, USA): All major water treatment plants are required to upgrade to enhanced nitrogen removal treatment technologies. Enhanced nutrient removal is the current state-of-the-art technology for nutrient removal in wastewater treatment plants. It is capable of reducing nitrogen concentrations in wastewater discharge to 3mg/l and phosphorous concentrations to 0.3mg/l. In contrast, biological nutrient removal technology can only reduce nitrogen discharges to 8mg/l and phosphorous discharges to 3mg/l (Saffouri 2005).
- Forest Regeneration and Clear-cutting Standards (Maine, USA): This includes forestry practice standards such as requiring separation zones between five acre or larger clear cuts or following regeneration standards, including over-story removal, clear-cut regeneration, and certification of regeneration activities.[20]

2.2.3 Environmental caps and limits

Environmental caps and limits regulate the permitted or allowable level of ecosystem service degradation. The allowable level of degradation or environmental threshold is established based on the point or range of conditions beyond which the ecosystem service benefits derived from an ecosystem are judged unacceptable or insufficient (Haines-Young et al. 2008). The environmental thresholds that underpin a regulatory environmental cap or limit are often defined through a combination of scientific, social, cultural, and political inputs. Environmental caps and limits most commonly involve open-access resources such the amount of pollutant entering a waterway or atmosphere, or water extracted from surface or groundwater.

For clarity, this document uses environmental caps (sometimes referred to as quotas) to refer to limits placed on the absolute level of emissions or discharge that may occur in a defined area (e.g. a cap on the amount of nutrients that can enter a waterbody), the maximum level of ecosystem service degradation that can be caused by a collective activity or industry (e.g. a catch limit for capture fisheries), or the loss of an ecosystem that supports desired ecosystem services (e.g., a cap on the amount of wetland loss). Most environmental caps are then implemented by allocating the cap between all sources contributing to ecosystem degradation. As specific technologies or practices are not prescribed, the regulated sources that fall under the cap generally have flexibility about how this cap is met.

In some instances, environmental limits can be applied to individual sources where there is no overall environmental cap. This document refers to these as individual source limits. Individual source limits are still performance-based in that they specify the level of emissions or discharge from a source, etc. However, as there is no environmental cap in place there is no guarantee that environmental thresholds will not be exceeded.

Policy strengths

General

- Caps and limits are performance-based so provide flexibility in how the cap is achieved, theoretically making it a less costly policy and more attractive to affected parties compared with other regulatory instruments.
- Encourages new 'best practices' and innovation.

[16] www.nzta.govt.nz/resources/rules/vehicle-exhaust-emissions-2007-index.html
[17] www.eeca.govt.nz/landing/standards-and-ratings
[18] www.sa.gov.au/subject/Water%2C+energy+and+environment/Water/Rainwater+tanks/Building+rules+regarding+rainwater+tanks
[19] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82421/suds-consult-annexa-national-standards-111221.pdf
[20] www.maine.gov/doc/mfs/rules_regs/index.htm

Environmental caps

- Environmental caps are one of the most effective ways of placing absolute limits on the level of degradation to ecosystem services that society deems acceptable.

Policy weaknesses

General

- Enforcement of a cap or a limit can be difficult, especially where multiple sources and sectors are involved. One major challenge is placing and enforcing limits on "nonpoint" or diffuse sources of degradation, e.g. sources of land-based pollution.
- Setting the cap or limit at an appropriate level can be difficult from both a scientific and political standpoint. Generally, the level of the cap called for through scientific analysis and the level of cap that is acceptable politically are different. Uncertainty about the actual impact of actions on the ecosystem services may further confound the process of identifying the environmental limit and setting the cap.
- An environmental cap or limit may restrict economic growth (often restricting increases in provisioning services). Coupling a cap with market-based trading or an offset mechanism (see Section 2.3.2) may provide some increase in the same provisioning services but it will still be less than if there was no cap.
- An environmental cap or limit may require new infrastructure and resources to implement and manage the cap successfully.
- Environmental caps or limits may require additional legislation if there are no existing legal means to set an effective cap or limit.

Environmental cap

- Allocating a cap between sources can be difficult and contentious. A cap places restrictions on relevant sources, and all methods to allocate a cap between sources will disadvantage some sources and give advantage to others, making allocation a challenging process.

Individual source limit

- As source limits are not set relative to an environmental cap there is no guarantee that, in aggregate, these individual source limits will ensure the environmental threshold for the resource in question is not exceeded.

Application to multiple ecosystem services and policy design features

Environmental caps are generally placed on a single ecosystem service (e.g. water purification, climate regulation). However, on occasion they have been placed on an entire ecosystem (e.g. no net loss of wetlands). In the latter case, the cap may be better able to maintain or preserve the suite of ecosystem services provided by that ecosystem at acceptable levels. However, the amount and type of services supplied, for example by a wetland, will change as the composition and functionality of those capped ecosystems changes over time, even if the total area remains constant. This could have implications where offsets are being proposed in conjunction with a cap and the metric used for the exchange does not take into account ecosystem changes over time.

Where the cap is imposed on a single ecosystem service, decision-makers should consider the synergies between ecosystem services when establishing the cap. It may be possible to set a limit for one service that has positive impacts on a variety of other ecosystem services. However, negative effects or unintended impacts of a cap or limit on other ecosystem services should also be assessed. For example, a limit on nitrogen loads in water (which relates to water purification services) may have a positive impact on phosphorous loads (regulating service-water purification), reduce GHG emissions (climate regulation) from lower nitrogen-fertiliser use, reduce algal growth (aesthetic values), and improve eco-tourism (cultural services) and wild-food production (provisioning service) from better water quality, but the limit may also reduce food production (provisioning service) due to lower livestock density and lower fertiliser use.

Where a cap or limit creates unintended impacts on other ecosystem services, decision-makers could consider adding a cap or limit on the negatively affected ecosystem service or providing other incentives or actions to mitigate these negative impacts.

Where multiple environmental caps or source limits are imposed, one environmental cap or limit will likely become binding before the others. This means that the cap or limit that is not binding is not exceeded.

In some cases, however, multiple caps or limits may have conflicting goals under certain circumstances. In this instance, these conflicts should be acknowledged and alternative ways to meet all environmental caps and limits provided. Examples for alternatives include:

- allowing regulated sources to meet their compliance obligations through a trading mechanism
- providing exemptions for non-compliance for certain types of practices/technologies that may have negative impacts on some ecosystem services but provide broader benefits, and/or
- developing rules that outline the process by which individual sources explicitly make trade-offs in meeting the different environmental caps or limits.

One challenge to implementing caps and limits effectively in the context of multiple ecosystem services is identifying the impact of these caps and limits on a wider array of ecosystem services. This will likely rely on biophysical and economic modelling and/or monitoring data to help determine the relationship between actions and ecosystem services. Given the current level of environmental, social, cultural, and economic understanding of the impacts of actions on ecosystem services, there are likely to be high levels of uncertainty in these relationships. However, even understanding the directional impacts (e.g. positive, negative, unchanged) on ecosystem services will help avoid creating unintentional policy impacts.

Carefully considering all ecosystem service impacts may also illustrate where the environmental threshold is best established to capitalize on synergistic relationships. It may be that the greatest benefit for multiple ecosystem services is best derived by placing a cap or limit on an ecosystem service that is not the service of immediate interest; for example, improvements in climate regulation services might be better achieved by targeting improvements in regulating services like water purification (which would reduce nitrogen losses).

Applications

- Lake Taupō Catchment Nutrient Cap (Waikato, New Zealand): The Waikato Regional Council has implemented a cap in the Lake Taupō catchment that limits nitrogen discharges to the lake from farmland and urban areas in the catchment. The cap represents a 20% nitrogen reduction goal that is needed to restore lake water quality. A public fund administered by the Lake Taupō Protection trust has been established to help achieve the required reduction in nitrogen. Under the nitrogen cap, all landowners in the catchment must determine whether they comply with the new permitted activity rules in the Waikato Regional Plan, or whether they need to apply for resource consent for their land-use activities. Resource consents place a nitrogen discharge allowance on individual farms. In the Lake Taupō catchment, the cap has been coupled with trading (an economic instrument, see Section 2.3), to reduce the cost to those affected while meeting the new regulatory requirements.
- Marine Quota Management System (QMS)[21] (New Zealand): The system directly controls harvest levels for each species in a nominated geographical area to ensure the sustainable utilisation of fisheries resources. A fish species can consist of numerous geographically isolated and biologically distinct populations. Each fish species in the QMS is subdivided into separate fish stocks defined by Quota Management Areas. The QMS can be adjusted in response to the condition of fish stocks, e.g., stocks in the snapper fishery QMA covering the Hauraki Gulf, East Northland, and Bay of Plenty are only about halfway towards the target level for long-term viability despite 16 years of efforts to rebuild a fishery that was overfished in the pre-quota management era. Further reductions in commercial catch limits were debated in 2013. Recreational catch is being restricted using environmental restrictions through a mix of an individual catch limit and an environmental restriction on minimum size limits for fish caught (Cumming 2013). The quota allocated under the QMS can also be traded.
- No Net Loss of Wetlands (USA): This policy capped wetland acres at 1989 levels. Any wetlands destroyed through development must be replaced through offsite mitigation to maintain the cap.
- Allowable Catch Limits (Australia): The Australian Fisheries Management Authority (AFMA) sets annual allowable catch limits for the southern and eastern scalefish and shark fishery. AFMA and the industry invest heavily in scientific assessments on the health of fish resources and a number of the assessments show that some fish populations can support an increase in allowable catch. As a result, aggregate total allowable catch in the fishery rose 6% in 2013. Catch limit increased for nine key stocks, including Blue Grenadier, which went from 4700 tonnes per year to 5200 tonnes per year because of strong fish stocks. On the other hand, scientific advice also showed that catch limits of some species needed to be reduced to ensure healthy stocks into the future. Catch limits for six species were reduced from the previous year's catch limit, including School Shark, which was reduced to allow these populations to improve.[22]
- Salinity Cap (New South Wales, Australia): This cap was enacted in the Hunter River basin as a response to water quality degradation resulting from mining activities. The cap sets a limit on the amount of total allowable saline discharge into the river at any given time. As a result of the cap, the amount of salinity (measured through electrical conductivity) has decreased overall. Two of the three river sections (middle and low) exceeded their salinity goal only once in 2008, and the upper sector has had 100% compliance with the new salinity goal (New South Wales Department of Environment, Climate Change and Water 2010).

Figure 4: **Hunter River Basin, New South Wales, Australia**

2.3 Economic Instruments

Economic instruments supplement or substitute for stand-alone regulatory approaches, providing entities with incentives (usually financial) to change their behaviour and thereby reduce their impact on the environment. "Economic instruments do not tell polluters what to do; rather, polluters find it expensive to continue in their old ways. Individuals and firms can use their superior knowledge of their own activities to

[21] http://fs.fish.govt.nz/Page.aspx?pk=81

[22] www.thefishsite.com/fishnews/16827/catch-limits-increase-as-stock-data-improves

choose the best way of meeting environmental standards."[23] We outline two categories of economic instruments: price-based and market-based (or rights-based) instruments.[24] While both categories involve changing price, the way price is being influenced is what defines each category. Price-based instruments directly change price, while market-based instruments indirectly influence price through markets.

2.3.1 Price-based instruments

Price-based instruments rely on explicit price signals to motivate changes in behaviour. There are two common types of price-based instruments – taxes that place a penalty on those who degrade ecosystem services and subsidies that provide rewards to reduce negative impacts on ecosystem services (Greenhalgh & Faeth 2001). Some forms of taxes and subsidies are outlined below.

♦ *Taxes, fees and levies*

Many forms of taxation, fees, and levies can be used to mitigate the negative impacts of policies and decisions, and the terminology used to describe these is sometimes used interchangeably. We use "taxes" to describe mandatory financial charges imposed on individuals and businesses by government, "fees" are imposed by governmental or non-governmental bodies and are paid for specific goods or services provided by that body (e.g. entrance to a sanctuary or national park), and "levies" are imposed by non-governmental bodies such as industry bodies for services provided by that body. Some examples of different forms of taxes, fees, and levies include:

- *Polluter pays, externality or Pigovian tax* is a financial penalty placed on activities that create a negative externality or environmental impact. In theory this internalises the externality. Sometimes they may also give a financial reward such as a tax rebate to ecologically sustainable activities. For example, Denmark's wastewater tax on point sources (industry and wastewater treatment plants) imposes a tax on every unit of nitrogen, phosphorous, and biological oxygen demand (BOD) discharged in wastewater (EcoTech 2001).
- *Input taxes* place a tax on those technologies, products or inputs with negative environmental impacts. This creates a price signal aimed to reduce demand for the taxed good. The effectiveness of this kind of tax is dependent on the elasticity of demand and availability of substitutes. For example, Sweden's fertiliser tax is levied on the fertiliser manufacturers or importers. This cost of the tax is then passed onto farmers and foresters through fertiliser prices (it is estimated that the tax comprises approximately 20% of the price of fertiliser), the result being a reduction in their use of fertiliser, thereby reducing their environmental impact (UCD Dublin 2008b).
- *Land-use tax* taxes the intensity of land use rather than the capital value of land. This moves away from taxing people on the value they add to an economy towards taxing them on the value they subtract from it (T. Stephens, formerly NZ Department of Conservation, pers. comm., 2010).
- *Dedicated environmental tax or fee with revenue recycling* are taxes and fees imposed directly on a sector or population where the revenue collected is used to fund activities or technologies that reduce environmental impacts (i.e. recycles the revenue). For example, in Maryland (US) an annual fee commonly called the "flush tax" is levied on every household and business in the state through their water and sewer bill. The revenues from this tax are used to upgrade wastewater treatment plants with nutrient removal technologies and to add nitrogen-removing capability to septic systems.
- *Levies* are commonly used by agricultural industry associations or companies to impose a payment on their producers or members. Usually an industry body identifies the need for a levy or charge to respond to a problem or opportunity requiring collective industry funding. Levies are generally levied on a per unit output basis (e.g., New Zealand Pork has a levy on each slaughtered pig that is used to fund activities of the Association (NZ Pork 2012) and DairyNZ imposes a per kg of milk solids levy which, in turn, funds the industry Association's activities, including environmental outreach and education, and research (DairyNZ 2012)).

Policy strengths

General

- Depending on the method of implementation, taxes can be difficult to evade, as they are mandatory payments. For example, a polluter-pays tax on fuel added at the petrol pump or to vehicle registration cannot be avoided.
- When applied to few sources (e.g. the Swedish fertilizer tax, which is imposed on a limited number of manufacturers and importers), these instruments can be straightforward to administer. Taxes and fees generate revenue for the government or non-government body rather than imposing an additional cost on the administering agency/ies.

Polluter pays, externality or Pigovian taxes

- Encourages the efficient use of resources and/or the use of less polluting technologies through a continuing incentive (Meister 1990).
- Targets the tax more effectively than 'blunter', more widely imposed tax instruments. The polluter-pays tax specifically targets those organisations that create negative environmental impacts.

Land-use tax

- Applies to domestic investments as well as foreign-owned investments that might otherwise be exempt from some taxes, likely generating more revenue for the government.

