Time for a third-generation economics-based approach to coral management

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INTRODUCTION

This chapter conveys a simple but critical message. Coral reefs provide an immense yet still underestimated value to society. Benefits include, amongst other things: food, recreation, education, health, coastal protection, support of other ecosystems and species, and enjoyment from social, cultural and spiritual aspects, as well as income generation and livelihood support (see Spurgeon, 1992; Moberg and Folke, 1999; Cesar, 2002; Whittingham *et al.*, 2003; Ahmed *et al.*, 2004). Regrettably though, corals are in serious decline and efforts to manage and protect them are generally inadequate and significantly under-resourced in terms of money and management skills.

In recent years economic approaches have been recognized as potentially providing powerful underpinning support for effective coral reef protection. However, given the continuous decline in status of corals (Wilkinson, 2004; Wilkinson, this volume) and the current unprecedented dynamic nature of the global economy, it is time for an updated economics-based approach. The approach needs to be more effective in demonstrating the benefits from enhancing coral management and protection, and should facilitate the maximization of potential long-term benefits derived from healthy coral reefs. To achieve this we need to broaden the issues explored, go well beyond just 'knowing' the 'numbers', and embrace a far more integrated and radical 'third-generation' economics-based approach.

Coral Reef Conservation, ed. Isabelle M. Côté and John D. Reynolds.

Aim and contents

An introduction to coral reef economics and a fairly comprehensive set of different coral reef values can be found elsewhere (e.g. Spurgeon, 1992; Cesar, 2002; Ahmed *et al.*, 2004). Consequently, to avoid replication, this chapter mainly focuses on highlighting how approaches to coral reef economics have developed and broadened, and how they need to further evolve in the future to aid coral conservation measures. A principal aim is thus to provoke thought and much needed change.

The introduction sets the scene by stressing some of the problems faced both in terms of our proficiency in estimating economic values for coral reefs, and with respect to the ever-growing threats to coral reefs in the turbulent and dynamic global market that now exists. The chapter then outlines the 'first-generation' approach based on a welfare economics perspective and the concept of total economic value. A more integrated 'second-generation' approach is then detailed, highlighting additional perspectives to be considered for a more holistic appreciation of coral values that includes: economic impacts; financial aspects; socio-economics and other indicators. The concept of a new 'third-generation' approach is then proposed. Finally, the chapter concludes by recommending steps to facilitate application of second- and third-generation economic approaches, thereby leading to improved coral reef management.

An immense yet underestimated value

The most authoritative and credible estimate of the global value of coral reefs to date is that by Cesar *et al.* (2003), who estimated net benefits of 'nearly US\$ 30 billion year^{-1}' to the global economy. Using a 3% discount rate and a 50-year timeframe, the corresponding global asset value of coral reefs is thus nearly US\$800 billion. The relative composition of this value in terms of key goods and services is provided in Fig. 12.1. It is based on an extrapolation of economic values from various studies and assumes a world area of 284 000 km^2 of coral reefs, representing an average value of US\$0.10 m^{-2} yr^{-1} of coral.

However, this estimate significantly underestimates the true value of corals. This is partly because many other benefits such as social, cultural, pharmaceutical and sand generation are omitted, but also because the biodiversity/non-use value (18% of the total) is probably vastly underestimated. For example, the American Samoa case study outlined later in this chapter reveals that non-use values, which represent the enjoyment gained by individuals without necessarily making personal use of the corals, could

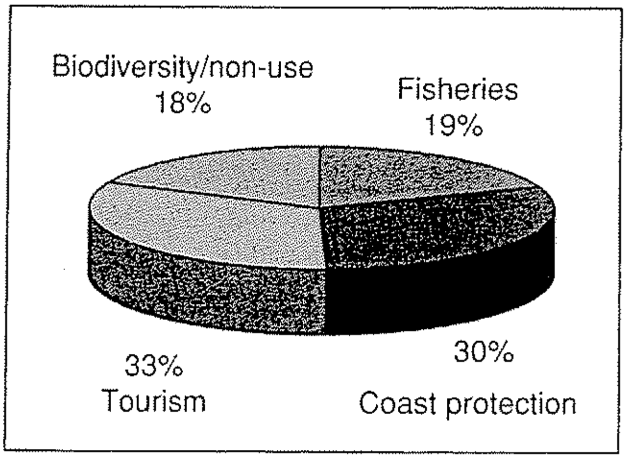


Figure 12.1 Relative contribution of various goods and services to the global value of coral reefs. (Modified from Cesar *et al.*, 2003.)

account for over 88% of the total annual value of their coral reefs. However, use values, particularly recreational use values, are admittedly relatively low in American Samoa.

It is worth noting that the widely publicized paper by Costanza *et al.* (1997), which estimated the value of the world's ecosystem services and natural capital, implied a global value of corals of US$377 billion yr^{-1}. This estimate was based on an assumed value of US$6075 ha^{-1} yr^{-1} for 620 000 km^2 of coral reefs, or an equivalent of US$0.60 m^{-2} yr^{-1}. The benefits evaluated for coral reefs comprised recreation (50%), coast protection (45%), food production (4%) and waste treatment (1%). However, the overall estimates for all habitats valued, including corals, is acknowledged to be uncertain due to well-recognized limitations in the valuation approach (e.g. Costanza *et al.*, 1997, 1998). Certainly for coral reefs, it appears to have extrapolated values from relatively high-value sites and applied them to all other coral reefs. For the specific services it represents, the value is thus probably an overestimate. However, other coral values with fewer estimates of value in the literature were omitted (e.g. non-use values, indirect services, medical and pharmaceutical uses, etc.) so the overall estimated coral value may actually be an underestimate.

To add reality to these large numbers, and to highlight their potential underestimation, it is interesting to note the outcome of a recent ship-grounding incident in Yemen. In August 2004, the *Iran Ardebil* ran aground on Mayyoun Island, damaging 2350 m^2 of coral reef. Despite the fact that corals there support minimal tourism and fishing activities, and provide no coast protection function, the shipping insurance company paid damage compensation of US$1.9 million to the Yemen government. This represents

US\$809 m^{-2} or US\$30 m^{-2} yr^{-1} assuming a 3% annuity discount rate. The claim and settlement were based on restoration and monitoring costs (see also Jaap *et al.*, this volume), backed by strong arguments relating to their non-use value (i.e. the relative uniqueness and quality of corals in the vicinity of the incident). Although strictly speaking a 'legal' rather than an 'economic' value, the value of US\$30 m^{-2} yr^{-1} is real in that it was actually paid and could be drawn upon in the future to inform other coral damage incidents.

Decline in coral status, inadequate management and increasing pressures

The fact that global coral reef status is under serious threat, with some locations facing particularly drastic degradation, is well documented. According to Wilkinson (2004), at a global level, 20% of the world's corals have been effectively destroyed, 24% are at imminent risk of collapse through human pressure, and a further 26% are under longer-term threat of collapse. The slow growth of corals and their strict requirement for certain conditions further compound the severity of this problem.