[23] Bedar (2006 p. 156)

[24] The literature is quite varied in how economic instruments are categorized, with no clear preference or agreed practice for categorization.

- Provides an incentive to shift the emphasis from increasing or intensifying production that may negatively affect ecosystem services, to less intensive production models that are more likely to maintain ecosystem health. The tax rate would need to be higher than the additional profit derived from intensified production (or negative impacts of intensified production).

Environmental tax or fee with revenue cycling

- Reduces the tax burden elsewhere in society, depending on how revenue recycling is implemented.
- Likely meets less public resistance to the imposition of a new tax if the spending goals for the recycled revenue are identified and transparent (Le Grand 2003).

Policy weaknesses

General

- Placing taxes, fees and levies on individuals or individual businesses may decrease pollution or environmental impact at a micro-scale; however, aggregate pollution levels may increase due to new entrants or new individuals creating additional environmental impacts (especially if the externalities far exceed any costs through internalised taxes, fees or levies).
- A tax that is not targeted or structured to encourage the reduction of environmental impacts will have little effect on changing undesirable behaviours.
- It is challenging to identify the appropriate price or tax level to induce behaviour change.
- Taxes that could negatively affect public perception of the initiative can be considered coercive.
- The cost of imposing taxes, fees or levies based on the degradation of an ecosystem service can be higher where it is time consuming and costly to quantify the impacts of actions, and/or to administer the process.

Polluter pays, externality or Pigovian taxes

- The administrative burden of recouping the tax revenue can be challenging as it must be coupled with monitoring or estimating the level of ecosystem service degradation caused by an individual or business. This can be especially challenging where the impacts are diffuse.

Environmental tax or fee with revenue recycling

- It is not always clear what level of tax will generate sufficient revenue to mitigate the negative externality.
- There is a danger that the funds generated by environmental taxes or fees are directed elsewhere rather than to the original purpose of environmental improvements, especially at times of government fiscal stress.

Land-use tax

- A tax on land can discriminate against those who are land rich, but income poor (e.g. retirees who are using land as capital to finance their retirement*).*
- Where land is rented or leased there can be implications for existing long-term contractual agreements should such a tax be implemented, and the tax would need to be levied on those who are making the land-management decisions or allow appropriate signals to be sent to those who manage the land, e.g. leaser could charge lease structure to cover the tax.

Application to multiple ecosystem services and policy design features

Taxes, fees and levies, in theory, can be straightforward to apply to the impacts on individual ecosystem services. Operationally, however, challenges arise. In the case of a polluter-pays tax, where the tax may vary based on level of impact to an ecosystem service, it may be difficult to understand and quantify the relationship between an individual or business action and the corresponding impact on an ecosystem. When taxes, fees, and levies are applied to a multiple ecosystem service context it is even more challenging. In the absence of measurement methodologies that enable the assessment of an action's impact on ecosystem services, administering a variable tax, fee or levy could be expensive, especially where there are many individuals and businesses covered by the tax. One way to lower administrative burdens is to levy flat taxes instead of a variable tax. For instance, because of administrative costs, Newton, Massachusetts (US) decided to levy a flat rate stormwater fee rather than a fee based on lot size (EPA New England 2009a).

To apply taxes, fees and levies to multiple ecosystem services, one could use a 'proxy' for the impact on ecosystem service(s) to impose a payment. This proxy would need to have a demonstrable relationship to a number of ecosystem services. For example, in the case of a land-use tax, land-use intensity could be the proxy when more intensive land uses are considered to have larger negative impacts on a number of ecosystem services. Another example is Sweden's fertiliser tax, which is premised on higher fertiliser use causing greater environmental degradation, and decreased fertiliser use having positive impacts on climate regulation and water regulation services. Some stormwater fee programmes in the United States use 'impervious area' or 'percentage of the lot that is developed' as proxies for the environmental damage caused by stormwater flow (EPA New England 2009a).

Applications

Polluter pays tax

- Waste Tax (New Zealand): This $10/tonne of waste tax has been imposed to shift the cost of waste disposal to a user-pays system under the Waste Minimisation Act 2008 (Ministry for the Environment 2009).

- Carbon Tax (Australia): This required large greenhouse gas emitting companies pay a tax on the amount of greenhouse gas they emit. In 2015, this tax system was expected to change to an emissions trading scheme (Australian Government Department of Climate Change and Energy Efficiency 2012). This tax was repealed from 1 July 2014.[25]

Input tax

- Raw Materials Tax (Denmark): This tax on extracted raw materials (sand, gravel, stones, peat, clay, and limestone) was introduced in 1990 in conjunction with a waste tax, to reduce the use of these natural materials and to promote the use of recycled products, such as construction and demolition waste. The combined aggregate and waste taxes have produced a greater demand for recycled substitutes: in 1985 only 12% of construction and demolition waste was recycled, compared with 94% in 2004 (European Commission DG Environment 2011). This has reduced the amount and rate of habitat destruction in some areas.

Dedicated tax with revenue recycling

- Stormwater Fees (USA): These fees are calculated for each household, generally as part of their water bill. These fees aim to motivate better stormwater management, with the generated revenue used to provide technical assistance, educational programmes, and upgrade storm water infrastructure (US EPA New England 2009).

Industry levies

- Dairy Australia: This levies 2.6655 cents per kilogram of milk fat and 6.4943 cents per kilogram of protein on its producers (DAFF 2012). Revenues generated fund several activities of the industry organization, including projects to improve on-farm nutrient management and water use efficiency (Dairy Australia 2012).

♦ *Subsidies*

Subsidies are payments to individuals or businesses that provide a financial incentive to change behaviour or adopt practices and technologies to reduce environmental impacts. Most often payments come from governments but in some instances these payments may come from private organisations as with Payment for Ecosystem Services programmes. Payments can be made for a change in practice, adoption of technology or improvement in an ecosystem service. Subsidies can provide benefits for multiple ecosystem services with a single payment. For example, in paying agricultural landholders not to clear native forest, several regulating and provisioning services can benefit, and these multiple impacts can be accounted for or incorporated into the size of the subsidy payment.

There are a number of types of subsidies, including:

- *Direct payments or payments for ecosystem services (PES)* are direct, contractual, and conditional payments to individuals or businesses in return for changing practices or technologies that improve the provision of ecosystem services (Wunder 2005; Wertz-Kanounnikoff 2006), see Box 2. For example, the US Conservation Reserve Programme and Wetlands Reserve Programme pay farmers a per hectare rental rate to retire marginal land from active agricultural production or to protect, restore, and enhance wetlands. Direct payments can also relate to maintaining or enhancing food-provisioning services such as those in the Commodity Title of the US Farm Bill.
- *Incentive payments* are direct compensation for additional actions, practices or technologies beyond business as usual to motivate individuals or businesses to achieve improvements in the condition of ecosystem services. For example, the State of Maryland Cover Crop Programme pays farmers a base payment to plant a cover crop to reduce nutrient and soil loss from arable land as well as additional payments to promote the use of specific planting practices to achieve greater environmental gain and to target farms with higher nutrient and sediment losses. The US Conservation Stewardship Payment pays farmers for additional conservation activities and for improving, maintaining, and managing existing conservation activities.
- *Cost-share payments* are a type of subsidy that covers a portion of the start-up and/or installation costs of implementing actions that reduce the degradation or improve the quality of ecosystem services (Greenhalgh 2009). Cost share is often used to encourage individual sources of ecosystem harm to adopt practices requiring initial capital investments (Feather & Cooper 1995). With cost share, the cost of implementing a management practice or technology is shared between the source (e.g. landowner) and another organisation (typically government). For example, the US Environmental Quality Incentives Programme (EQIP) pays farmers a portion of the cost of implementing improved environmental practices or technologies.

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[25] http://www.environment.gov.au/topics/cleaner-environment/clean-air/repealing-carbon-tax

Box 2: Payments for Ecosystem Services

Payments for Ecosystem Services (PES) programmes are often considered to be markets. However, we have classified them as a type of subsidy as they involve a direct payment for the implementation of a practice or technology to protect or enhance an ecosystem service. There is no real exchange of a 'commodity' that represents the ecosystem service(s) between a buyer and seller. Instead, one party who needs or wishes to see an improvement or the maintenance of an ecosystem service or services pays another whose actions can impact on that ecosystem service. For example, a company that bottles drinking water may pay upstream farmers for the practices they implement that reduce nutrient and sediment losses from their farms, thereby improving water quality or water purification services.

Payments for ecosystem services occur in two situations. Either the owner of the ecosystem that supplies the service is paid to enhance the quality or quantity of a service that is degraded by their own activities (i.e. reducing negative externalities), or they are paid for the supply of a service as an offset for activities which are occurring elsewhere (FAO 2007). Payments for ecosystem services are often found in situations where a potential provider of a service is poorer than the buyer (Vatn 2010), e.g. when carbon credits are bought by parties in developed countries from reforestation or revegetation projects in developing countries. However, poverty reduction may not be an explicit goal of a PES programme (Pagiola et al. 2005).

Policy strengths

General

- Voluntary incentives are more palatable with individuals and businesses than non-voluntary options.
- Provides a lower risk cost option for individuals and businesses to install or implement practices or technology that reduce ecosystem degradation or improve the quality of ecosystem services, as it provides for all, or for a portion, of the cost of making that change.
- Provide a contractual agreement for an individual or business to undertake specified actions to improve environmental performance that provide a greater guarantee of the specified action(s) being undertaken.
- Provides external funding for high-cost projects that local government or individuals alone may not be able to fund fully.
- When payments are tied to performance (i.e. actual change in the condition of an ecosystem service) rather than a practice or technology, there are direct incentives to choose practices and technologies that are most suited to the individual or business (i.e. increased flexibility) and maximise improvements in ecosystem services (i.e. increased effectiveness).

Cost-share payments

- Provide incentives for the individual businesses receiving them to actually implement and maintain the practice/technology in question. This is because they pay for a share of the cost of implementing the practice and if they do not implement or maintain the practice correctly it will incur a real future cost.
- May be politically attractive as private funds may be used to complement public funding to achieve greater ecosystem outcomes.

Payments for ecosystem services (PES)

- May be politically attractive as private funds may be used to complement public funding to achieve greater ecosystem outcomes.
- Provide a direct incentive for environmental actions.
- Provide non-environmental benefits in addition to environmental benefits, e.g. they may offer financial security for otherwise impoverished land owners.

Policy weaknesses

General

- May be ineffective in cases where changing practices or technology to improve environmental performance may require more than a financial benefit to induce behaviour changes by individuals or businesses (i.e. social or cultural barriers to change may exist), or a higher payment than that being offered to make the required changes.
- Must be carefully managed to make sure they are not supporting activities that would have occurred in the absence of a subsidy.
- Programme administration can be costly, especially where a programme requires visits by technical staff before funds are awarded. Programme delivery will require sufficient funds and personnel to avoid bottlenecks and ensure the successful delivery of the programme.
- Failure to maximize environmental improvements if the subsidy does not target the implementation or installation of the most cost-effective practices/technologies (Feather & Cooper 1995).
- Requirement for an external source of funds from a government agency or similar organization to make payments.
- Insufficient size of the external source of funds to achieve the desired amount of environmental improvement.
- Depending on how subsidies are implemented there may be insufficient flexibility for the most appropriate practices/technologies to be implemented for a given situation. Consequently, the subsidies may not necessarily target the areas or actions where the greatest improvement in ecosystem services can be achieved for the lowest cost.

- Effectiveness will depend on how many sources participate and for what actions the funding is used. Low adoption may mean that few improvements are achieved.

Cost-share payments

- For high cost-mitigation options, cost-share may not cover a sufficient portion of the cost to make the practice affordable for individuals or businesses to implement/install. For instance, a technology may cost $100,000 to install; even with 50% cost share intended recipients are still expected to spend $50,000 of their own funds, which may not be affordable.
- Practice or technology-based cost-share programmes require constant updating to ensure they remain technologically relevant and appropriately costed.

Payments for ecosystem services (PES)

- The voluntary nature of these programmes may mean there are insufficient incentives to achieve widespread adoption.
- These programmes can be high risk to the private investor where they are relying on the resulting improvement in ecosystem services to reduce their current or future costs of operation (e.g. clean water for drinking water plant). The risk comes from insufficient adoption by relevant individuals or businesses to achieve the needed improvement in ecosystem services.

Application to multiple ecosystem services and policy design features

Subsidies are most commonly used to enhance provisioning and regulating services such as crop production or erosion regulation. Subsidies can account for multiple ecosystem services by creating ranking systems that score the various ecosystem service impacts of an action. Ideally, scores should be aggregated (and where necessary normalised) so that investment options can be compared. The choice of indicators for the scoring should be chosen with care to reflect the aspect of the ecosystem service affected by the decision/policy being made and where possible should be quantitative. The weighting of scores can be used to give more importance to one or more ecosystem service(s) over others if that is appropriate. Preference surveys can be used to elicit information to assist with weighting scores, and rules could be used to ensure important ecosystem services are not negatively affected by an aggregated scoring system.

The challenge with aggregating scores is that it can mask the trade-offs between services. Therefore, documenting the positive and negative impacts on ecosystem services alongside the aggregate score is warranted.

An alternative means of incorporating multiple ecosystem services into payment schemes is to subsidise specific practices or technologies that are known to provide benefits for multiple ecosystem services. For instance, revegetating land can reduce nutrient (water purification) and sediment losses (erosion regulation), and flooding (water and natural hazard regulation); increase carbon sequestration (climate regulation) and habitat (habitat formation); improve pollinator habitat (pollination) and aesthetic values; and restore the mauri of water when close to waterways (spiritual values), etc. However, there may be some downsides to revegetating land that should be accounted for, such as reduction in certain provisioning services like food production and water flow (freshwater provision).

As with other mechanisms, there is a danger of conflicting subsidy goals. For instance, an agricultural production subsidy that promotes more intensive agricultural practices could be at odds with a conservation subsidy aimed at improving regulating services (such as erosion regulation). Decision-makers need to be cognisant of these conflicts and avoid developing conflicting subsidy programmes.

Applications

Direct payments and PES

- Private payments (France): To protect its source waters from nitrate pollution caused by agricultural operations, Vittel mineral waters, a division of Nestlé Waters, paid local farmers to adopt alternative management to reduce their nutrient losses and enhance water purification services. In return for adopting an extensive grazing system and halting the production of maize, farmers received a payment of €150,000 in addition to five years of annual payments of €200 per hectare (Perrot-Maître 2006).
- Non-government organisation payments (Bolivia): Fundación Natura Bolivia piloted a PES scheme in Santa Cruz, Bolivia, to protect water quality in the valley by paying upland land holders to improve land management. Land holders in the programme were given honey bees and hive equipment rather than cash payments in return for halting slash-and-burn agriculture.

Incentive Payments

- Environmental Stewardship Programme (United Kingdom): an agri-environment scheme that provides funding to farmers and other land managers in England to improve resource management on their farms. The Entry Level Stewardship programme awards payments to farmers who meet certain criteria for land management. Under the programme implementation of certain practices translates into points. A farmer who achieves 30 points per hectare qualifies for payments of £30 per hectare in priority areas, or £8 per hectare in non-priority areas. Nearly 40 per cent of England's dairy farms are enrolled in the Entry Level Stewardship programme (Natural England 2012).