Meanwhile, in the Caribbean, Burke and Maidens (2004) report that 64% of corals are currently threatened by human activities (10% very high, 33% high and 21% medium threat). Around 60% of Caribbean corals are threatened by over-fishing, 35% are threatened by inland sediment and pollution, and 33% by coastal development. Coral cover in this region has declined from 55% to *c.* 10% in the past three decades (Gardner *et al.*, 2003; Côté *et al.*, this volume). Disease and rising sea temperatures serve to intensify those impacts which stem from anthropogenic activities, thereby causing additional loss of corals and keystone organisms (Harvell *et al.*, 1999; McWilliams *et al.*, 2005; Precht and Aronson, this volume).

The inadequate and under-resourced management and protection of coral reefs is also widely acknowledged (e.g. Wilkinson, 2004), but less often quantified. Burke and Maidens (2004) report that in the Caribbean, only 20% of corals are within marine protected areas (MPAs), and only 6% of the 285 MPAs are effectively managed.

Unfortunately, given today's unprecedented dynamic business climate and the key trends affecting the global economy, the status of the world's coral reefs is likely to decline further. Figure 12.2 highlights some key trends and associated consequences likely to have adverse effects on coral reefs. Whilst some trends are well recognized, others are perhaps more subtle. Examples include technological advances that will lead to more efficient

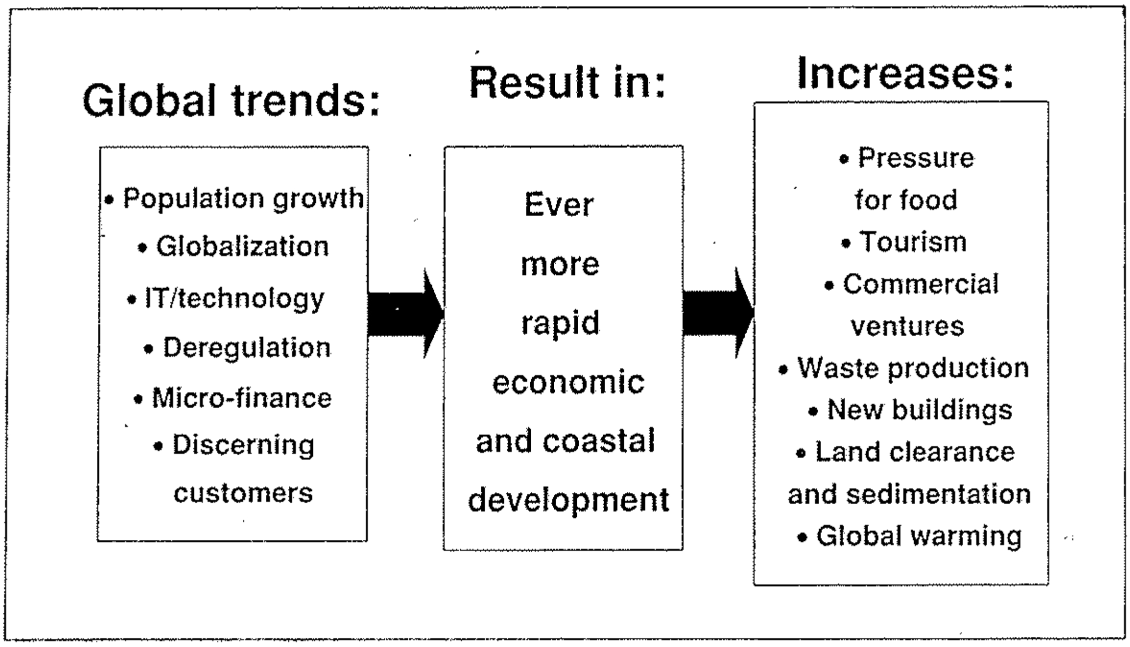


Figure 12.2 Key global trends likely to have adverse effects on coral reefs.

fishing techniques, increased micro-finance initiatives that will result in better-off local communities demanding more resources, and increasingly discerning global consumers who will desire a greater variety of products and activities to satisfy their more sophisticated demands.

The potential solution

So what is the solution to all this gloom and doom? There is of course no single solution. The answer lies in tackling the issues in a multitude of creative ways at all levels. In order to slow down and reverse current trends, whatever approaches are adopted certain features are required (see Box 12.1.). Costanza (2003) also stresses the need for a dramatic shift in the way we approach science if we are to end up with a sustainable and desirable world to live in. Amongst other things, he advocates a consilient transdisciplinary approach that draws upon: envisioning; a pragmatic philosophy built on complex systems theory and modelling; a multiscale approach; and a consistent theory of cultural and biological co-evolution.

FIRST-GENERATION ECONOMIC VALUATION APPROACHES

Welfare economics

The *Concise Oxford Dictionary* describes economics as the 'practical science of the production and distribution of wealth'. A strand of economics most

Box 12.1 Necessary features of future solutions to protect coral reefs

(1) Address the root causes of problems.
(2) Radical and innovative yet simple to implement.
(3) Collaborative, involving a blend of organizations such as governments, businesses, academic institutions, NGOs and local groups.
(4) Supported by appropriate politicians, businesses, 'personalities' and local people.
(5) Supported by appropriately targeted awareness campaigns at all levels.
(6) Holistic, integrated and multidisciplinary in approach.
(7) A mix of global, regional and local regulations and market-based instruments.
(8) 'Third-generation' economics-based approaches.

relevant to the use and management of coral reefs is neoclassical 'welfare economics', which can be defined as the 'science guiding the optimum allocation of scarce resources between competing uses for the maximization of human welfare'. Few could argue that this is not what humans should be striving for with respect to managing and protecting coral reefs for the long term.

At the heart of neoclassical welfare economics is the concept of measuring welfare (i.e. utility or individual preferences). This is generally achieved by measuring people's 'willingness to pay' for additional (marginal) units of a good or service, and aggregating it to determine total net benefits (i.e. less costs) for a national economy.

A few decades ago it became apparent that conventional economic and welfare economic approaches that relied on market prices failed to account for the true value of environmental goods and services. This is because some environmental goods (e.g. certain fish and recreational use) and most services (e.g. coastal protection) are not traded and thus have no recognizable market value. As a result, government decision-makers would make inappropriate decisions resulting in serious degradation of natural resources. This led to the introduction of 'environmental economics' as a means of helping to correct such 'market failures' (e.g. see Pearce *et al.*, 1989).

Box 12.2 Potential applications of welfare economics to coral reef management

(1) To prioritise where expenditure is best targeted.
(2) To enhance decision-making for optimising welfare.
(3) To highlight the winners and losers and facilitate equitable distribution.
(4) To help justify additional management costs and expenditure.
(5) To inform damage assessments and determine appropriate compensation.
(6) To help control people's behaviour and utilization of resources.
(7) To enhance revenue generation.
(8) To maximize benefits.
(9) To minimize costs.

Environmental economics predominantly focuses on the development and application of environmental valuation and economic instruments, although it does address other issues such as international trade and sustainability. Environmental valuation involves estimating monetary values for environmental goods and services. Economic instruments are market-based means of incorporating non-market-based environmental values (i.e. externalities) within the decision-making process (i.e. internalized).

When its inadequacies are appropriately corrected for, approaches based on welfare economics give rise to various potentially valuable applications that can assist coral reef management. These uses are briefly outlined in Box 12.2.

Total economic values

The first generation of economic-based approaches applied to coral reefs was predominantly that of welfare economics, focusing on different components of the concept of total economic value (TEV). Examples include Hodgson and Dixon (1989), Spurgeon (1992), Cesar (1996), and numerous others cited by Cesar (2002), and Ahmed *et al.* (2004). The key elements of the TEV concept are highlighted in Fig. 12.3 and are described in more detail in Spurgeon (1992) and Cesar (2002). The main point of TEV is that ecosystems such as coral reefs provide benefits and value to individuals and society, not only from direct uses, for example from tourism and

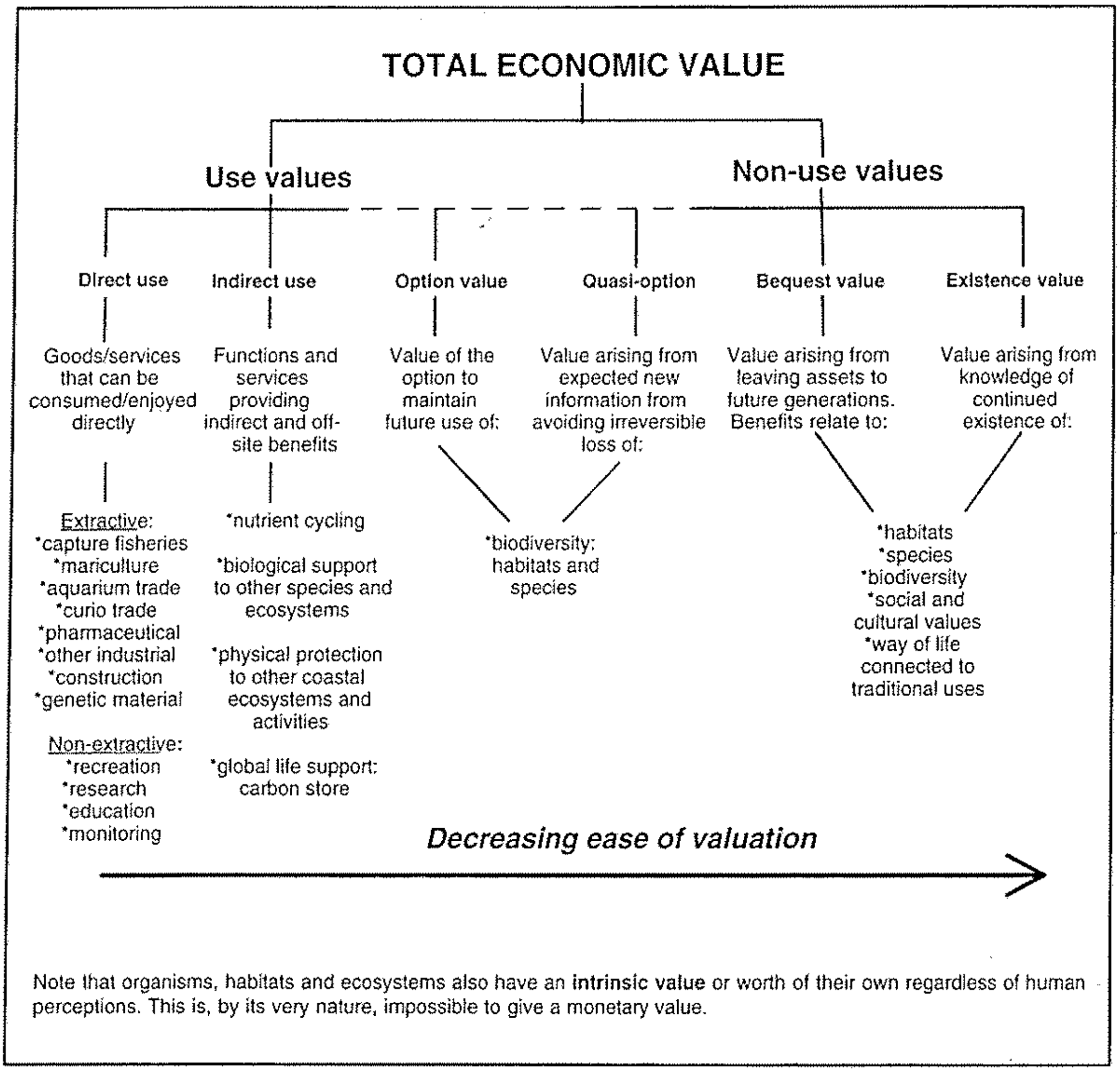


Figure 12.3 The concept of total economic value. (Based on Spurgeon (1992) and Barton (1994).)

fisheries, but also from indirect uses and without necessarily any actual use (i.e. non-use value).

Indirect-use values relate to the fact that benefits can accrue indirectly (i.e. off-site), away from coral reefs, for example through providing a coastal protection function whereby wave energy is absorbed hence protecting nearby resources on land (e.g. Sheppard, this volume). Non-use values relate to the fact that people may derive benefit simply from knowing that corals continue to exist, with motives relating to their own personal satisfaction (existence value), for the benefit of future generations (bequest value), for their own possible future use (option value) or for other people's current use (altruistic value). Organisms, habitats and ecosystems also have an 'intrinsic value' or worth regardless of human perceptions. It is impossible to place a monetary value on intrinsic value, but it should not be ignored.

Economic welfare valuation techniques

Many techniques are available to estimate the economic welfare value of environmental goods and services, as summarized in Table 12.1. Further details and guidance on how they can be applied can be found in Hufschmidt *et al.* (1983), Grigulas and Congar (1995), Dixon *et al.* (1997) and Bennett and Blamey (2001).

Examples of applications

The number of neoclassical welfare valuation studies conducted to date is expanding, but is still limited. Applications tend to focus either on specific types of value at a specific location, or on partial/complete valuations assessing impacts of different management or development options on a range of key values for a location or country. A comprehensive range of such examples is reported in Cesar (2002) and Ahmed *et al.* (2004).

More sophisticated examinations of specific values include studies by Rudd and Tupper (2002) and Weilgus *et al.* (2003). They have explored recreational and non-use values associated with specific coral reef attributes using choice experiments (e.g. effects of water quality, and abundance and size of fish and corals). Rudd and Tupper (2002) found that divers in the Turks and Caicos were willing to pay at least US$10 more per dive to observe larger or more abundant Nassau groupers (*Epinephelus striatus*). Weilgus *et al.* (2003) found that divers in Israel were willing to pay US$2.60 and US$1.20 per increased unit of fish diversity and water visibility, respectively, per dive.

There are also applications at a global and regional level, albeit using many crude assumptions. Examples include Cesar *et al.*'s (2002) global estimate of coral reef value, Burke *et al.*'s (2002) estimate for Southeast Asia and Burke and Maidens' (2004) estimate for the Caribbean. Average net benefit values applied for these studies range from US$700 to US$270 000 km^{-2} for tourism; US$14 500 to US$41 000 km^{-2} for fisheries; US$2000 to US$1 000 000 km^{-2} for coast protection; and US$2400 to US$75 000 km^{-2} for aesthetic/biodiversity value.