Cost-share subsidies

- Water Quality Subsidies (New Zealand): The Lake Taupo Protection Fund and central government funds for capital projects to improve water quality in the Rotorua lakes are essentially cost-share programmes between central government and local authorities. The central government has provided funding for actions to reduce nutrient losses in these catchments as long as the funds are matched by the respective regional and district councils. These funds are targeted at permanent reductions in nutrient levels for Lake Taupo (and to date this has precluded the funds being used for on-farm changes in management practices) or structural projects to reduce in-lake nutrients for Rotorua.

- Energywise Insulation Subsidy (New Zealand): In this programme, a homeowner (including landlords) receives up to $1,300 (or 33%) towards the cost of ceiling and underfloor insulation if their house was built before the year 2000.[26] The remainder can be paid off over time (see low-interest loan section).
- Environmental Quality Incentives Programme (EQIP) (USA): A US Department of Agriculture's (USDA) cost-share conservation programme in which the state or catchment identifies resource priorities (e.g., water quality, soil loss, habitat loss, etc.) and the corresponding agricultural management practices that can mitigate those resource concerns. The USDA maintains a cost-share schedule where each approved practice is given a percentage of the project cost or a standard cost-share rate. For example, infrastructure projects such as a feedpad may receive a 50% cost-share based on a contractor quote for construction. With a cover crop (where vegetative cover is grown on previously fallowed cropping land), the USDA is more likely to stipulate a given amount per acre of cover crop planted.

Figure 5: Lake Taupo, New Zealand (Photo: Suzie Greenhalgh)

♦ *Tax credits and rebates*

A tax credit is an amount deducted from the total amount owed by a taxpayer, and can be used to encourage investment in technologies or adoption of behaviours that reduce negative impacts on ecosystem services. Some examples of tax credits are found in the Applications section below. Rebates are similar to credit systems except that a refund is given to an individual after they have made the payment rather than being deducted before the payment is made. In the case of taxes, a rebate would be a refund given after the full tax amount has been paid; while credit is directly deducted from an individual's tax or rates liability. Most often, rebate schemes are operated by private companies rather than government agencies.

[26] http://greenstarinsulation.co.nz/infobox/energywise-insulation-subsidy/

Policy strengths

- Administration is typically straightforward as it uses existing tax or payment systems.
- Usually voluntary and more likely politically acceptable.
- May not be constrained by a funding limit like with a subsidy.

Policy weaknesses

- Real improvement in ecosystem services is uncertain as the tax credit or rebate may not provide sufficient incentives for voluntary uptake.
- May require initial up-front capital to undertake the actions that generate the tax credit or rebate, so may exclude the participation of lower income individuals or businesses.
- The rate of voluntary uptake may be insufficient to result in any discernible change in ecosystem services. Setting the optimal tax credit or rebate level and determining eligibility criteria are important for providing sufficient incentives to promote participation.
- Rebate systems can have a higher administrative burden as they involve refunds being given to individuals after the payment has been made.

Application to multiple ecosystem services and policy design features

Tax credits and rebates could be applied to improve the condition of individual ecosystem services or to actions that improve multiple ecosystem services. The administrative cost between the two will vary as it is likely to be more expensive to determine the actual improvement for each additional ecosystem service because of the need to measure, monitor or estimate the change in each ecosystem service condition. Using a proxy like implementation of a practice or technology or change in land use may be easier and cheaper to observe and monitor. For instance, tax credits might be given to landowners who agree to restore certain portions of their land to natural vegetation. Areas of restored natural ecosystem can be used as proxies for improvement of several regulating services. However, this simple proxy of 'area' or land cover does not provide any indication of how well the restored ecosystem is functioning, which is an important consideration for enhancing ecosystem services.

Applications

- Conservation Easement Tax Credit (Iowa, USA): The Rural Heritage Conservation Extension Act (2011) allows landowners to deduct up to half their income for 16 years in exchange for conservation easements, while farmers and ranchers could deduct all theirs. The amount they can deduct is the difference in land value before and after the easement was in place (Iowa Environmental Focus 2011).
- Resource Enhancement and Protection Program (REAP) (Pennsylvania, USA): The programme provides a tax credit for farmers who implement best management practices (BMP) to improve water quality. The tax credit covers eligible costs such as BMP construction and installation,

equipment and materials, design and engineering planning costs. Pennsylvania estimated that over a two-year period (2007–2008) the program reduced nitrogen pollution by 73,562 kg (162,176 pounds) and phosphorous runoff by 6,776 kg (14,939 pounds) (Pennsylvania Department of Agriculture 2009).

- Renewable Energy Bonus Scheme – Solar Hot Water Rebate (REBS) (Australia): This was a federal government scheme that operated between 2007 and 2012 to help eligible home-owners, landlords or tenants replace electric storage hot water systems with solar or heat pump hot water systems. Under REBS, eligible households could claim a rebate of $1,000 for a solar hot water system or $600 for a heat pump hot water system. The programme funded over 255,000 applications in excess of $323 million AUD (Australian Government Department of Climate Change and Energy Efficiency 2013).

Low-interest loans

Low-interest loans offer voluntary incentives for individuals or businesses to invest in activities or technologies that result in positive impacts on ecosystem services. In the context of the environment, low-interest loans have primarily been used as a way to motivate adoption of energy-efficient technologies. For instance, in New Zealand, the Heat Smart Hawke's Bay programme offers homeowners low-interest loans to cover the cost of installing insulation and replacing non-compliant burners and open fires in homes built before 2000. The loan is repaid through property rates over 10 years. Low-interest loan policies are also commonly implemented as a means of financing restoration and environmental protection.

Policy strengths

- The overall fiscal burden to the government is likely to be smaller than other price-based economic instruments because loans are repaid over time.
- Potentially more politically palatable to decision-makers and the public because of its voluntary nature and lower financial burden on government.

Policy weaknesses

- No guarantee of large-scale adoption of practices or technologies that will improve ecosystem services.
- Low-interest loans will only motivate portions of the public who would normally have considered these actions.
- Given that money has to be repaid, those with insufficient income are unlikely to participate.
- There must be initial funds available to capitalize the loan fund.

Application to multiple ecosystem services and policy design features

Low-interest loans could be used to finance activities or technologies that lead to the improvement in the condition of multiple ecosystem services. For instance, afforestation projects will lead to multiple ecosystem service benefits. Loans could be given preferentially to projects or technologies that have the greatest potential to improve multiple ecosystem services. This would involve developing eligibility criteria and/or ranking criteria for project/activity types to allocate dollars where they could most effectively lead to improvement of multiple ecosystem services. Loans to be given on a performance basis would require estimating the change in the condition of ecosystem services, as these loans are given before implementation (thus measurement is not an option for approving the loan). Loan terms can also be written to benefit those practices or technologies that have greater positive impacts on multiple ecosystem services.

The lender and borrower will be better able to identify technologies and activities that have a low impact on the environment through the inclusion of ecosystem services dependencies and impacts assessment in lending requirements.

Applications

- Energywise Insulation (New Zealand): In addition to the cost-share subsidy discussed earlier, the programme also offers homeowners the ability to pay the remaining balance of the insulation installation via a mortgage or rates (similar to repaying a loan).[27]
- Clean Water State Revolving Fund (CWSRF) (United States): A $5 billion per annum programme that offers low-interest loans to municipalities and wastewater treatment plants to help fund water quality protection projects for wastewater treatment and watershed management (US EPA 2009a). While the majority of loans are used to fund wastewater treatment infrastructure projects, some funding has been used for watershed protection projects. Since it started, the CWSRF programme has spent more than $2.9 billion to control pollution from nonpoint sources and for estuary protection (US EPA 2009a).
- National Fund for Rural Areas (Nationaal Groenfonds) (Netherlands): This is a financing vehicle for environmental projects undertaken at the regional or landowner scale. The Fund provides grants, subsidies, and low-interest loans to finance permanent afforestation projects that are greater than five hectares in size. The Fund is financed through domestic purchases of voluntary carbon credits generated through these projects.[28,29]

2.3.2 Market-based instruments

This document distinguishes between price-based economic instruments (taxes, subsidies, fees, etc.) and market-based economic instruments. Market-based instruments refer to any policy where a market-like mechanism is created to determine the price paid for an environmental outcome (Morrison & Greig undated). They encourage behaviour through market signals rather than through explicit directives such as pollution control levels or methods (Stavins 2001). Market-based instruments have some key, theoretical advantages over stand-alone

[27] http://greenstarinsulation.co.nz/infobox/energywise-insulation-subsidy/
[28] http://www.nationaalgroenfonds.nl/English/Paginas/default.aspx
[29] www.carbonfix.info

regulation or price-based economic instruments, especially in efficiency and cost-effectiveness in improving environmental quality and meeting environmental goals (e.g. Tietenburg 2006).

In theory, market-based instruments can provide the same or better environmental protection at lower cost to business than a stand-alone regulation. This is because businesses can weigh the marginal costs of reducing impacts against the cost of purchasing reduced impacts from another source of the same/similar environmental degradation. Therefore, assuming low compliance, information, and transaction costs, market-based instruments should be more efficient than a 'blunt' regulation where differences exist between regulated sources in terms of compliance ability and costs. Market-based instruments encourage efficient resource allocation (improvements are achieved at lowest cost) and technology innovation, while providing flexibility to regulated sources (by selling or buying rights and in how improvements are achieved). Together, these should reduce compliance costs (Greenhalgh et al. 2010).

Also, market-based instruments may:

- Avoid some negative incentives that may accompany regulation. For example, legislation protecting endangered species may turn species on private land into liabilities, providing landowners with an incentive to "shoot, shovel and shut up" (Lueck & Michael 2003).
- Improve equity as they encourage greater internalisation of costs by private parties (i.e. the polluter pays principle).[30]
- Offer the advantage of enabling regulators to specify and control the level of environmental degradation directly by using regulation to stipulate an environmental cap. Price-based instruments such as subsidies and taxes are unable to specify environmental caps because they rely on the influence of the pricing mechanism to change polluter behaviour.

The market-based instruments we explore here include ecolabelling, environmental markets and auctions or tenders.

♦ *Ecolabelling*

Ecolabelling, a voluntary certification approach, certifies that products are produced in an environmentally preferable way to other products in the same product/service category, based on life cycle or other considerations. Ecolabelling is meant to create consumer preference for "green" products and thus generate a financial return to the supplier of the certified product in the form of increased revenues. Ecolabelling of agricultural products can provide incentives, in the form of higher market prices or market access, for farmers to certify their products and adopt sustainable agricultural practices (Selman & Greenhalgh 2009).

Ecolabels can be certified using internationally developed and recognised standards (e.g. ISO 14020 family for environmental labels and declarations), regionally relevant umbrella schemes (e.g. EUREPGAP), or local/national standards (British Farm Standards, carboNZero). In other instances, ecolabelling could be used in conjunction with mandatory local, regional or national environmental policies (e.g. Taupo Beef in New Zealand).

Ecolabels have been used successfully where industries have gained a reputation for unsustainable practices, and there is distinct commercial advantage in differentiating goods with environmental credentials, for example, the fishing industry, the forestry sector, and the agriculture sector. There are several fishing and fish product-related ecolabels. The most widely used and accepted label is that of the Marine Stewardship Council, which certifies products as sustainable, particularly in the context of overfishing. Its independence and third-party certification process have been credited for its wide adoption (Potts & Haward 2007), despite it being criticised for a lack of stringent standards, which allows a loose interpretation of the rules for certification (Jacquet et al. 2010). Other labelling schemes, like the Swedish KRAV, take a broader view than just fishing, and include more production stages in their certification (Thrane et al. 2009).

Policy strengths

- Provides easy identification of products and services that are produced in a sustainable manner and are often quality assured. The type of label identifies the ecosystem service(s) the label is designed to protect or enhance. This enables consumers can make informed choices about the purchase of products or services.
- Ecolabel participants may gain increased market share, creating a positive feedback loop to incentivise joining the scheme.
- Ecolabel products may command a higher price in the marketplace, resulting in higher revenues for those participating in the ecolabel scheme.
- Over time ecolabelling programmes may be a mechanism to ensure new or continued access to markets, as retailers and consumers demand improved ecosystem management.
- Participation in ecolabel schemes is voluntary so will be more politically palatable than mandatory schemes.
- Ecolabelling programmes may spur the development of best-practice criteria for production.

Policy weaknesses

- Depending on the scheme, the requirements may not actually be rigorous enough to result in improvements in the condition of ecosystem services.
- Depending on the scheme, meeting the standards may be quite arduous and expensive (e.g. third-party certification), limiting participation in the ecolabel scheme.
- Environmental standards may vary between countries, which may result in consumer confusion over the benefits associated with various products.

[30] This does not hold for all markets. For example, where polluters receive free allocations of credits, the market follows a "*polluted* pays principle" (see Salzman 2005, pp. 932–955).

- The link between the certification standard or ecolabelling and positive environmental outcomes can be tenuous, or at best aspirational (Lewis et al. 2008). The benefits of targeted and specific actions undertaken by individuals for an ecolabel may be superseded by the general improvement in sustainability of practices on a larger scale.
- Mandatory requirements for ecolabelling of goods may be viewed as "protectionist" and a barrier to international trade.
- The success of any ecolabel scheme relies on the willingness of consumers to pay price premiums for the environmental improvements portrayed by the scheme.

Application to multiple ecosystem services and policy design features

Ecolabelling scheme rules are the key determinant in the number and type of ecosystem services the scheme incorporates. The rules stipulate what requirements need to be met to participate in the scheme. Adding multiple ecosystem services to a scheme is likely to increase the time and cost of meeting scheme requirements and any verification costs required. Schemes can account for ecosystem services either by directly measuring or estimating them or through proxy practices/technologies that benefit multiple ecosystem services.

Applications

- Taupo Beef (New Zealand): A pilot programme by two farms in the Lake Taupo catchment to gauge whether diners will pay a premium for beef produced in compliance with New Zealand's most stringent environmental rules to protect water quality. The environmental standards that underpin the ecolabel were developed by Waikato Regional Council and became effective in 2011 (Waikato Regional Council 2011).
- Forestry Stewardship Council (FSC) (International): The FSC forest certification process identifies wood and products sourced from a certified well-managed forest. It incorporates 10 principles and 57 criteria ranging from legal compliance, land tenure, and workers' rights to environmental impacts.[31]
- Healthy Grown Potato (International):[32] An independent programme that certifies that potatoes have been produced using stringent, reduced-pesticide environmentally friendly growing standards including integrated pest management (IPM) farming practices. Farmers wishing to market their products as Healthy Grown must undergo a mandatory certification process. Through this programme, growers implement on-farm conservation to improve biodiversity and restore native ecosystems on unfarmed parcels of land. The Healthy Grown Program was developed through a collaborative effort by the Wisconsin Potato & Vegetable Growers Association, World Wildlife Fund, the University of Wisconsin, and other conservation groups (healthy-grown.com 2012).

[31] https://ic.fsc.org/principles-and-criteria.34.htm

[32] http://www.healthygrown.com/

♦ *Environmental markets*

Environmental markets involve the exchange or trade of a 'commodity' between two parties. The commodities exchanged in environmental markets (e.g. nitrogen, carbon, water) are often proxies for the environmental quality or ecosystem service of concern, and are traded in currencies (i.e. tradable units, such as kilograms, tonnes, or acres). The commodity that is traded is often referred to as a credit when the improvement in an ecosystem service comes from a non-regulated party and/or an allowance when parties are regulated.