An example of a recent state-of-the-art first-generation economic welfare study attempting a more complete valuation of coral reef values is one undertaken in American Samoa (Spurgeon *et al.*, 2004; Spurgeon and Roxburgh, in press). As outlined in Box 12.3, it incorporates monetized social and non-use values as well as key ecosystem service values. The study estimated an annual value of coral reefs of US$1.3 million without non-use,

Table 12.1. Environmental valuation techniques

Category of technique	Name of technique	Description of approach
Market-price based	Market values	This approach is based on the assumption that the value of a good is based on its price in the market place. The value of the good is taken as the market price, less the cost of production and any transfer payments made, such as taxes and subsidies.
	Change in productivity	Changes in environmental quality can lead to changes in productivity and production costs, which in turn lead to changes in the volume and price of goods. For example, a decline in coral reef quality will lead to a decline in artisanal fishery catch and hence loss of market value.
	Damage costs avoided	Under this approach, the value of an environmental asset, such as coastal or flood protection, is taken to be represented by the saving made by avoiding damage to assets it protects. For example, the value of coastal defence provided by a beach or coral reef would be considered to be equal to the cost of repairing or replacing infrastructure and buildings damaged by erosion and flooding.
	Substitute/ surrogate prices	The substitute or alternative cost approach values a particular environmental service or good according to the market value of available substitutes. If an alternative good or service that provides a similar benefit has a market value, then the market price for this can be used as a proxy for the non-marketed good or service. For example, fish consumed at a subsistence use level can be assumed to have the same value as similar fish sold in a nearby market.
	Defensive or preventative expenditure	Defensive expenditures, such as the provision of extra-filtration for purifying water, are considered as minimum estimates of the benefits of environmental improvements. Such an increase in quality must provide a benefit to the individual at least as great as the cost of the defensive equipment, because otherwise the individual would settle for lower quality and avoid spending the money.
	Expected values	Value is based on potential revenues (less potential production costs) multiplied by probability of occurrence.
Cost-based	Replacement cost	The value of an environmental asset (or the function it performs) can be given a proxy value based on the cost of replacing the function with an alternative. For example, the value of a coral reef's shoreline protection function can be estimated based on the cost of providing an equivalent man-made shoreline protection scheme.

(cont.)

Table 12.1. *(cont.)*

Category of technique	Name of technique	Description of approach
Revealed preference/surrogate market (uses market-based information to infer a non-marketed value)	Travel cost method	This technique centres on the expenditure incurred by households or individuals in order to reach recreational sites, such as diving destinations, and uses these expenditures as a mean of measuring willingness to pay for the recreational activity. The sum of the cost of travelling, including the opportunity cost of time and any entrance fee, gives a proxy for market prices in estimating demand for the recreational opportunity provided by the site under investigation. By observing these costs and the number of trips that take place at each of the range of prices, it is possible to derive a demand curve and hence overall value for the particular site.
	Hedonic price	This approach seeks to isolate the contribution that environmental attributes make to the total market value of an asset. For example, the proportion of the price differential between two otherwise identical houses accounted for by being within a protected area or overlooking a healthy coral reef reveals an individual purchaser's valuation of the importance of that attribute.
Stated preference/construed market approach (questionnaire surveys to ask people's direct willingness to pay)	Contingent valuation	This is a carefully constructed and analysed questionnaire survey technique asking a representative sample of respondents how much they are willing to pay (WTP) for an environmental benefit or what they are willing to accept (WTA) in compensation for a loss. The questionnaire format thus stimulates a hypothetical (contingent) market for a particular good.
	Choice experiments	As above, however, respondents are presented with several short descriptions of a composite good (e.g. a good, such as a diving destination, described in terms of a number of valuable characteristics, such as fish diversity, fish abundance, coral health, and price to pay). Each description is treated as a complete package and differs from the other packages in respect to one or more of the good's characteristics. Respondents then select their preferred package (pairwise comparison) based on their personal preferences. It is then possible to isolate the effects that variation in individual characteristics has on the price.
Transfer of values	Benefit (value) transfer	This methodology uses the transfer of economic values estimated in one context and location in order to estimate values in a similar or different context and location. The values should ideally be adjusted based on key criteria and variations that apply in the different contexts and locations. This technique is increasingly being used when it is not feasible to carry out primary data collection.

Source: Spurgeon *et al.* (2004).

Box 12.3 Total economic valuation case study: American Samoa

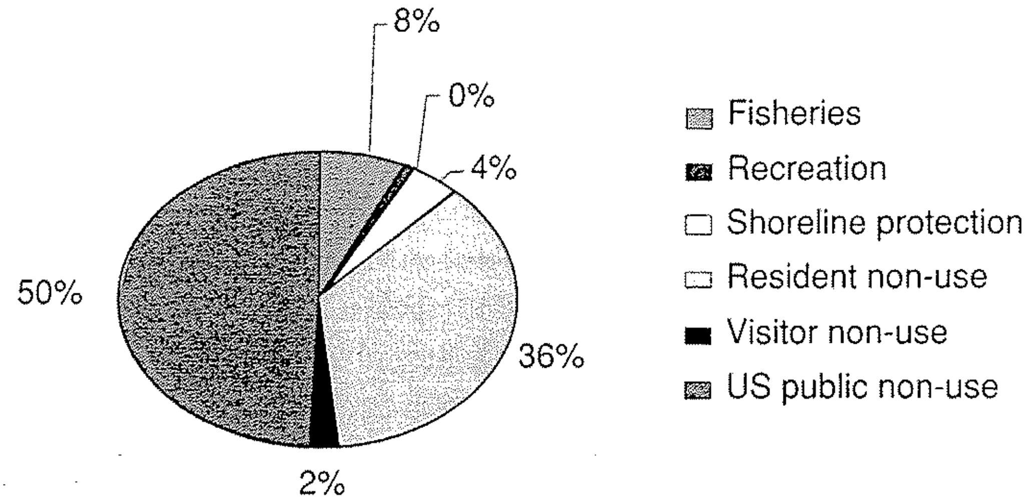
Aim The study aimed to determine the total economic value of coral reefs and mangroves for all five main islands of American Samoa (Pacific Ocean). By estimating different current and potential values it was hoped that this would assist with the design and implementation of an Integrated Coastal Zone Management strategy.

Approach The study comprised four main data gathering processes: a review of literature; interviews with technical experts on the islands; focus groups with representatives of selected villages; and a willingness-to-pay questionnaire survey targeted at local residents on the main islands of Tutuila and Ofu.

The willingness-to-pay survey attempted to elicit the value that local residents place on maintaining the islands' coral (and mangroves) in terms of both enjoyment from subsistence fishing and non-use value (evaluated based on willingness to contribute money or time subsequently converted to money, based on a standard wage rate). Non-use value for visitors and the US public were based on assumed benefit transfer values (see Table 12.1). Fishery values were based on market and substitute prices, and coastal protection benefits were calculated based on cost savings from delaying the installation and repair of coastal protection structures.

Based on the identification of potential threats and opportunities, total potential benefits (over 25 years) were also evaluated and compared under a business-as-usual (BAU) scenario and an optimum sustainable management (OSM) scenario.

Results The estimated annual coral value was around US$10 million, comprising: subsistence fishery US$650 000; artisanal fishery US$45 000; recreation US$75 000; indirect fishery US$70 000; coast protection US$450 000; resident non-use US$3.6 million; visitor non-use US$215 000; and US public non-use possibly in the order of US$5 million. The breakdown of TEV below shows that non-use value (which includes a strong element of social and cultural value) represents potentially around 88% of overall benefits. The value equates to an average US$0.05 m^{-2} yr^{-1}, but site-specific values were considerably higher (up to US$2.5 m^{-2} yr^{-1}), particularly where the corals are important for fisheries, coastal protection, recreation and their protected area status.



Other key findings were that:

- Ongoing beach mining has resulted in a cost of US$0.5–2.3 million yr^{-1} (i.e. US$90–450 m^{-3} bag of sand/coral rubble) due to the resulting need for man-made coastal protection installations. This excludes the considerable potential lost recreational value.
- There is much scope to enhance and increase capture of fishery, tourism and non-use values.
- An OSM scenario could result in benefits that are five times greater than those of the BAU scenario in 25 years time.

Contributors The project was undertaken by James Spurgeon, Toby Roxburgh and Stefanie O'Gorman of Jacobs, Dr Nick Polunin of the University of Newcastle upon Tyne, Robert Lindley of the Marine Resource Assessment Group (MRAG) and Doug Ramsey of the National Institute of Water and Environmental Management (NIWA). It was conducted for the American Samoa Department of Commerce and Coral Reef Advisory Group (CRAG), and was funded by the US National Oceanic and Atmospheric Administration.

US$5 million including resident and visitor non-use values, and possibly an additional US$5 million (between US$0.5 million and US$100 million or more) for potential US citizen non-use value. The case study reveals that non-use values in this instance could represent at least 88% of the overall value. As such, this suggests that the non-use value of Fig. 12.1 is perhaps a considerable underestimate. An interesting innovation of the American Samoa study was that the different values were mapped out and determined on a spatial basis around the islands using remote sensing and geographical information system (GIS) technology (see Fig. 12.4).

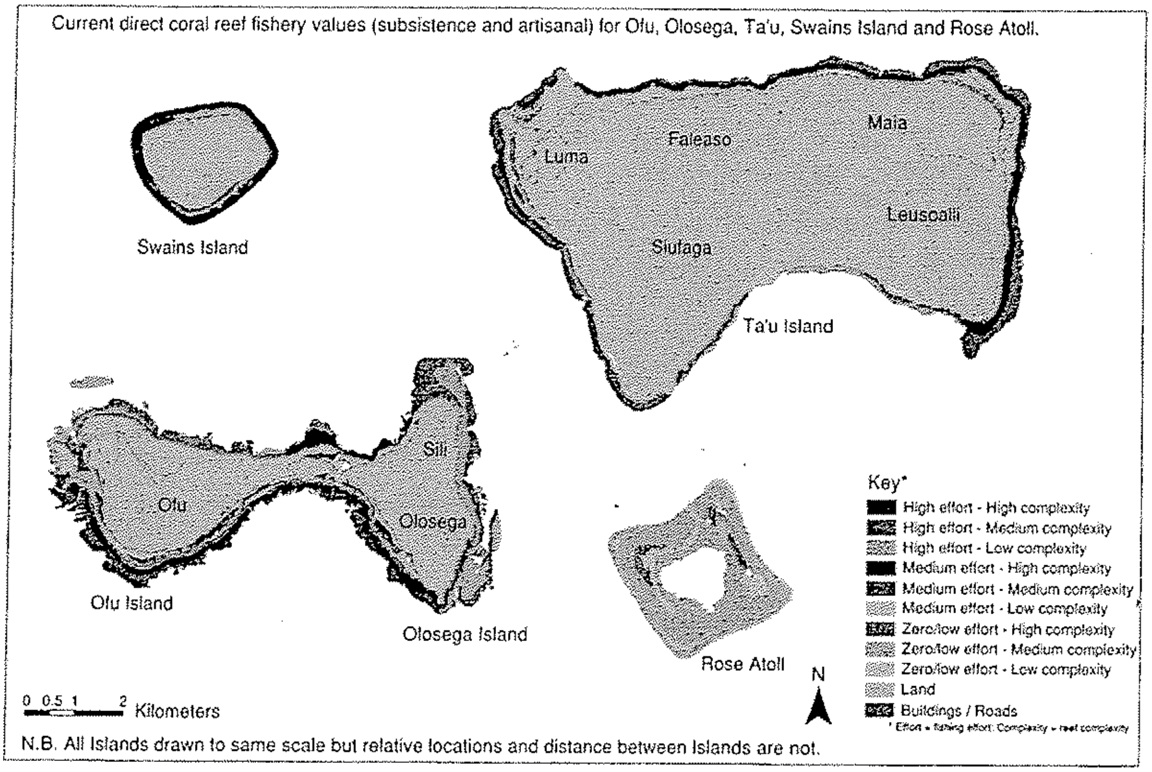


Figure 12.4 Map showing spatial variation in direct use fishery (subsistence and artisanal) values for four islands in American Samoa. (From Spurgeon *et al.*, 2004.) (See also Plate 12.4 in the colour plate section.)

SECOND-GENERATION APPROACHES TO CORAL REEF VALUATION

Comprehensive first-generation neoclassical welfare-based economics approaches encompassing the concept of TEV are still only just becoming relatively mainstream and accepted by decision-makers. However, over the past decade or so, growing concern from a number of academics and think-tanks has arisen, highlighting the fact that neoclassical welfare economics is failing us when it comes to more sustainable and equitable decisions regarding use of the planet's valuable resources. Box 12.4 provides a brief summary of thinking behind the need to evolve from a purely neoclassical approach to resource allocation decision-making, in particular highlighting the advent of ecological economics.

Consequently, a potential second-generation economics-based approach to valuing coral reefs has arisen, although it does not yet appear to have been fully applied. It can best be described as an approach that draws upon and fully integrates a far wider mix of indicators of 'value', as advocated to an extent by ecological economists. Five main categories of such 'values' are outlined and briefly compared in Table 12.2. Note that most existing coral reef valuation studies tend to focus on one category of value, rarely addressing the full range of other value types.

Box 12.4 A summary of thoughts on the need to embrace alternatives to neo-classical welfare economics

In an attempt to move away from neo-classical economics, Costanza (1989) presented what he proclaimed to be a new discipline of 'ecological economics'. It was introduced as a new field that addresses 'the relationships between ecosystems and economic systems in the broadest sense'. He went on to say: 'It will include neoclassical environmental economics and ecological impact studies as subsets, but will also encourage new ways of thinking about linkages between ecological and economic systems.' Later, Costanza *et al.* (1991) suggested an additional interpretation of ecological economics. They stressed the transdisciplinary nature of ecological economics and the fact that it focused more directly on the problems rather than the particular intellectual tools and models used to solve them, thereby ignoring arbitrary intellectual turf boundaries.