There a two types of environmental markets:

- *Regulatory environmental markets* (sometimes termed mandatory or compliance markets) are created and regulated through government legislation (See Box 3 for some examples of some legislative frameworks). These markets create rights to use natural resources or to degrade ecosystem services (e.g. by polluting the environment), up to a specified limit (i.e. environmental cap, (national) environmental standard or individual source limit), and allow these rights to be traded, providing incentives for those who reduce environmental impacts at least cost, to sell those improvements to others.
- Typically, an environmental goal and associated quantitative cap[33] is established by policy, statute or regulation, and the cap is allocated between relevant sources.[34] The cap may be an overall cap, that covers all sources of environmental degradation, or a cap to cover a portion of the sources (e.g. all point sources in a water quality market). Sources that reduce their effects, emissions, discharges or abstraction to levels below their allocation may sell any excess credits, permits or allowances. Conversely, those whose effects, emissions or discharges or abstractions exceed their allocation, or who have no allocation, must either buy credits, permits or allowances from these sellers to cover the excess, or face a penalty (Greenhalgh et al. 2010). Penalties could take many forms, e.g. fines, exclusion from further participation in the market, or reduced allocation of credits, permits or allowances.
- Some regulatory markets have qualitative environmental goals (e.g. to achieve 'no net loss' or a 'net gain' in biodiversity) but no associated measurable and quantitative cap. Instead, the regulation underpinning these markets may prohibit certain activities (e.g. indigenous vegetation clearance, species habitat destruction, drainage of wetlands, increases in stormwater runoff) and only allow these activities where an 'offset' is purchased that is sufficient to replace the ecosystem services damaged by the activity (see Box 4 on offsets).

[33] Environmental goals are often qualitative and ambiguous to interpret. Most qualitative goals are accompanied by a quantitative cap.

[34] Caps are usually allocated through the free distribution or auction of tradeable credits, permits or allowances.

- *Voluntary*[35] *environmental markets* are typically driven by consumer preferences and are not established or enforced by government.[36] Instead, they usually have policies, standards, and verification and audit procedures intended to protect the reputation of credits and hence public relations benefits to purchasers. The credibility of voluntary markets are variable (see WWF 2008) with some markets developing standards to improve the comparability, consistency and rigour of the trades (e.g., the Voluntary Carbon Standard (VCS 2007) for the generation of voluntary carbon credits) and to provide consistency around the baseline or benchmark for a trade.

Box 3: Legislative Frameworks for Ecosystem Service Markets

- The New Zealand Resource Management Act (RMA) requires the Minister for the Environment to consider the use of economic instruments to achieve the purposes of the Act (Section 24(h)) but offers no guidance regarding authorisation to set up and operate markets (Greenhalgh et al. 2010). Sections 9, 15(a), 15(b) and 30 are the sections through which trading could be conceived.
- In the United States, the Clean Water Act (CWA) provides the foundation for catchment pollution caps. The CWA requires states to adopt water quality standards for various pollutants. Violation of these standards may result in a total maximum daily load (TMDL) being developed for the waterbody. A TMDL defines the maximum amount of a pollutant that can be discharged into a waterbody yet still maintain water quality standards. During the TMDL development process, pollutant loads are allocated among the various sources in a catchment (point and nonpoint), so that water quality standards can be met. The pollutant limit allocated to point sources under a TMDL, or 'wasteload allocation,' forms the basis for a water quality-based effluent limit that is placed on the regulated facility's discharge permit. These permit limits – or threat of permit limits – have driven the development of a large number of water quality trading programmes (Greenhalgh and Selman 2012). The United States Environmental Protection Agency released an official Water Quality Trading Policy in 2003 providing guidance to states on how trading can occur under the Clean Water Act and its implementing regulations.

[35] We note that the decision to participate in either a compliance or voluntary market is voluntarily. In a compliance market it is possible to meet the regulatory requirements with or without trading.

[36] For example, a voluntary market for carbon offsets has emerged for those who reap benefit from taking responsibility for their carbon emissions by voluntarily purchasing carbon 'offsets'. These 'offsets' are often bought from retailers or organisations that invest in a portfolio of offset projects and sell slices of resulting emissions reductions to customers in relatively small quantities.

Box 4: Defining Offsets

Offset is one of the most confusing terms in the market literature as it is applied with similar, but slightly different, meanings by different markets. Regardless of the context, offsets usually refer to an action that compensates (fully or in part) for the loss of environmental quality. For instance, where entities are unable to reduce their pollution discharge they may compensate for this by purchasing an 'offset' from other entities that can decrease their pollution discharge.

'Offset' is commonly used in greenhouse gas and carbon markets, and increasingly in biodiversity markets. In a compliance carbon market, offsets refer to the reduction in greenhouse gas emissions (either credits from non-regulated entities or allowances from other regulated entities) purchased to meet regulatory caps. In voluntary carbon markets, offsets mitigate an entity's own greenhouse emissions. These offsets are generally in the form of credits from non-regulated entities who have implemented an emissions-reducing project.

For biodiversity, offsets have been defined as "conservation actions intended to compensate for the residual unavoidable harm to biodiversity caused by development projects, so as to ensure no net loss of biodiversity" (ten Kate et al. 2004). However, the term "biodiversity offset" is increasingly used as a generic term for a variety of regulatory and voluntary biodiversity compensation programmes that are otherwise known as mitigation banking, biodiversity banking, biodiversity trading, conservation banking or species banking. Most such schemes neither fit the definition nor meet the standard of ten Kate et al. (2004).

Policy strengths

General

- Participation in markets is voluntary.
- Markets are typically performance/outcome driven, not practice-based. This rewards the measured or estimated improvement in an ecosystem service or reduction in ecosystem service degradation, not the implementation of practices that lead to improvements or reduced degradation. This ensures flexibility and does not lock the markets into a specified set of practices that require updating over time.
- Markets can promote innovation if they are designed to allow and promote innovation, e.g. allowing participants to test, and obtain credit for, new management practices aimed at improving ecosystem service condition.

Regulatory environmental markets

- In theory, markets will reduce the cost of meeting a stated environmental goal, by providing flexibility in how that goal can be achieved.
- Markets can be designed to include multiple sources of environmental degradation.

- Markets may allow for some growth under a regulatory cap by allowing new sources to purchase allowances from sources that already have an allocation under the cap. The regulatory or environmental cap is what ensures the overall improvement in ecosystems services.
- Markets may lead to faster achievement of environmental goals by providing sources with flexibility in how they meet their regulatory obligations. Therefore, instead of regulated sources being out of compliance before they have changed practices or upgraded technology they can purchase improvements from elsewhere to meet their regulatory obligation.

Voluntary environmental markets

- Voluntary markets provide unregulated individuals or businesses that want to compensate for their environmental impacts with a mechanism to purchase environmental improvements off willing sellers of such improvements.

Policy weaknesses

General

- Markets often require new infrastructure (such as registries and marketplaces) and modification of existing procedures (e.g. consents/permit processes and databases) to operate efficiently.
- The design and operation of markets is relatively new, and some up-skilling will likely be required by any party operating an environmental market.
- Markets often have high transaction costs. In large part these costs are attributable to the processes that ensure the stated improvement in the ecosystem services is real, additional, and verifiable. Transaction costs may also include locating buyers and sellers where markets have few participants, programme administration costs, and the perceived risk that the purchased improvements will not generate the stated improvements.
- Activities that rely on a permanent land use or practice change and are traded in a market can pose challenges to ensuring these changes are permanent and will not be reversed in the future (e.g. forestry credits in greenhouse gas markets), especially where the supplier of the credit for the trade is not subject to any regulatory obligations.

Regulatory environmental markets

- Existing regulatory legislation may inhibit the use of markets either by explicitly not allowing them, not sanctioning their use, or specifying the use of alternative instruments to meet an environmental goal.
- There must be a sufficiently stringent regulation to drive demand if markets are to be useful. Regulatory requirements have often been too weak or set at a level insufficient to drive demand for credits in regulatory markets. In these cases, the underpinning regulation is unlikely to make any real improvements in the condition of ecosystem services.
- Unless all relevant sectors are capped, there is risk of leakage occurring from an environmental market.
- There is often the perceived or real risk that markets will result in *hot spots* where ecosystem service degradation in one area increases as a result of trades in credits, permits or allocations from another area.
- It is likely that the establishment of any new regulation that underpins a market and allocating the cap among sources will be unpopular by those impacted (see Section 2.2.3 on regulation for a broader discussion). While this refers to the underpinning regulation it can affect the implementation of the market that is aimed at increasing flexibility for regulated sources.

Voluntary market

- Voluntary markets often lack sufficient drivers to induce participation by potential demanders of ecosystem service credits.
- Voluntary markets may lack the rigour of regulatory markets in terms of their additionality[37] and verification requirements, which in turn diminishes the value of these markets as a means to create net benefits to ecosystem services.

Application to multiple ecosystem services and policy design features

Outside the commodity markets for the food and fibre provisioning services, markets are most commonly found for regulating ecosystem services such as water purification and air and climate regulation. Another provisioning service that can be managed using a market are the capture fisheries (Quota Management System for the New Zealand fishing industry) and freshwater.

Multiple ecosystem services can emerge in three ways in a markets context: through markets for ecosystems that provide a suite of ecosystem services (e.g., wetlands); through multiple markets for single ecosystem services (e.g., water purification, climate regulation); and through a single market that covers multiple ecosystem services. Few examples are found for the latter.

Where there are distinct markets for different ecosystem services, there may be actions that generate improvements in the service covered by the market but also generate other benefits (or negative impacts) for other ecosystem services (which may or may not be covered by a market). For example, a riparian buffer established to reduce nutrients in a water-quality market could also provide benefits that might be sold in a carbon or habitat market. In some instances, a formal market may also provide incentives for other environmental strategies to be developed that explicitly target the co-benefits generated

[37] Additionality refers to whether an action would have occurred regardless of the policy being implemented to change behaviour. For an action to be additional it would not have occurred unless the policy had been implemented. It is a criterion often used for greenhouse gas reduction projects.

by the formal market, e.g., the Waikato Regional Council's Regional Carbon Strategy (Huser et al. 2012).
To improve the robustness of markets for multiple ecosystem services the market rules should clearly address some of the key concerns raised about multiple ecosystem service markets, such as additionality and how benefits are accounted for (Kaiser & Associates 2004; Carroll et al 2007; Greenhalgh 2008; Bianco 2009; Marshall & Selman 2010; Ruhl 2010; Woodward 2011; Cooley & Olander 2012). Rules should include:

1) Market entry requirements

Many of the concerns about the use of markets for ecosystem services focus on how the eligibility in different markets is treated and thus whether trades are additional. Typically, in a single market, any ecosystem service improvement above and beyond a regulated source's allowable limit is eligible for trading, while for unregulated sources the specified baseline defines what can be traded. Baselines can be devised in a number of ways, including:

- setting baseline requirements equal to the existing state/condition of an ecosystem or the current practices/technologies being used;
- establishing baseline based on the implementation of a certain set of practices;
- specifying a level of environmental performance of ecosystem state/condition;
- requiring a certain level of improvement (e.g. percent) in an ecosystem or ecosystem service(s) over current conditions; or
- using land characteristics to identify the baseline level of emissions or discharges.

Challenges arise where multiple, single-ecosystem-service markets exist and a single activity generates multiple environmental services that are eligible for the various markets. This can potentially lead to what is known as double-dipping. Current market rules rarely cover this circumstance. To counter this problem some rules options are:

- stipulate that a single activity may only sell associated environmental service benefits in one market (i.e. if the water purification benefits associated with a riparian buffer strip have been traded in a water quality market then any carbon benefits are not eligible to trade in a carbon market);
- allow for the sale of multiple ecosystem service benefits from one activity to be traded in the respective environmental markets as long as the market baseline or allowable limit requirements of all markets are met and assurances are in place that no single ecosystem service is sold in more than one market; or
- outline how the benefits from the single activity could be separated and traded in different markets. An example of the latter could be to identify a common metric denominator (e.g. hectares of land, or kilograms of inputs) and then allow portions of the land or reduction in inputs and their associated improvement in ecosystem services to be traded in the relevant markets.

Concern also arises where another instrument has paid for an improvement in an ecosystem service and this improvement is then traded in a market. This could occur where a subsidy programme (such as a United States Department of Agriculture Conservation Programme) has been used to cost-share the implementation of a practice or restoration of an ecosystem, and the ecosystem service benefits are then traded in the market, thereby receiving two payments for the same activity. To address this, market rules should either disallow any benefits generated using subsidy payments to be traded in a market or allow only the non-cost shared portion of the benefits to be traded in the market (Greenhalgh et al. 2006).

2) Calculating multiple benefits

Ecosystems or actions may have positive and negative impacts on ecosystem services. To ensure these are transparently considered within a market, the impact on all relevant ecosystem services should be assessed. While straightforward in markets that cover multiple ecosystem services, even a single ecosystem service market can include rules that state the need to document impacts on all ecosystem services. Incentives for actions or ecosystem restoration that have greater overall ecosystem service benefits could be provided either by offering more favourable trading terms for those actions/ecosystems with more benefits (e.g. higher prices, lower trading ratios) or by disallowing trades where there are any negative impacts or sizeable negative impacts. Any additional documentation increases the accounting burden on the market, so simplified accounting calculations could be provided for those ecosystem services that are not the focus of the actual market.

3) Tracking trades

Multiple ecosystem markets can create several complexities and can prove to be administratively challenging. A single registry that centralizes data about projects and all associated ecosystem service benefits, as well as issuance of credits and execution of trades, could help prevent fraud and ensure environmental integrity across markets.

Applications

Regulatory markets

- Lake Taupo Nitrogen Market (New Zealand): The market works alongside the nitrogen cap placed on nonpoint discharges into Lake Taupo (see Environmental Caps and Limits section) to maintain nitrogen discharges to the lake at 2001–2004 levels. Trading is allowed between agricultural sources in the catchment.[38]
- Hunter River Salinity Trading Scheme (Australia): The scheme allows for the trading of salinity discharge rights among mining operations along the Hunter River. The New South Wales government auctions 200 Scheme credits every two years. Each credit gives the holder the right to discharge 0.1% of the total salinity cap for a given river block during high flows. A river block is defined as the section of water that flows past the town of Singleton on a

[38] www.waikatoregion.govt.nz/Community/Your-community/For-Farmers/Taupo/Nitrogen-trading-in-the-Lake-Taupo-catchment/

given day. For example, if a given river block allows 112 tonnes of salt, an operator holding 10 credits would be able to discharge of 1.12 tonnes of salt. No discharges are allowed during low flow, and unlimited discharges are allowed during flood conditions. A license holder's need to discharge depends on highly variable operational conditions at each site. Credit trading gives each license holder the flexibility to increase or decrease their allowable discharge from time to time, while limiting the total amount of salt discharged across the valley. The trading system is online, and relies on real-time data and monitoring. The trades can be for one or many blocks (i.e. a single day or longer periods), and the terms of the trade are negotiated by the parties involved (Department of Environmental Conservation NSW 2003).

- Colorado Big-Thompson (CBT) Trading Scheme (USA): A well-established water rights trading system that diverts water from the western slope of the Rocky Mountains to the eastern slope. The rights to the water from the CBT project have been allocated to users (farmers, industries, municipalities). The water rights are homogeneous and well understood. The water rights market, in existence since the 1960s, includes market prices, brokers, short-term rentals, and permanent leases of water in the system. Trades occur within the agricultural sector and between the agricultural and municipal and industrial sectors. The unit of trade is one acre foot (1200 m^3) for one year, and a total of 310 000 acre feet (380 000 000 m3) per year of water are allocated by the CBT project. In years with above-average rainfall the allotment is cut back proportionally to save for dry years. Similarly, allocations are proportionally reduced if there are less than 310 000 acre feet (380 000 000 m^3) available for a given year. The trading system is run by the Northern Colorado Water Conservation District (Carey & Sunding 2001).

Figure 6: Rocky Mountains, Colorado, USA

♦ *Auctions and Tenders*

Reverse auctions, procurement auctions or tenders (hereafter 'reverse auctions') are a type of funding allocation strategy. They are competitive bidding systems with a single buyer and multiple sellers. Unlike standard auctions, in which multiple buyers compete to buy goods from a single seller, multiple sellers in reverse auctions compete to sell goods to a single buyer.

The bidding process is key to a reverse auction as, in theory, it gives participants the incentive to reveal the minimum compensation they are willing to accept to adopt or change management practices. Willingness to accept, which only the participant knows, is important information for administrators of a reverse auction, as they want to minimize programme costs. By making selection competitive, producers have an incentive not to inflate their bid price much beyond the minimum price they are willing to accept, as this may lead to not being selected into the programme at all.

In this way, reverse auctions can be cost-effective tools for allocating conservation funding in programmes with a limited budget. Applicants are awarded funding based on the cost-effectiveness of addressing a specific ecosystem service (e.g. water purification, habitat provision), relative to all other bidders. Funding is allocated to the most cost-effective applicants until either the programme has reached its funding allocation limit, or a break point in the cost-effectiveness of bids is reached (Greenhalgh et al. 2007, 2010). As with any new approach, effective communication strategies are needed to advertise and gain good participation in the auction.

Policy strengths

- Allocates government or external funding cost-effectively where a budget constraint exists.
- Auctions can engage a greater number of potential participants because of the flexibility in the amount of funding a participant can receive (Selman et al. 2008). The amount awarded to an individual depends on how cost-effectively they can implement a practice or achieve a reduction compared with others participating in the auction.
- Depending on auction rules, an auction may attract a different set of participants than traditional subsidy programmes because of flexibility in bid prices (Selman et al. 2008).
- Auctions are most often performance-based, which means auctions are likely not only to minimise costs, but also to maximise environmental improvements.

Policy weaknesses

- To operate the auction an external source of funds is required, e.g., government agency, private foundation, etc.
- Auctions are a relatively new tool for allocating conservation dollars and are likely to require some up-skilling by administering bodies for the successful design and implement of an auction.
- As auctions are typically performance based, the improvement in ecosystem services associated with various actions often needs to be estimated. Therefore, robust measurement methodology(ies) must be available.

- Auctions are considered by some to be unfair as larger or wealthier land managers might be able to capture more funding by putting in lower and therefore more competitive, bids. These land managers are using more of their own dollars.
- There is a potential risk of price collusion, especially in cases where only a few landowners are participating.

Application to multiple ecosystem services and policy design features

Reverse auctions have been used as a means of paying for regulating ecosystem services such as water purification and also for biodiversity (e.g. BushTender in Australia[39]). As biodiversity underpins all ecosystem services these auctions are also relevant examples. Many biodiversity auctions use a habitat metric that relates to the habitat provision supporting service. Similar issues arise as for subsidies (e.g. subsidies described in Section 2.3.1).

Challenges with designing an auction for multiple ecosystem services include the metric(s) to use, how to rank bids with more than one service, whether one service is more important than other services and needs to be weighted more highly when ranking bids, and whether or not the ecosystem services metrics need to be aggregated to rank bids.

Applications

- East Coast Forestry Project (ECFP) (Gisborne & East Cape, New Zealand): Established in 1992, the project provides grants through a tender process to land holders who have converted non-productive and often bare land to commercial forestry or any other sustainable land use such as reversion to native forestry (Ministry of Agriculture and Forestry 2005). Currently the project is falling short of meeting the ultimate land-cover target: a 2005 progress review found that only 31 707 ha of the 120 000 ha 2020 target had been planted (Bayfield & Meister 2006).
- Conestoga Watershed Phosphorous Auctions (Pennsylvania, USA): The Conestoga watershed is impaired by high levels of phosphorous, with one of the main contributors being the agricultural sector. In 2006 the Pennsylvania Environmental Council, the Lancaster County Conservation District and the World Resources Institute cooperatively implemented two reverse auctions to help reduce phosphorous losses to local waterways. The purpose of these reverse auctions was to pay farmers to implement BMPs that reduced phosphorous losses to local waterways. The reverse auction project awarded approximately US$486,000 to farmers to implement BMPs that reduced phosphorus losses by an estimated 92 000 pounds (~42,000 kgs). Dollars were allocated to projects that reduced the most phosphorous per dollar spent. Farmers were allowed to alter their bids to make their projects more cost effective. Money was allocated until the budget was exhausted. When compared with other US cost-share payment allocations in the same county, the reverse auction was seven times more cost effective at reducing phosphorous (Greenhalgh et al. 2007; Selman et al. 2008).
- EcoTender Programme (Victoria, Australia): This reverse auction allocated conservation funding to landowners willing to improve management of their land in a way that improved environmental outcomes. The Victorian government acted as the sole buyer. Landowners submitted bids that represented the price they required to undertake management actions. Environmental outcomes of each bid were estimated using a catchment modelling framework that estimated environmental outcomes for salinity, water quality, water quantity, carbon sequestration, and biodiversity. Outcomes were equally weighted and bids were ranked both as a function of cost (bid price) and as estimated environmental outcomes, and contracts were awarded up to the auction budget constraint (Eigenraam et al. 2006).

Figure 7: **Manure storage, Lancaster, Pennsylvania, USA (Photo: Bob Nichols)**

2.4 Ecosystem Preservation and Restoration

Ecosystem preservation and restoration policies protect or restore portions of the landscape to maintain or restore ecosystems and their services. Several mechanisms that can be used for ecosystem preservation and restoration, including the creation of protected areas, ecosystem restoration, land purchases, establishment of covenants or easements, and stewardship agreements. We have included these policies as a separate section as these all specifically relate to ecosystems rather than ecosystem services. Some of these could also be included in other sections such as protected areas could be considered a subset of regulatory approaches.

Given the similarity between these policies, the section on applying to multiple ecosystem services is found at the end of the section and applied to the suite of policies described.

[39] www.depi.vic.gov.au/environment-and-wildlife/environmental-partnerships/innovative-market-approaches/bushtender

2.4.1 Protected areas

Protected areas are "clearly defined geographical spaces, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (UNEP-WCMC 2012). Protected areas generally limit exploitation of resources and human occupation to maintain valuable ecosystems. Some, such as the Soufriere Marine Management Area in St Lucia may allow mixed uses. New Zealand already has a large proportion of land set aside to preserve biodiversity:[40] 33.4% of land is protected (either privately or as part of the conservation estate), and 7% of New Zealand's territorial seas are protected (Ministry for the Environment 2008, 2010). However, most of New Zealand's protected landscapes cover the same or similar ecosystems, leaving many ecosystems with little or no protection.

Policy strengths

- Protected areas preserve ecosystems and the biodiversity that underpins all ecosystem services, which generally provide benefits to regulating, cultural, supporting, and some provisioning services, e.g. capture fisheries, freshwater, wildfoods, and bioprospecting.
- In some instances, protected areas provide benefits to provisioning services in areas immediately adjacent to the protected area because they serve as refuges or nurseries for plants and animals in surrounding areas or in cases of mixed use protected areas directly provides provisioning services like capture fisheries. However, in some cases these areas may reduce neighbouring provisioning services e.g. harbour pests.
- Should provide permanent and legal protection of the ecosystem services provided by the protected area.

Policy weaknesses

- Acquisition, restoration, and/or maintenance of these areas can be costly. In addition, management of these areas is ongoing and will incur annual costs. Funding sources must be established to cover these costs in perpetuity, for example, pest management is necessary to preserve biodiversity and the health of ecosystems in New Zealand.
- Many protected areas are established without thought to the infrastructure and institutions that will be needed to manage them effectively.
- Weak management and inadequate protection of boundaries can lead to degradation of the ecosystem services provided by that area, for example, the intensive dairy farming in the Hauraki Plains in New Zealand impacts on the adjacent internationally significant RAMSAR protected Kopuatai wetland. In other areas, activities like poaching and illegal logging can be common in those protected areas with ineffective management.
- Establishment of protected areas may lead to displacement of indigenous communities, or prohibitions of the use of traditional provisioning resources on which these communities rely (e.g. hunting, fuel, etc.).
- Decisions to establish protected areas have often been made without input from or consultation with communities that would be most affected by the establishment of protected areas, leading to ongoing conflicts over management of the resource.
- Protected area policies tend to protect lands nobody has wanted in the past (i.e. lands with low productivity). Thus protected areas do not typically preserve biodiversity on more productive land as this land has already been converted to productive uses.

Applications

- Protected Areas Network (New Zealand): in 2007, New Zealand had the largest proportional area of land set aside for conservation (33.4% of land) when compared with 29 other OECD countries, and had more than double the OECD average of 15.5% (Ministry for the Environment 2010). Where monitoring has occurred in the 7% of New Zealand's territorial seas that have been protected, these marine reserves have been shown to provide positive biodiversity outcomes (Ministry for the Environment 2008). For example, monitoring carried out inside the Kapiti Island Marine Reserve found that edible fish, shellfish (including lobster) populations were benefiting in abundance, and individuals were larger than when samples were taken before the marine reserve was in place (Stewart & MacDiarmid 2003). Further, there is strong anecdotal evidence that the reserve feeds local fisheries, and commercial and recreational fishermen alike are known to favour areas immediately outside the reserve.
- Danube Delta (Romania and Ukraine): In 1998, 6264 square kilometres were protected as part of the UNESCO Man and Biosphere program. The Danube Delta lies on the coast of the Black Sea and is Europe's largest wetland and reed bed. It is a critical ecosystem for capturing and cycling nutrients (UNESCO 2007).

Figure 8: Nelson Lakes National Park, one of New Zealand's protected areas

[40] And as a consequence, this will help the conservation of ecosystem services.

2.4.2 Ecosystem restoration

Ecosystem restoration policies are those that fund activities aimed at restoring an ecosystem and its associated ecosystem services to a stable, healthy, and sustainable state. Ecosystem restoration policies may be motivated by several goals, including natural hazard regulation (e.g. storm surge protection, hillside stabilization), and restoration of regulating services (e.g. water purification, climate regulation, pest regulation), of important cultural or scenic areas, and of important habitat to maintain biodiversity (supporting service).

Policy strengths

- These policies directly enhance biodiversity as well as regulating, cultural, supporting, and some provisioning services (e.g. freshwater, genetic resources and wildfoods) by restoring the ecosystems that provide them. Restoration policies can restore critical habitats or ecosystem services that are important for natural hazard regulation (e.g. wetlands in coastal areas can protect against storm surges), thereby saving money over the long term by providing natural defences to natural hazards and mitigating environmental damage caused elsewhere.

Policy weaknesses

- Ecosystem restoration can be costly. In addition, management of restored areas is ongoing and will incur annual costs. In some cases, funding sources must be established to cover these costs in perpetuity.
- Outcomes of restoration activities are not always certain. There are no guarantees that restoration activities will result in a healthy, well-functioning, and stable system that can provide the full array of desired ecosystem services.
- The sources and causes of ecosystem degradation are often ongoing (e.g. pollution, development pressures, etc.). For ecosystem restoration to be successful, policies must also address both short-term and long-term outcomes.

Applications

- Motutapu Restoration Trust (New Zealand): The trust is an organization with a mission to restore the natural and cultural landscape of Motutapu Island. Restoration activities include restoring natural forests and native plant communities, reintroducing threatened species, protecting and interpreting archaeological sites on the island, and re-establishing Māori links to the island through cultural activities (Motutapu Restoration Trust 2011).
- Mississippi River Delta (USA): Channelization and levees on the Mississippi River have led to loss of wetlands in the delta region. The deltaic wetlands, which once relied on silt from the overflowing Mississippi, have started to submerge. The importance of the ecosystem services wetlands provide has recently become well known. The role they play in storm surge protection as well as their importance as a nursery to valuable Gulf fisheries have been highlighted by recent disasters. As a result, state and federal governments, as well as environmental organisations, have begun wetland restoration projects throughout the Mississippi delta region. Most recently, a Bill has been introduced that would divert the British Petroleum oil spill fines towards restoration of these important ecosystems (Fertel 2012).

2.4.3 Land purchases

Land purchases for the purpose of this document refer to policies where private land is purchased and retired from productive uses or converted to less intensive uses (e.g.,hunting, fishing). Land purchases can be undertaken by public or private parties. For example, some environmental organizations (e.g. The Nature Conservancy, Trust for Public Lands) have purchased land in sensitive ecosystems to preserve or restore ecosystem services. Similar activities can be undertaken by government agencies.

Policy strengths

- Can be used to preserve priority landscapes and their associated ecosystem services.
- Provide a greater guarantee that the land and its associated ecosystem services will be preserved in perpetuity because ownership is passed to the government or an environmental organisation whose mission relates to ecosystem health.
- Land purchases to retire land do not require any regulatory amendments, though legislative provisions may facilitate retirement (e.g. covenants; see Section 2.4.4)

Policy Weaknesses

- Land that has high productive value will generally be costly and perhaps harder and more expensive to attain. Alternatively, degraded lands might be cheaper to acquire, but costly to restore.
- Land purchases require funding to purchase land and institutions for ongoing management. In addition, where land is secured in perpetuity, management requirements must be successfully communicated to future administrators if delivery of ecosystem services is also to be secured.
- Large-scale land purchases by groups or individuals might be seen as “bio-piracy” or “green colonialism.” In Brazil, where foreigners have made large purchases of Amazon forest, the Brazilian government was prompted to pass a law restricting land-purchases by foreigners (Juniper 2006).
- Sensitive lands are often imperilled by a myriad of social and economic drivers. Unless land purchases are made in an area with strong property rights and adequate management, simply purchasing the land may not reduce these pressures.
- Land purchases may dispossess populations of people with no land tenure, but who are dependent on the ecosystem services provided by the land.
- The purchase and retirement of highly productive agricultural land will likely improve water purification, erosion control and climate regulation but also reduce provisioning services. This will have implications for the

financial returns from the land parcel and the region as a whole. There may also be wider regional economic effects as there may be lower demand for some services provided in local towns (e.g. fertiliser suppliers, farm machinery contractors and suppliers).