Interestingly, Pearce and Barbier (2000) argue that ecological economics is not a new discipline as such, rather a new category of analysis, or synthesis of approaches, where a single discipline approach will not suffice. However, Pearce (2006) does acknowledge five features of ecological economics that distinguish it from environmental economics. These are that ecological economics tend to (1) place greater emphasis on the Earth's 'limits' and regard environmental problems as more serious, (2) reject the substitutability assumption implicit in neoclassical production functions, (3) reject the 'smoothness' of various production functions in neoclassical economics suggesting a preference for quantity-based regulations rather than economic instruments, (4) be more suspicious of discounting future costs and benefits and monetizing environmental damage, and (5) stress the well-known fact in welfare economics that what is economically efficient is not necessarily optimum from the standpoint of a social welfare function.

Far more radical arguments have been put forward by Ekins *et al.* (1993) and Robertson (1999) who state the urgent need for a 'new economics'. Ekins *et al.* (1992) suggest that 'economic progress should be directed to the well-being of people and the earth, and quality of life rather than quantity of consumption and accumulation'. Robertson (1999) promotes the subordination of money-based calculations and values to real-life considerations and ethical and political values.

More recently, Gowdy (2004) claims that welfare economics is undergoing a revolution, as revealed by relatively modern 'experiment-based' economics approaches. He points out that the need for interpersonal comparisons of utility, the requirement to consider the social context of decision-making, and the complexity of human behaviour necessitate a shift from mainstream economic theories and policies towards an empirical science-based approach to environmental policy and sustainability. Getzner *et al.* (2005) also question the appropriateness of a purely monetary orientated welfare-based approach to inform decision-making, and suggest that alternatives such as multi-criteria analysis and 'citizens' juries' should be considered alongside, and in some instances instead of, environmental valuation methods.

More attempts at resource valuation should ideally be second-generation studies that capture the essence of all the categories of value identified in Table 12.2. Unfortunately, this is rarely the case for any natural resource, let alone corals. In part this is due to the complexities involved and the budgetary constraints of adequately quantifying such a broad mix of values; a problem regularly manifested in narrowly scoped terms of reference for such studies. Where different categories of value are considered together, it is essential that they are not all simply added together, because of issues of double-counting and incompatibility. An appropriate format for presenting the results is thus required where different values (e.g. financial, economic and non-monetary) can be displayed together.

Spurgeon *et al.* (2005) provide an example of a study that combines welfare values (recreational consumer surplus and non-use values) with socio-economic impacts (visitor and management expenditures, both direct and knock-on, and associated jobs), as well as integrating other environmental indicators (e.g. extent of ecosystem services, social, cultural, educational, health and research values). The study assessed the economic costs and benefits of protecting 300 areas of conservation value (Natura 2000 sites) in Scotland under the EU Habitats and Birds Directives.

The comparison was made at both a national (for all 300 sites) and local level (12 case study sites). An integrated 'appraisal summary table' reporting format was developed to reveal a broad range of associated costs and benefits and to highlight which stakeholder groups gained the benefits and incurred the costs. It is worth noting that annual non-use values from protecting all 300 sites was US$58 million (51%) for Scottish residents (2.3 million households) and US$54 million (48%) for visitors to Scotland who did not

Table 12.2. Alternative approaches to assessing 'economic-related' values

Approach	Objective	Methods used	Example
Welfare economics (encompassing total economic value)	To guide the optimum allocation of scarce resources between competing uses for the maximization of human welfare	• Environmental valuation techniques • Benefit (value) transfers • Total economic value • Cost–benefit analysis	Spurgeon *et al.* (2004) calculated an annual TEV of around US$10 million for America Samoa based on fishery, recreation, coastal protection and non-use values and compared future TEV under different management scenarios (see Box 12.3).
Economic impact analysis	To assess the contribution to, and/or the effect on, local, regional and national economies (e.g. in terms of expenditures and jobs)	• Input–output models • Expenditure surveys • Value transfers • Multiplier effect	Hazen and Sawyer (2001) estimated that the coral reefs of southeast Florida generate US$4.4 billion worth of local sales and US$2 billion of income, and support 71 300 jobs.
Socio-economic analysis	To understand and quantify the social, cultural, economic and political aspects of individuals, organizations and communities	Qualitative and quantitative: • Focus groups • Surveys • Interviews • Visualization techniques • Stakeholder analysis	Hoon (2003) identified 24 different types of socio-economic benefits from coral reefs on Agatti Island (west of India). She also found that 12% of poor households on the island depended on coral reefs for 100% of their incomes, and 59% of poor households relied on reefs for 70% of their incomes.

Financial analysis	To determine the financial viability and sustainability of enterprises and organizations, by focusing on transaction/market-based costs and benefits	• Budget forecasts • Profit and loss accounts • Cash flow analysis • Balance sheets • Business plans	The Coastal Zone Management Authority and Institute of Belize (2003) undertook a financial analysis to assess financing options for planned marine park and coastal management in Belize. They estimated potential revenues from Belizeans and non-Belizeans of over BZ$5 million and identified a financing gap of BZ$322 000.
Other non-monetary 'value'-based approaches	To highlight the relative importance of biodiversity and other natural and man-made assets and features	Environmental and Social Impact Assessments • Sustainability indicators • Index of captured ecosystem value • Multi-criteria analysis scoring and weighting techniques • Energy-based approaches	Fernandes *et al.* (1999) used multi-criteria analysis to determine the relative importance of various ecological, economic, social and global objectives and indicators amongst different stakeholders for Saba Marine Park. The approach also highlighted the fact that enhanced education and enforcement were commonly agreed by the stakeholders to be the best means of improving upon all four objectives.

visit the sites (17 million), compared to an estimated US$0.85 million (1%) consumer surplus user value for site visitors (2.7 million adult visits per year). These values (at exchange rate UK£1 = US$1.89) were based on fairly rigorous and comprehensive contingent valuation surveys.

First- and second-generation economic instruments

Economic instruments are a means of internalizing environmental values which are otherwise excluded from market prices. Box 12.5 gives a few examples relevant to coral reef management. Synergy (2001), Morris (2002) and Spergel and Moye (2004) provide useful additional information, options and examples. The instruments are considered together here as 'first- and second-generation' because although they are generally based on welfare economics theory, an integrated approach to developing them is likely to enhance their implementation success. Such instruments have a number of potentially important functions, including the control of human behaviour and resource overuse (e.g. through taxes and fees to restrict consumption and use) and raising revenues for management and conservation. However, economic instruments are not without their problems (Panayotou, 1994) and only work effectively under certain conditions and when strategically planned and implemented.

THIRD-GENERATION APPROACHES TO CORAL REEF VALUATION

In order to improve the chances of protecting coral reefs for future generations, we should not only strive to implement a second-generation economics-based approach, but also explore a new 'third-generation' (3G) approach. This approach could be considered as just an extension to the 'ecological economics' approach, whereby certain disciplines, characteristics and objectives are given slightly more emphasis. Key features of a 3G approach would involve focusing on the following:

(1) Incorporating modern and appropriate 'business management' principles and approaches.
(2) Gaining a better understanding of what the values mean and knowing how to make the most of them.
(3) Involving appropriate use of innovation, technology and collaboration.
(4) Accounting more fully for the concepts of quality of life, spirituality, and inter-generational equality.