Applications

- Bay of Plenty Open Space (New Zealand): The Regional Council purchased 6.5 hectares of former farmland that was considered to have cultural significance, as well as recreational and open space values (Bay of Plenty Regional Council 2010).
- Lake Taupo Protection Trust (New Zealand): The Trust was established in 2007 to protect water quality in Lake Taupo (NZ) by reducing nutrients to the lake by 20%. One strategy of the Trust has been to purchase land. In 2008, the Trust purchased two working farms that were then leased back to the original owners, but with new low-nitrogen strategies in place (Lake Taupo Protection Trust 2008).
- Montana Legacy Project (USA): In 2008, the Nature Conservancy and The Trust for Public Land announced they had reached an agreement to purchase approximately 320 000 acres (1300 km^2) of western Montana forestland from Plum Creek Timber Company (NYSE:PCL) for US$510 million. The purchase is part of an effort to keep these forests in productive timber management and protect the area's clean water and abundant fish and wildlife habitat, while promoting continued public access to these lands for fishing, hiking, hunting, and other recreational pursuits.
- Amazon (Brazil): In 2006, Johan Eliasch, a wealthy environmentalist, purchased 400,000 acres of Amazon rainforest from a timber company for US$14 million to preserve the land. The purchase ultimately prompted the Brazilian government to pass a law restricting land purchases by foreigners.

2.4.4 Covenants and easements

Covenants and easements are legal restrictions placed on land. They are legally binding voluntary agreements that allow landowners to retain ownership of the land while placing limits on the use of that land. These restrictions are tied to land titles or deeds and therefore are passed on to future owners. The key difference is that with easements, the development rights that reflect land-use restrictions can be transferred to a third party (e.g. government, environmental organisation). In the United States, land trusts are often established to manage conservation easements in perpetuity. Covenants, on the other hand, are usually placed on land in exchange for the ability to develop land more intensely elsewhere, and the landowner maintains responsibility for managing the covenanted land.

Compensation may or may not be given to retire land. Compensation can take a number of forms, including direct financial payments from an external source (typically government but could also be other sources such as non-profit organisations) and loan forgiveness or tax incentives. In the United States, estate taxes (or death duties) are lower for land that has a conservation easement (similar to a covenant) placed on it. Easements are treated like philanthropic donations and given tax relief (Greenhalgh 2009).

Policy strengths

- Are voluntary agreements.
- Are legally binding.
- Can be used to preserve priority landscapes and their associated ecosystem services.
- For easements, the landowners receive payments for relinquishing the development rights of their land, which may make them an attractive option for landowners.
- Often these instruments can protect ecosystems on private lands in perpetuity.
- The contractual arrangements can provide flexibility and can be tailored to different contexts.

Policy weaknesses

- Enforcement of the conditions of the easement or covenant may be weak and thus may not achieve the anticipated level of ecosystem or ecosystem service preservation.
- Because these instruments are voluntary, there is no guarantee of participation.
- Ongoing institutional capacity and funding are necessary to manage easements in perpetuity.
- Provisioning services on lands with covenants or easements may be reduced as a condition of the land use restrictions.
- Covenants and easements can limit the flexibility of landowners to react to changing commodity markets and land prices.

Applications

- QEII National Trust (New Zealand): The Trust was created under legislation (Queen Elizabeth the Second National Trust Act 1977) 'to encourage and promote, for the benefit of New Zealand, the provision, protection, preservation and enhancement of open space'. The enabling legislation also forms the framework for the establishment of covenants that place permanent restrictions on the use and management of open space. Open space is defined in the Act as 'any area of land or body of water that serves to preserve or to facilitate the preservation of any landscape of aesthetic, cultural, recreational, scenic, scientific, or *social interest* or *value*' (emphasis added) (QEII Trust 2010a).
- While some ecosystem services are explicitly encompassed by this definition, 'social interest or value' could readily be interpreted to include all ecosystem services. The area in New Zealand under QEII covenants as of June 2012 was 122 275 ha, representing more than 0.7% of land outside the crown estate (QEII Trust 2010b).[41]

[41] www.openspace.org.nz/

- Nga Whenua Rahui (New Zealand): This contestable Ministerial fund was established in 1991 to provide funding for the protection of indigenous ecosystems on Māori land. The Fund, administered by the Nga Whenua Rahui Committee and serviced by the Department of Conservation, receives an annual allocation of funds from Government. Covenants, or Kawenata, are one method used by the Fund to protect indigenous ecosystems. The covenant agreements are sensitive to Māori values and vary in duration from at least 25 years (typically) to being permanent. Cultural use of these natural areas is blended with the acceptance of public access within the agreements. The objective is long-term protection with inter-generational reviews of conditions (Department of Conservation 2013).
- Farm and Ranch Land Protection Program (FRPP) (USA): For this programme the United States Department of Agriculture provides matching funds to help purchase development rights to keep productive farm and ranch land in agricultural uses. Working through existing programmes, USDA joins with state, tribal or local governments, and non-governmental organisations to acquire conservation easements or other interests in land from landowners. USDA provides up to 50% of the fair market easement value of the conservation easement (USDA 2013).

2.4.5 Stewardship agreements

Stewardship agreements are typically agreements made between organisations regarding the management and use of land. These agreements are typically established between associations not individuals. Stewardship agreements can take many forms but three common forms are:

- Memorandum of Understanding (MoU): a document that describes a bilateral or multilateral agreement between parties. It expresses a convergence of will between the parties indicating an intended common line of action. It is most often used in cases where parties either do not imply a legal commitment or in situations where the parties cannot create a legally enforceable agreement. It is a more formal alternative to a gentlemen's agreement.
- Memorandum of Encumbrance (MoE): often an agreement between two parties where one party agrees to restrict uses on their land.
- Accord: a formal agreement between parties that outlines a series of actions and/or goals that all parties to the Accord agree to undertake (Greenhalgh 2009).

Policy strengths

- Stewardship agreements require no regulatory amendments or additional infrastructure.

Policy weaknesses

- Stewardship agreements are voluntary agreements with no legal repercussions for those who do not meet the goals outlined in the agreement. Therefore, there may be negligible improvement in ecosystem services when a number of significant sources fail to meet the goals of the agreement. The goals of the agreement may be less stringent than regulatory measures.
- To improve effectiveness, any stewardship agreement should cover all major protagonists. To obtain this level of agreement, the goals of the agreement may be weaker than those necessary to achieve real improvements, e.g. Deans & Hackwell (2008) on water quality.
- Like other practice-based approaches, stewardship agreements, whose goals specify the adoption of certain management practices, are not flexible and do not allow individual sources to implement the mitigation options that offer them the greatest reductions, are most cost-effective to implement/install, and/or which the source feels comfortable implementing/installing (adapted from Greenhalgh 2009).

Applications

- Clean Streams Accord of 2003 (New Zealand): This is an agreement between local councils, central government (the then Ministry of Agriculture and Forestry and the Ministry for the Environment) and the dairy co-operative Fonterra in New Zealand. The purpose of the accord is to reduce the impact of dairying on the health of water bodies (rivers, lakes, wetlands, and groundwater) through a series of actions (Dairying and Clean Streams Accord 2003). Action priorities and targets for these actions are set down in the accord. This Accord was succeeded by the Sustainable Dairying: Water Accord in 2013.[42]

Application to multiple ecosystem services and policy design features

Ecosystem preservation and restoration policies conserve land or landscapes that provide multiple ecosystem services. Historically, these policies have most often been applied to protect biodiversity and/or certain amenities or uses, i.e. a mixture of supporting and cultural services. More recently, protection and restoration may also encompass efforts to improve regulating services (e.g. water quality) or provision of services (e.g. maintenance of agricultural land through purchase of development rights). In some instances, landscape preservation or restoration may have a negative impact on provisioning and/or some cultural services (e.g. where access to the land by indigenous populations is denied). In many instances, however, these policies will also lead to improvements in cultural services such as aesthetic and spiritual values and eco-tourism and recreation. When considering how and where to invest resources in land preservation or restoration activities, decision-makers should

[42] www.dairynz.co.nz/page/pageid/2145879933/Sustainable_Dairying_Water_Accord

consider the suite of ecosystem services that will be benefited and/or impacted.

One important consideration with these types of polices is "leakage." Leakage is where a decrease in degradation in one place results in an increase in degradation in another area. For example, if land is taken out of production through preservation policies, then other non-agricultural land that is not protected may either be brought into production or existing agricultural land-use may be intensified to meet food demands.

Successful implementation of these policies will also require that decision-makers are transparent when making decisions regarding the protection or restoration of ecosystems and include affected communities in the decision-making process.

3. SUPPORTING IMPLEMENTATION OF POLICY INSTRUMENTS: RESEARCH, MONITORING AND EVALUATION

Research, monitoring, and evaluation activities complement the implementation of any policy instrument by:

- providing information on the status, trend and condition of ecosystem services;
- identifying the drivers of ecosystem service change;
- providing information and tools to inform policy development; and
- establishing effective measures and monitoring programmes to track how policy and related processes impact and depend on various ecosystem services, and to adaptively manage the policies implemented.

There is a wide array of research, monitoring and evaluation activities and strategies, and we outline just some of these in this document. This is not an exhaustive list, given the diversity of options available, but outlines some of the focus areas.

3.1 Monitoring

Long-term monitoring is required to track the condition of and interaction between ecosystem services, as well as the impact of policies on the condition of ecosystem services. Time-series monitoring data are used to evaluate long-term trends and provide a better understanding of the drivers, sources, and impacts of ecosystem degradation. Just as important, monitoring of multiple ecosystem services is needed to understand the interactions between them, both positive and negative. Monitoring data are also needed to detect any unintended impacts of policies that focus on a single ecosystem or subset of ecosystem services, to help assess the effectiveness of policies and to adaptively manage and improve policies. Long-term monitoring data are also required to calibrate bio-physical and economic models that can help assess the potential impacts of policies and decisions on ecosystem services before they are implemented.

In general, governments and other institutions that undertake monitoring have focused monitoring efforts on ecosystem services where degradation issues are evident, e.g. water use, water and air quality, and climate change. Data on some of the provisioning services like food and fibre production are collected to track economic performance, but this is often at a different scale to the policy instrument that is being implemented. As a result, it can be challenging to determine the impact of a policy instrument on provisioning services. Monitoring of cultural and supporting services is generally more difficult, as these services are typically less tangible and robust methodologies are currently unavailable to monitor the conditions and trends of many of them adequately over time. However, there have been some advances in measuring the cultural services supplied by ecosystems for Māori in New Zealand in recent years (Harmsworth & Tipa 2006; Harmsworth et al. 2011) and more methodologies being proposed in the literature (Chan et al. 2011; Daniel et al. 2012).

For monitoring to be effective, it is important to select with care an indicator that is appropriate for extrapolating long-term trends in ecosystem services and also demonstrates the impact of the policy on ecosystem services. For example, in the MA assessments some of the capture fisheries indicators included employment in the marine products sector (number of people), total fish catch (metric tons), fishmeal in animal feed (percent), and value of coastal products used for jewellery and curios (currency) (Layke 2009). The ability of these indicators to convey relevant information on the ecosystem services and their ability to demonstrate the impact of a policy on capture fisheries differs widely. Often monitoring data may exist, but the indicators that are monitored may vary by region, making trends in ecosystem services over larger geographies (e.g. river basins) difficult to determine. In addition, for monitoring data to be useful, indicators must be monitored with the appropriate frequency, and there must be appropriate quality assurances and checks in place to ensure that data are valid, defensible, and able to be extrapolated to determine larger trends. Indicators often provide high-level and aggregated information and must be underpinned by more comprehensive data so that their results can be systematically analysed and interpreted and, if necessary, effective policy changes can be implemented.

Sometimes, monitoring programmes are legislatively mandated. In most cases, however, monitoring is undertaken by agencies that are implementing policy to track state-of-the-environment trends and assess the effectiveness of environmental policy in achieving its goal. Long-term monitoring can be expensive and requires a secure funding source and long-term commitment from landowners (including indigenous landowners like Māori in New Zealand), businesses, research institutes or government agencies.

Applying to multiple ecosystem services and design features

The effectiveness and usefulness of monitoring data for tracking the condition of ecosystem services will depend on the indicator(s) being monitored. It is often hard to draw direct inferences as to the condition of ecosystem services based on a single indicator. For instance, water quality measures (e.g. *E. coli*, pH, colour (hue), visual clarity or turbidity, filtered BOD, dissolved reactive phosphorous, dissolved inorganic nitrogen) as well as flow are needed to assess the swimability of freshwater rivers and streams for recreational purposes (Nagels et al 2001). Therefore, a combination of indicators and supporting data is needed to assess the condition of ecosystem for recreational cultural services.

To monitor the impact of a policy instrument effectively, all ecosystem services targeted by the policy, impacted by the policy, and on which the policy depends should be monitored with suitable frequency and scale to track their response to the policy instrument. This may mean that more than one indicator may be needed to convey the necessary information for a given ecosystem service. Where monitoring budgets are constrained, an assessment to identify those ecosystem services most affected by the policy instrument or on which the policy depends should be undertaken to ensure meaningful data are collected to evaluate policy performance.

Applications

- National River Water Quality Network (NRWQN) (New Zealand): In 1984 the National Water and Soil Conservation Authority passed a resolution recognising the need for a national monitoring network (Smith & McBride 1990). The NRWQN was set up in 1989 with the clearly described aims of detecting significant trends in water quality and developing better understanding of the nature of water resources to assist their management (Smith & McBride 1990). There are 77 sites around the country measured for 15 different water quality indicators.[43] Assessments of trends in water quality have been published for the last decade (Ballantine et al. 2010) and since monitoring began (Ballantine & Davies-Colley 2009). Information gathered through this routine monitoring is used further to examine the impact on water quality of other factors, for instance climate and environmental factors. Regional councils supplement the national water-monitoring programme with their own sites, for example, the Waikato Regional Council monitors 100 river and stream sites on a monthly basis.
- Water Matters (New Zealand): In an innovative move that was a first for New Zealand, Horizons Regional Council implemented a web-based water use monitoring system that records the individual water takes of holders of water consents. Water-consent holders are then able to compare what they have personally taken in a day to their consented amount, and what the catchment, region, management or consent zone have used, as well as the total consented amount. Water Quality Matters, a similar initiative also run by Horizons Regional Council, uses information from both upstream and downstream of 36 monitoring sites where there is permitted discharge into a waterway.
- Regional Monitoring (New Zealand): Section 35 of the RMA requires that regional councils undertake environmental monitoring relating to state of the environment, policy effectiveness and regulated activities. The NZ Statistics Act 1975 mandates the collection of data, including production statistics, albeit at a national scale. Finer resolution production data are typically collected in a confidential capacity and the result aggregated before being made public.
- Fish and Game NZ (New Zealand): Periodic surveys of anglers' use of those lakes and rivers managed by Fish and Game are undertaken.[44]
- Upper Mississippi River Basin Protection Act[45] (USA): The Act is aimed at establishing a monitoring network and bio-physical modelling programme to identify nutrient and sediment sources in the Upper Mississippi River Basin.