Box 12.5 Examples of economic instruments relevant to coral reef management

- **User and entrance fees** (e.g. Bonaire and Bunaken Marine Parks)
- **Fines** (e.g. Egypt, USA and Mexico, for coral damage)
- **Licences** (e.g. fishing in USA)
- **Tradable quotas** (e.g. fishing in New Zealand)
- **Concessions** (e.g. tourism in Togean Islands and Komodo Island, Indonesia)
- **Hotel taxes** (e.g. Turks and Caicos Islands)
- **Environmental taxes** (e.g. discharge and carbon taxes)
- **Deposits** (e.g. returning bottles in USA)
- **Socially responsible investment funds** (e.g. Asian Conservation Company, Philippines)

Incorporating business management principles

The proliferation of business schools and the volume of research undertaken around the world to understand and improve how businesses work are staggering. The future management of coral reefs, both within and outside protected areas, cannot afford to ignore this valuable knowledge base. However, the significance of adopting the latest and most appropriate business management techniques is not yet apparent to many within the coral reef management community. Notable exceptions include Jameson *et al.* (2002) and Merckl (2003).

Virtually all management decisions within a business can be explained by this basic strategy formula:

$$\textit{profit} = \textit{quantity} \times \textit{margin}$$

where margin is calculated as selling price minus cost. Businesses generally exist to make a profit, which can primarily be achieved by increasing the quantity of products (units) they sell, increasing the selling price of each unit, or reducing the cost of producing each unit.

With minor modifications this formula can equally be applied to enhancing the management of coral reefs. The formula instead becomes:

$$\textit{benefit} = \textit{quantity} \times \textit{net surplus}$$

where net surplus is the sum of producer surplus, consumer surplus and other benefits

In this case, one seeks to maximize 'welfare benefit' or overall 'surplus' rather than profit. There are two main types of surplus. 'Producer surplus' is the margin or profit made by individuals, businesses and organizations providing products and services (i.e. the selling price less production costs). Consumer surplus is the amount of additional satisfaction (welfare), in terms of enjoyment and quality of life, that people gain over and above what they have to pay (i.e. money) in order to derive pleasure from that good or service (i.e. an individual's maximum willingness to pay less selling price). 'Other benefits' encompass additional benefits that remain elusive to monetary valuation, not least intrinsic value.

Those people and organizations with responsibilities and influence over coral reef health should ideally be seeking to maximize this total welfare benefit accruing to society. This can be achieved by using business-related concepts that seek to 'optimise'(1) the quantity or goods used (e.g. fish caught) or people using a reef (e.g. tourists visiting); (2) the selling price; and (3) the costs of production and management. The overall optimizing approach should generally tend towards an increase in quantity and selling price and a reduction in costs, but to an optimal level that takes into account issues such as sustainable yields, carrying capacity, congestion costs, and the availability of substitute sites, goods and services, etc. As any business would do with such valuable assets, a precautionary approach should also be taken, particularly when setting optimum limits for extractive uses. For example, with respect to coastal tourism development, understanding and managing tourism life cycles and recreational succession (Jobbins, this volume) is essential for optimum and sustainable economic gain.

Interest in business management approaches has begun in the context of marine protected areas (MPAs), a key tool in coral reef conservation and management. However, few MPAs are managed as effectively as they could be, often due to inappropriately trained and inexperienced managers, inadequate funding and severe political and administrative constraints (Wells, this volume). Indeed, Merckl (2003) believes that the lack of an effective network of MPAs is not due to a shortage of funding but due to a lack of capacity in terms of adequate professional and business management skills. The goal of financial self-sufficiency has been much discussed but is generally far from fully realized. However, a business approach forces managers to consider financial viability from the outset and to optimize their approach in the face of intense and growing competition between MPAs for funds and visitors (e.g. Jameson *et al.*, 2002). Merckl (2003) quite rightly proposes the need for a professionally managed, conservation-focused, protected area management company. It will only be through maximizing benefits, capturing a broad range of values and minimizing costs, that MPAs will ultimately be financially sustainable. The challenge is to devise ways to capture the disperse benefits that are so often remote from those who pay the costs.

Numerous approaches and tools from several distinct disciplines within the sphere of business management could be used to significantly enhance coral reef benefits to society, reduce management costs and help reach conservation objectives. Some such approaches are highlighted in Table 12.3. A further explanation of these and many other methods and tools can be found in the following texts: Rosenfield and Wilson (1999), de Wit and Meyer (1999), Drury (2001), Slack *et al.* (2001), Johnson and Scholes (2002) and Kotler *et al.* (2002).

Better understanding of values and making the most of them

A second requirement of the 3G approach is that we need to have a far better and more detailed understanding of different coral reef values. Current coral reef valuation studies merely scratch the surface when it comes to calculating and understanding coral reef values. In particular, we need to grasp fully the potential implications of gaining a more in-depth understanding of people's consumer surplus and non-use values. Much can also be gained from better understanding of the value of other ecosystem functions, as well as pharmaceutical, social, cultural, spiritual, health, educational, and research benefits, to name but a few.

This knowledge will allow us to carry out more accurate and complete valuations of coral reefs and help improve decision-making that affects these ecosystems. In addition, it will enable more appropriate economic instruments and regulatory mechanisms to be developed that help protect corals and raise the vital revenues needed to contribute to their protection.

A better understanding of consumer surplus is particularly needed for benefits gained by fishers and recreational users. We could learn a great deal more about different market segments and the associated differences in levels of willingness to pay for different features. Then, using various methods such as price discrimination, product differentiation, capacity management techniques, business plans and competitor analysis (e.g. of other nearby dive sites and marine parks), actions could be taken to increase overall consumer surplus as well as the amount of money appropriated in ways such as visitor fees or fishing licences, to support site management.

For example, price discrimination can be achieved by providing a range of different prices for visitor entry. Such options include simply setting different rates for foreign and local visitors. However, options could go far beyond this, with a variety of different priced entry packages being offered. For example, alternatively priced packages could allow access to different

Table 12.3. Examples of potential business approaches to help enhance MPA and coral reef benefits and revenues, and reduce associated management costs

Discipline	Methods and tools that could be used
Marketing	• Market segmentation, targeting and positioning • Modifying the marketing mix for services (i.e. product, price, promotion, place/distribution, process, physical evidence and people) • Product differentiation and branding • Competitor analysis
Operations management	• Capacity management • Performance objectives • Total quality management
Organizational behaviour	• Motivational theory • Group dynamics • Change management techniques
Strategy	• PESTLE analysis (i.e. understanding the political, economic, societal, technical, legal and environmental context) • Porter's generic strategies model (i.e. selecting a business strategy based on either cost leadership, differentiation or market focus) • Porter's five forces model (i.e. understanding the competitive forces of supplier and buyer powers, barriers to entry, threat of substitutes, and degree of rivalry) • Porter's value chain (i.e. identifying cost and differentiation opportunities associated with the main business activities of inbound and outbound logistics, operations, marketing and sales, service, procurement, technology development, human resources management and firm infrastructure) • Ansoff's diversification matrix (i.e. identifying options for diversification based on new or existing customers and related or unrelated technologies) • Ashridge mission model (i.e. development of a reinforcing strategy based on defining an ethos and purpose and developing appropriate associated values and actions) • Scenario planning (i.e. developing strategies based on understanding the potential implications of alternative future scenarios)
Financial and management accounting	• Activity-based costing • Cash flow management • Business plans • Budgets/profit and loss

locations (of differing quality and features), or provide different level of information (leaflet, pamphlet, maps and membership options, etc.). Different quality guides, transport and meals could also be offered by parks for groups of different sizes at varying prices. The options are numerous. Much can be learned from terrestrial parks and well-run commercial visitor attractions. Furthermore, advantages available to a fully coordinated international or national network of MPAs could be significant, both in terms of economies of scale and potential marketing and pricing strategies.