3.2 Biophysical and economic modelling

Biophysical and economic models are used to estimate trends in the condition of ecosystem services or to predict the effectiveness/impact of technologies, practices, developments or policy on a range of ecosystem services. Models are often calibrated with monitoring data. Biophysical models can typically be placed in one of two categories: process-based or empirical-based. Empirical-based models create relationships from on-the-ground trials or site-data. This may mean these models are not as accurate outside the data used to create the empirical relationship. Process-based models are mathematical representations of real-world systems (e.g. ecosystems and their services) that estimate environmental events and conditions and are ideally calibrated to monitoring data. Models are used to simulate ecosystems that are too large or complex for real-world monitoring. They may or may not account for more than one ecosystem service.

Economic models typically focus on the financial side of decisions but rely on information about ecosystem services that provide a financial return (e.g. many of the provisioning services). Increasingly, the regulating services are being added to these models to complement the economic aspects of decisions.

Models can be a cost-effective way of evaluating recent trends in ecosystem services and are the only way to explore potential future trends. Governments can use models to explore how various policy options or external shocks (e.g. peak oil) might impact positively or negatively on ecosystem services. To evaluate policy trade-offs or the wider impacts of external shocks more fully, economic and biophysical models can be linked.

While models can be valuable, even essential, in developing and implementing environmental policies, it is often challenging to develop, maintain, and operate them given limited financial and human capital. It may also be challenging to obtain the data (e.g. monitoring data, cost data, etc.) needed to populate the models. In addition, it can be challenging to incorporate multiple ecosystem services into a single model, or to select the most appropriate model for a particular purpose.[46] This may be due to the lack of data on certain ecosystem services, the inherent difference between ecosystem services (particularly the provisioning/regulating services and cultural services) or the different time and spatial

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[43] These are dissolved oxygen, pH, conductivity, temperature, visual clarity, Secchi disk depth, turbidity and absorption coefficients, *E.Coli*, dissolved nutrients (NH_3, NO_3 and DRP), TP/TN, flow, lake height, chlorophyll a, benthic invertebrates, and periphyton growths.

[44] http://fishing.fishandgame.org.nz/where-freshwater-fish-nz [accessed June 16, 2013].

[45] H.R. 3671: http://thomas.loc.gov/cgi-bin/query/D?c111:3:./temp/~c111K08cX6::

[46] Refer to directory: http://tools.envirolink.govt.nz/ for a list of tools and their purpose for New Zealand and www.landcareresearch.co.nz/publications/researchpubs/MODEL_REVIEW_V1-1.pdf for a list of models.

scales at which different ecosystem services are affected by actions or policies.

Applying to multiple ecosystem services and design features

The main constraint to incorporating multiple ecosystem services into modelling is the level of understanding of the interaction between ecosystems, ecosystem services, and actions that are undertaken on a piece of land or within a landscape. As more information becomes available models can become more sophisticated and inclusive of additional ecosystem services.

Applications

- OVERSEER and SPASMO (New Zealand): These biophysical models have been developed initially to address nutrient management issues at the farm-scale but have been increasingly applied to water quality issues (water purification services). OVERSEER is an empirical model; SPASMO is a process-based model. OVERSEER is evolving to account for both nutrient (nitrogen and phosphorous) and greenhouse gases.
- NZFARM (New Zealand): This is a catchment-level economic model that uses bio-physical modelling outputs to estimate the impacts of various policies, resource constraints, and technological advances on various ecosystem services (such as the food, fibre and freshwater provisioning services, water purification, water regulation, climate regulation and erosion regulation). This model can be used to assess the trade-offs between ecosystem services associated with different policy scenarios and/or resource constraints (Greenhalgh et al. 2012).
- Land-Use Management Support System (LUMASS) (New Zealand): This is an optimization model that supports land-use decisions based on the impacts of land use on ecosystem services (Herzig & Rutledge 2013).
- Waikato Integrated Scenario Explorer (WISE) (New Zealand): This is a dynamic, spatially explicit regional model that integrates economic and demographic models with land-use change, climate, water quality, hydrology, and terrestrial biodiversity models to explore impacts of future development scenarios or the consequences of policy options across economic, social and environmental aspects.[47] Over time, WISE can be further enhanced to incorporate additional ecosystem services layers into the model (Hart et al, 2013).
- Integrated Valuation of Environmental Services and Trade-offs (InVEST) (Global): This is a free and open-source software suite developed by the Natural Capital Project to inform and improve natural resource management and investment decisions. InVEST quantifies, maps, and values environmental goods and services. Users quantify, visualize, and compare the delivery of key ecosystem services under different scenarios of land, water, and marine uses. InVEST model outputs describe natural resources in terms of their biophysical supply, the service they provide humans, or their projected socioeconomic value. These outputs provide a framework for governments, corporations, development banks, conservation organizations, and other decision-makers to evaluate the effects their decisions will have on the environment and on human well-being (Natural Capital Project 2013).

[47] www.creatingfutures.org.nz/

4. IMPLEMENTING POLICY: INSTITUTIONS AND GOVERNANCE

While the policies outlined in Sections 2 and 3 have the potential to improve or mitigate damages to ecosystem services, they cannot be effective without the appropriate institutions and authorities to implement them. When considering the suite of policies that can be used to integrate and enhance ecosystem services, decision-makers should also consider whether appropriate institutions exist to administer the policies or implement the actions, whether there is institutional capacity and capability to enact and enforce the policies, and whether there is suitable transparency and accountability in existing institutions to ensure that policies are supported by the communities on which they impact. The following sections describe the various aspects of institutions that are critical for creating and implementing successful policies which incorporate ecosystem services.

4.1 Institutional Mandates

Most current institutions were created before the concept of ecosystem services was formalised, and thus are not necessarily organized to facilitate the efficient management of these services as a whole. While many laws have 'integrated management' as part of their mandate (e.g. New Zealand's RMA (Section 59), Conservation Act (Section 17D), Environment Act (preamble)) often the institutions to enact these laws have been internally organised in a way that makes true integration challenging. For example, authorities responsible for the management of various aspects of ecosystem services are apportioned over national institutions like departments or ministries, as well as over regional and local municipalities, which also wield considerable decision-making authority over areas like land use.

Furthermore, even within the various institutions there may be further disaggregation of the management of resources. For example, within a department of the environment there may be separate offices to deal with air, water, toxic chemicals, climate change, etc. To create and administer effectively policies that consider a holistic ecosystem services approach, procedures must be in place that institutionalise an ecosystem services approach. For example, the US government requires an Environmental Impacts Assessment for all government projects or regulations. Similarly, New Zealand has RMA processes (including resource consent processes) where the impact of an activity on the environment has to be assessed. Requiring these assessments to consider all ecosystem services could ensure any proposed project or regulation accurately measures and accounts for impacts and dependencies on ecosystem services before progressing.

Alternatively, there might be flexibility to create new or joint institutions that would have either advisory capacity or perhaps even decision-making capacity for implementing projects and policies. For example, the Chesapeake Bay Program was established by the US Environmental Protection Agency to work specifically on issues concerning the restoration of the Chesapeake Bay. The Program comprises representatives from several federal agencies and is charged to work collaboratively with federal, state, and local actors to implement restoration policies and environmental caps. Another example of a bridging institution is the Office of Ecosystem Markets created by legislation within the US Department of Agriculture (United States Department of Agriculture 2008). The office is charged with coordinating ecosystem markets approaches across all the relevant agencies in the US government and also works extensively with national environmental organizations. While the office has no rule-making authority, it serves as a conduit for coordination, information exchanges, and best practices for ecosystem markets. The establishment of the Hauraki Gulf Forum in New Zealand as a new institution with its own Act of Parliament is another example where a new institution has been created to facilitate a more holistic approach to managing ecosystems under increasing threats.[48]

4.2 Institutional capacity

Institutions often lack the funding, staff, and/or technical expertise to develop, enforce, and monitor policy or otherwise carry out their mandate. Without adequate institutional capacity and capability, the effective implementation of policies is not possible. Capacity is often a key challenge in New Zealand as the RMA devolves many decisions affecting ecosystem services to the regional and district councils. These councils have a varied capacity, capability, and ability to monitor ecosystem services, develop appropriate policy, and enforce policy decisions. The devolution of decision-making makes it challenging and costly for these organisations to monitor and engage in decisions across all jurisdictions and ecosystem services and the decisions that impact on the various services. It would not be cost effective to build and duplicate the required capability in each of the 78 councils as opposed, for example, to pooling the expertise for the benefit of all. It is important to note that institutional capacity will also vary in the type of policy being implemented.

In some places, businesses and civil society organisations have taken active roles in conservation, environmental education, and monitoring. However, in New Zealand, they have a relatively small presence and also face capacity issues of their own.

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[48] www.aucklandcouncil.govt.nz/en/aboutcouncil/representativesbodies/haurakigulfforum/Pages/home.aspx

One foray into the creation of partnerships to enhance capacity in New Zealand is the partnership of Department of Conservation (DOC) and Fonterra (New Zealand's largest dairy cooperative).[49] The two organisations are working together to improve the natural habitats of five key waterways in significant dairying regions around New Zealand. As the expert in conservation and biodiversity, DOC is working with Fonterra, local communities, and farmers in activities such as enhancing riparian areas and wetlands, managing pests and weeds, and making sure the right habitats are in place around farms to improve biodiversity and encourage native fish and birds. This should enhance the provision of ecosystem services in these areas.

4.3 Institutional transparency and accountability

Without appropriate transparency and accountability within institutions, there is an added risk of policies failing to incorporate the full range of ecosystem service impacts and dependencies adequately into their decision-making processes. Public input and inclusion is important in gauging policies that will take into account the full range of ecosystem services and on making trade-offs between ecosystem services. In addition, accountability of institutions will ensure policies are adequately enforced and monitored for effectiveness.

[49] www.doc.govt.nz/getting-involved/partnerships-and-donations/partnerships/fonterra-partnership/

5. SELECTING APPROPRIATE POLICY INSTRUMENTS

This document has described a number of policy instruments that can be applied to influence the management of multiple ecosystem services. It is unlikely that a single policy will provide the solution to complex environmental problems involving multiple ecosystem services. Rather, a mix of policy instruments is likely necessary. Most environmental policy instruments have been designed to focus on individual ecosystem services, sometimes having unintended negative impacts on other ecosystem services. For example, a subsidy that promotes planting of trees for carbon sequestration benefits (e.g. New Zealand's Permanent Forest Sinks Initiative) may reduce surface water flows needed for irrigation and hydroelectric generation (provisioning services) downstream. Likewise, a policy that promotes wetland construction may conflict with other policy instruments that penalise the emission of GHGs (because wetlands emit methane, a GHG gas). In another example, policies to decrease GHGs may provide incentives to convert pasture and livestock production to cropping where some crops may place more pressure on other ecosystem services, e.g. water purification services, given that some crops have high nutrient leaching rates.

When choosing a policy instrument many factors need to be considered. The context and characteristics of the instrument are important and many of these are outlined below, along with a comparison of instruments against this set of characteristics.

Apart from the characteristics of the instrument, other factors that should be considered when choosing an instrument include:

- **Existing legal framework:** The legislative framework to introduce a new policy instrument or to address a new environmental issue often takes a considerable amount of time. Depending on the existing legal framework and governance processes, some types of instruments may be considered preferable over other instruments. For example, voluntary instruments may be preferred over mandatory instruments where there is no legislated mandate or legal precedence to maintain, protect or enhance an ecosystem service or set of ecosystem services.
- **Attitude of the affected parties and implementing agencies to different instruments:** Affected parties will respond differently to different instruments, and their response will affect the political acceptability of an instrument. Instruments that are poorly perceived are likely to be more challenging and costly to implement. If an instrument is poorly perceived, another instrument or a mix of instruments could be proposed to address the concerns of the affected parties, and/or the instrument could be designed to mitigate the negative perceptions.
- **Attitude of the affected parties and implementing agencies to the issues the instruments are addressing:** In some instances, it is the issue itself that the affected party (and sometimes the implementing agency) does not relate to. This may occur where they do not believe the issue exists, do not believe they contribute to the issue or when there are no options available for them to mitigate their contribution effectively. This can affect the type of instrument(s) chosen.
- **Institutional capacity to implement and operate an instrument**: The institutional capacity of an organisation to implement an instrument or to provide the supporting infrastructure for an instrument can affect how successfully an instrument is implemented in terms of cost, staff buy-in, and ability to design and implement an instrument for the specific context (also see Section 5).

The Policy Choice Framework (Kaine 2012) also provides some additional guidance on how to account for some of these factors, particularly understanding the reasons behind behaviours that reduce the flow of ecosystem services, stakeholder attitudes, and institutional capacity.

5.1 Factors to compare instruments

To help compare policy instruments, this document lists some factors that decision-makers can use to evaluate the suitability of various instruments (Table 1):

- **Voluntary vs regulatory:** This document has explored a variety of voluntary and regulatory policies that can be applied to ecosystem services. While regulatory measures tend to create increased certainty in the environmental outcome, they may also require considerable political capital to implement. Where regulations are likely to be contentious, the time and effort spent crafting regulations and securing stakeholder support could be considerable. On the other hand, voluntary policies are likely to encounter less resistance, but may also result in less certain outcomes.
- **Suitability for multiple ecosystem services:** The policies described in this document vary in their ability to be applied to multiple ecosystem services: some policies are better suited to a single service, while others apply more generally to an ecosystem, and not individual services. For instance, policies such as zoning laws, land conservation, and easements are best suited for protecting ecosystems. Education and outreach policies can easily be adapted to a multiple ecosystem approach. Meanwhile, while many approaches to regulation and taxes described in this document are more easily applied to single ecosystem services, they could also be adapted to a multiple ecosystem approach if desired.
- **Performance vs practice-based**: Many policies fall into either a performance-based approach, where the environmental outcome becomes the ultimate goal, or a practice-based approach, where the implementation or adoption of specific practices is the ultimate goal. Performance-based approaches are generally more likely to provide flexibility to the affected party by giving them the means to choose how the performance standard is met. On the other hand, practice-based approaches, while less flexible, are easier to monitor. By using a practice-based approach, decision-makers may also select the types of

practices most likely to have beneficial impacts on multiple ecosystem services.

- **Induces behaviour change:** Ultimately, most environmental policy seeks to promote behavioural change, but some policies are likely to be more successful than others. For example, taxes and fees are policies that, if well crafted, can create significant behaviour change when they are linked to level of impact on ecosystem services. However, flat taxes or fees are less likely to impact on behaviour as there is no additional reward for those who take actions to reduce their negative impacts on ecosystem services or enhance the condition of ecosystem services. Flat taxes or fees, however, may be easier to implement and administer.
- **Provides flexibility:** Certain policy instruments may provide more flexibility than others. For example, environmental standards can be crafted in a way that allows the affected party flexibility in how that standard is met. Prescriptive policy instruments, on the other hand, may be more straightforward to implement, but may also need to be revisited often to ensure they are reflective or responsive to the current state of knowledge.
- **Creates certainty for environmental outcomes:** The certainty of environmental outcomes will vary with each policy. For example, education and technical outreach policies tend to have less certain environmental outcomes than regulatory policies. However, policies that provide greater environmental certainty are likely to require greater political capital to implement and may also require significant institutional capacity or financial capital.
- **Promotes innovation:** Policies that promote innovation are generally flexible price-based or market-based instruments. For example, environmental markets and pigouvian taxes are both likely to spur innovation as regulated entities search for alternative technologies to increase their competitiveness while meeting or minimizing their financial obligations. Other types of policies that might spur innovation include investment policies that fund research and development, or provide funding for experimental technologies. Educational policies might also provide a means for fostering innovation.
- **Cost burden:** Local, regional and national agencies always face stretched budgets, and the degree to which a policy incurs implementation, administration, monitoring, and enforcement costs for an agency will always be a factor when selecting appropriate instruments. Similarly, the cost burden placed on those sources impacting on ecosystem services or affected by degraded ecosystem services is a consideration when weighing the 'fairness' of a policy instrument.
- **New institutional capacity or infrastructure**: In some instances policies are likely to require additional human and institutional capacity and/or infrastructure. These institutional costs will need to be carefully considered when selecting appropriate policy instruments.
- **Enforcement costs**: Most of the policies, both regulatory and voluntary, will require some degree of enforcement, though these costs will vary significantly among policy instruments. For example, voluntary subsidy programmes are likely to require some degree of verification, and, in some cases, contract enforcement may be necessary. However, the burden is likely to be much lower for these voluntary programmes compared with a regulatory programme that requires regular monitoring and reporting from regulated entities and administrative and enforcement capacity on the part of the regulating agency.

5.2 Common challenges for policy instruments

There are a number of common challenges to implementing policy instruments, including:

- Setting targets and resolving trade-offs: quantitative goals to achieve an outcome are challenging, increasingly so when multiple goals for multiple ecosystem services are required, and especially where the goals are at odds with each other. For example, a goal to increase milk production may conflict with goals to improve water purification services by a given amount and to maintain aesthetic values in a catchment. In this example the desired increase in food production will likely result in greater intensity of production that could increase nutrient leaching (which may overwhelm the water purification services) and also mean that native vegetation is cleared across the landscape, thus reducing its aesthetic appeal.
- Integrating monitoring that measures both activities (processes) and results (outcomes): choosing the appropriate metric, indicator or proxy to represent the ecosystem service(s) is important. This relates to the appropriateness of indicators to assess *a priori* the impact of policy instruments and their design, and also *ex post* to track and evaluate how well the policy instrument is performing and achieving its goal. When evaluating the effectiveness of policy, it is not only the ecosystem service indicators that should be tracked but also the policy implementation process and the institutional capacity of the administering organisation. Should a policy fail, evaluation should be able to determine whether policy design, policy implementation or the institutional capacity of the administering organisation led to its failure (Mortimer 2013).
- Engaging communities and stakeholders: most policy is aimed at changing behaviour; however, achieving behaviour change can be challenging. In a voluntary context this means the success of the policy depends on the uptake of the actions the policy is trying to achieve. A common problem with many voluntary programmes is their uptake. Often financial incentives are used, and while such incentives may move some people, others will still not participate. Smart outreach and engagement programmes are needed to promote and achieve participation.

Table 1: Comparison of policy instruments against specified policy-relevant factors

	Voluntary or mandatory	Applied to single or multiple ecosystem service(ES) or ecosystem[a]	Performance or practice based	Induces behaviour change	Provides Flexibility	Certainty of environmental outcome	Promotes Innovation[b]	Cost burden[c]	New institutional capacity or infrastructure	Enforcement cost
Outreach and Education										
Access to information	Voluntary	All	N/A	Yes	N/A	Uncertain	No	Agency	No	N/A
Awareness campaigns	Voluntary	All	N/A	Yes	N/A	Uncertain	Depends	Agency	No	N/A
Environmental education	Voluntary	All	N/A	Yes	N/A	Uncertain	Depends	Agency	No	N/A
Technical Assistance	Voluntary	All	N/A	Yes	N/A	Uncertain	Depends	Agency	Maybe	N/A
Regulatory Approaches										
Bans and restrictions	Mandatory	Single ES & ecosystem	Practice	Yes	No	Certain	No	Affected party	No	Depends
Standards	Mandatory	Single ES	Depends	Yes	Depends	Certain	Depends	Affected party	No	Depends
Environmental caps	Mandatory	Single ES & ecosystem	Performance	Yes	Yes	Certain	Yes	Affected party	Yes	High
Economic instruments										
Taxes										
Polluter pays tax	Mandatory	Single ES	Performance	Yes	Yes	Uncertain	Yes	Affected party	Yes	High
Input tax	Mandatory	Single & multi ES	Practice	Yes	No	Uncertain	No	Affected party	No	Low
Land use tax	Mandatory	All	Depends	Yes	Depends	Uncertain	Depends	Affected party	Yes	Depends
Environmental tax/fee	Mandatory	Single & multi ES	Depends	Maybe	Depends	Uncertain	No	Affected party	Depends	Depends
Levies	Mandatory	Single & multi ES	Depends	Maybe	Depends	Uncertain	No	Affected party	No	Low
Subsidies										
Direct payments	Voluntary	All	Depends	Yes	Depends	Uncertain	No	Agency	Depends	Depends
Incentive payments	Voluntary	All	Depends	Yes	Depends	Uncertain	Yes	Agency	Depends	Low
Cost-share payments	Voluntary	All	Depends	Yes	Depends	Uncertain	Depends	Both	Depends	Low
Tax credits	Voluntary	All	Depends	Yes	Depends	Uncertain	No	Agency	No	Low
Low-interest loans	Voluntary	All	Depends	Yes	Depends	Uncertain	No	Both	No	Low
Market-based instruments										
Ecolabelling	Voluntary	All	Depends	Yes	Depends	Uncertain	No	Affected party	Yes	Low
Markets	Voluntary	All	Performance	Yes	Yes	Certain	Yes	Affected party	Yes	High
Auctions and tenders	Voluntary	All	Performance	Yes	Yes	Uncertain	Depends	Both	Yes	Low

	Voluntary or mandatory	Applied to single or multiple ecosystem service(ES) or ecosystem[a]	Performance or practice based	Induces behaviour change	Provides Flexibility	Certainty of environmental outcome	Promotes Innovation[b]	Cost burden[c]	New institutional capacity or infrastructure	Enforcement cost
Ecosystem preservation and restoration										
Protected areas	Mandatory	Ecosystem	N/A	No	N/A	Certain	No	Agency	No	N/A
Ecosystem restoration	Voluntary	Ecosystem	N/A	No	N/A	Uncertain	Depends	Agency	Depends	N/A
Land purchases	Voluntary	Ecosystem	N/A	No	N/A	Certain	No	Agency	No	N/A
Covenants and Easements	Voluntary	All	Practice	Maybe	No	Certain	No	Agency	No	Depends
Stewardship agreements	Voluntary	All	Depends	Maybe	Depends	Uncertain	Depends	Affected party	No	Depends

a: This indicates whether the policy is best applied to a single ES, multiple ES, an ecosystem or is suitable for all contexts (ie. single ES, multiple ES and ecosystem)

b: Depends: the form of the policy instrument will change the response (mostly tied to whether it is a performance-based instrument or not)

c: This is the cost of setting up the policy instrument. It does not refer to who bears the cost of establishing the instrument, which is typically borne by the agency

6. CONCLUSIONS

Environmental and ecosystem degradation and the decline of many of our ecosystem services are becoming increasingly recognised by governments, industry and the general public. In response, policies and actions are being assessed and developed to halt this decline, reverse the degradation and assess the trade-offs between the services. The array of instruments at a decision maker's disposal for addressing this decline is vast as are the design features that can be considered.

To date, most issues relating to the decline in the condition of ecosystem services have been dealt with individually, and the policy instruments that have emerged typically target a single or, at most, a couple of services. To manage multiple ecosystem services more effectively and to address trade-offs between services, these instruments often need to be modified and enhanced.

This document explores an array of policy instruments, their strengths and their weaknesses, and provides some observations about applying them to multiple ecosystem services. It is useful for identifying the types of instruments a decision maker may like to investigate and how they can be compared. The systematic assessment of the impact of decisions on multiple ecosystem services and the wise choice and design of policy instruments will reduce the likelihood of unintended policy impacts, providing a solid platform from which to halt and reverse the decline of many of our ecosystem services.

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8. GLOSSARY

Additionality	Whether an action would have occurred regardless of the policy being implemented to change behaviour. For an action to be additional it would not have occurred unless the policy had been implemented and the policy intervention is deemed to be causing the activity to take place (adapted from Gillenwater 2012). Therefore, it is the property of an *additional* activity and is a criterion often used for greenhouse gas reduction projects.
Baseline	A level of environmental performance that must be achieved, a set of practices or technologies that must be implemented, or an eligibility date against which an action is compared.
Commodity	Proxies for the environmental quality or ecosystem service of concern that are traded in currencies (i.e. tradable units, such as kilograms, tonnes or acres) (Greenhalgh et al. 2010).
Conservation Act 1987	Developed to promote conservation of the natural and historic resources of New Zealand, the act established the existence of a Department of Conservation in New Zealand. It also defines conservation land classes and the activities allowed and prohibited on those lands.
Cost-share	A type of subsidy payment where the cost of the technology or practice is shared between the participant and the organisation that provides the subsidy funds.
Cultural services	The non-material benefits obtained from ecosystems such as existence values and recreational values (MEA 2005).
Department of Conservation (NZ)	Under the Conservation Act 1987, DOC's role is to manage all land held in the conservation estate, preserve freshwater fisheries, promote the benefits of conservation, and foster recreation on conservation land. DOC's role is also to provide advice to the Minister for Conservation (for more information refer to www.doc.govt.nz/about-doc/role/legislation/conservation-act/)
Double dipping	When someone sells the improvements in multiple services from a single action into multiple markets and gains multiple payments for the same action.
Economic instrument	A means by which decisions or actions of government affect the behaviour of producers and consumers by causing changes in the prices to be paid for these activities (United Nations et al. 2005). Economic instruments are fiscal and other economic incentives and disincentives to incorporate environmental costs and benefits into the budgets of households and enterprises. The objective is to encourage environmentally sound and efficient production and consumption through full-cost pricing. Economic instruments include effluent taxes or charges on pollutants and waste, deposit–refund systems and tradable pollution permits (United Nations 1997).
Ecosystem services	The benefits people derive from nature, e.g., fresh water, pollination, and aesthetic values (MEA 2005).
Ecosystem	A collection of plants, animals and microorganisms interacting with each other and with their non-living environment, e.g. native forest, cultivated system or urban garden (adapted from Ranganathan et al. 2008)
Environmental Cap	An environmental or pollutant limit placed on a catchment, other specified area or aggregated set of individual sources of pollutant.
Environmental (ecological) threshold	The point at which a relatively small change in external conditions causes a rapid change in an ecosystem or the environment. When an environmental or ecological threshold has been passed, the ecosystem may no longer be able to return to its natural state.
Fee	A fixed sum charged, by an institution or by law, for the privilege of performing a certain activity or engaging in a type of activity.
Individual Source Limit	An environmental or pollutant limit placed on individual actors or businesses, often in the form of a permit or an allowance.
Institutions	Any structure or mechanism of social order and cooperation governing the behaviour of a set of individuals within a given community. Institutions are identified with a social purpose, transcending individuals and intentions by mediating the rules that govern cooperative living behaviour. The term "institution" is commonly applied to customs and behaviour patterns important to a society, as well as to particular formal organizations of government and public services (Durkheim 1895).
Land use	The human use of land. Land use involves the management and modification of natural environment or wilderness into built environment such as fields, pastures, and settlements.

Leakage	Leakage is a secondary effect of a policy and may be an upstream or downstream effect. Often these effects involve a market response as the alternative providers or users of an input/product react to a change in market supply or demand caused by a policy. For example, a downstream market response may occur when forest protection that reduces timber supply causes logging to shift to adjacent forests to meet unchanged timber demand. Leakage is where an activity that is constrained by a policy in one area moves to another and the there is no net change as a result of the policy. For example, if agriculture does not fall under a cap, a farmer might generate credits in a trading scheme by applying best management practices on one tract of land, while continuing poor management practices on another tract (adapted from WRI/WBCSD 2005).
Levy	Imposing or collecting a payment by an authority or force. Levies are often collected on the production of a commodity, good or service and used to fund marketing, research, and development.
Market-based Instrument	Instruments that seek to bring market opportunities in areas that have largely been controlled by direct regulation (from Hatton MacDonald et al. 2004), e.g. the use of an auction that creates a trading space for an ecosystem service.
Metric	Parameters or measures of quantitative assessment used for measurement, comparison or to track performance or production.
Negative externalities	A non-priced cost absorbed by a person or persons other than those directly involved in decision making. Occur when a product or decision costs the society more than its private cost.
Offset	An action that compensates (fully or in part) for the loss of environmental quality, e.g. entities unable to reduce their pollution discharge may compensate by purchasing an ‘offset’ from other entities that can.
Performance-based policy	Policy based on achieving a specified and quantifiable target.
Policy (policy is shorthand for policy, legislation and strategies)	A principle or rule to guide decisions and achieve rational outcomes. A policy is a statement of intent, and is implemented as a procedure or protocol. Policies can assist in both subjective and objective decision-making.
Planning	Formulation of a programme for a definite course of action, e.g. a regional plan or district plan.
Practice-based policy	Based on the implementation of a given set of defined actions.
Price-based instrument	Instruments that influence environmental performance by subsidising mitigation actions or that place a price on negative or polluting activities, e.g. a fee for discharging effluent into a stream (from Hatton MacDonald et al. 2004).
Provisioning services	The goods and products obtained from ecosystems, such as wild-caught foods and fisheries, and freshwater (MEA 2005).
Regulation	Institutional measures aimed at directly influencing the environmental performance of polluters by regulating processes or products used, by abandoning or limiting the discharge of certain pollutants, and/or by restricting activities to certain times, areas, etc. (Opschoor et al. 1994).
Regulating services	Benefits obtained from natural processes occurring within an ecosystem, e.g. regulation of air quality through natural sinks for pollutants and purification of water through natural filtration (MEA, 2005).
Reporting	Document containing information organized in a narrative, graphic, or tabular form, prepared on ad hoc, periodic, recurring, regular basis.
Resource Management Act 1991	This act governs the sustainable environmental management of land, air, soil, and water resources and the ecosystems in New Zealand. It defines the process for acquiring permissions for permitted activities on private and public land, and lists activities prohibited for the country as a whole, and at a more localised level.
Reverse auction	Sellers compete to supply an ecosystem service at the lowest price, i.e. prices are bid down, not up. These are particularly efficient where budgets are limited.
Subsidy	A measure that keeps prices for consumers below market levels, or keeps prices for producers above market levels or that reduces costs for both producers and consumers by giving direct or indirect support. The most common definition of a subsidy refers to a payment made by the government to a producer. Subsidies can be direct – cash grants, interest-free loans – or indirect – tax breaks, insurance, low-interest loans, depreciation write-offs, rent rebates.

Supporting services	The underlying processes without which the remaining ecosystem services would not be supplied, e.g. nutrient cycling, soil formation, primary production, photosynthesis and water cycling (MEA 2005).
Tax	A financial charge or other levy imposed on a taxpayer (an individual or legal entity) by a state or the functional equivalent of a state by which failure to pay is punishable by law. Taxes are also imposed by many administrative divisions. Taxes may be direct or indirect taxes and may be paid in money or its labour equivalent.
Technical assistance	Assistance by which innovations in land management, new technology or management practices, etc., can be transferred to individuals or organisations.

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