Considerable scope also exists for enhancing and appropriating (capturing) non-use values. Unfortunately, non-use value has received much bad press because many people think it is simply too hypothetical and nebulous, and therefore not particularly relevant. However, non-use value becomes increasingly important the more we understand it. It reflects the importance people attach to maintaining coral reefs so that other people can benefit from them, either now or in the future. As such, it can encompass many of the wider social and cultural values humans associate with corals, and can be of significant value.

Non-use values are measured in terms of how much people are willing to contribute (e.g. through money, labour or other means) to ensure that the resource continues to remain in the same (or better) quality and quantity. In a sense, non-use value can be considered in exactly the same way as consumer surplus. However, there is rarely a market to capture this benefit, so virtually all the value usually remains uncaptured outside the market-place. The most common ways of capturing this benefit are through charity collections and subscriptions; user fees, donation boxes and 'friends of. . .' schemes where visitors are informed of the site's ongoing maintenance requirements; and through government tax.

The amounts stated by respondents in willingness-to-pay (or contribute) surveys are likely to represent values that they would pay without complaining if forced to pay, if they felt others were paying and if they thought the contribution was being spent wisely. If users do not have to pay, they generally will not (like consumer surplus). The easier it is for them to pay and the more they are encouraged in an appropriate way, the more likely it is that they would contribute that money (or their time).

Non-use values can be enhanced and appropriated using exactly the same principles and business approaches as for consumer surplus. Some charities have recognized this and are becoming increasingly business-like in their strategy to raise funds. The war to capture non-use values has been raging for a while, and will continue with increasingly sophisticated and daring tactics.

Involving innovation, technology and collaboration

In the same way that businesses are transforming and adjusting to today's rapidly changing global economy, 3G economics-based approaches need to involve appropriately modern solutions. Decision-makers, NGOs, academics and consultants with an interest in managing and protecting coral reefs should be constantly looking towards cost-effective innovative approaches, appropriate technology and broadly but well-targeted collaborations in both undertaking of valuation studies and development of suitable economic and regulatory instruments.

Accounting for spirituality, quality of life and inter-generational equity

A shift has been taking place globally over the past decade or so stressing the significance and resurgence of a more spiritual approach to life, human values and connectivity with the Earth (e.g. Covey, 2004). The 3G economics-based approaches will need increasingly to acknowledge and reflect this reality.

Governments and businesses are already beginning to do this too. For example, the UK government is focusing its policies on how it can build a better 'quality of life' for its citizens (DETR, 1999). Some large companies are now looking at 'ethos'-based strategies to determine how they should best develop, grow and compete in the future (Cummings and Wilson, 2003). Given the high level of spiritual and quality of life connections that many fishing communities have with coral reefs (for example in the Pacific), it is clearly an area that needs careful consideration. Determining how best to deliver inter-generational equality is something that will also become increasingly important. Results from the Millenium Ecosystem Assessment (Reid *et al.*, 2005) showing that two-thirds of the world's ecosystem services are in decline hammer this point home. Building in the concepts of 'sustainability', fully accounting for all environmental values in policy and economic decision-making, and changing individual behaviour patterns are critical steps that must be taken. Dealing appropriately with the problems of using economic 'discount rates' (see Pearce *et al.*, 1989) in decision-making to reflect people's preference for money now also needs resolving.

THIRD-GENERATION ECONOMIC INSTRUMENTS

There is scope for a wide range of novel 3G economic instruments. However, many will simply be variations of current ideas and applications. Hallmarks of 3G economic instruments will include an appropriate blend of sophistication, simplicity, practicality, imagination and boldness.

Possible examples, amongst many others, include:

- A more ambitious and well-thought-out approach to using price discrimination for user fees, for divers, snorkellers, and general park visitors that is cost-effective to administer (e.g. Bonaire Marine Park).
- Applications of carbon tax credits and offsets to corals. Forests and tree-planting schemes are benefiting significantly from the current focus on these carbon-based instruments, and considerable work has been undertaken in looking at seagrasses for sequestering carbon (K. Teleki, pers. comm.). However, not only do corals have a value in helping to store carbon (Emerton, 1998), but also they are one of the most adversely impacted habitats from increased carbon dioxide emissions and global warming (Hughes *et al.*, 2003). They surely deserve some of the increasingly available carbon funds.
- New and innovative ways of ensuring equitable distribution of coral-reef-related revenues amongst local communities, particularly from high-value extractive uses such as bioprospecting, the marine aquarium trade and the live fish trade (see Vincent, this volume).
- Development of approaches to consider and internalize impacts on coral reefs from land-based sources through river basin management initiatives and land-use-based economic instruments.
- Exploring ways in which coral coastal protection services can be internalized, for example through contributions from protected settlements, tourist facilities and other benefiting commercial operations.

CONCLUSION: THE NEXT STEPS

Some important steps associated with economics-based approaches to improve the fate of coral reefs are as follows.

(1) Raise the profile of the importance, value and status of corals and their continuing degradation to all stakeholders, in particular those in influential positions, and highlight what can be done. Carefully and strategically planned educational and awareness campaigns need to be targeted at all levels, including children, local communities, the general public, tourists, reef managers, local government officials and politicians (e.g. see Browning *et al.*, this volume). A far more powerful 'values'-based message needs to be put across. In addition, influential politicians, organizations, corporations and appropriate personalities around the world should be specifically targeted to either add their voice to the plight of coral reefs or to impose changes that will help

protect corals. Key individuals to target would be those known to dive and holiday in coral reef locations, those keeping marine aquaria, and those who could most readily make a difference (e.g. politicians in America and Australia where the Kyoto Agreement has yet to be signed).

(2) Undertake further well-targeted studies to fill gaps in our understanding of coral values, and to explore current and potential applications of economic instruments. Greater levels of funding should be allocated to studies and pilot activities that attempt to demonstrate in the field how economics-based approaches can be used to increase our understanding of the societal values of corals, raise additional revenues for coral management and reduce coral management costs.

(3) Develop and provide appropriate guidance and training in integrated economic-based approaches and relevant business management techniques to coastal managers and relevant decision-makers. There is a need to provide simple, fully integrated and readily available guidance materials and training for coastal managers and relevant decision-makers on the potential for economic and business approaches to be adopted to enhance coral reef protection and management. The guidance and training should complement other international initiatives (e.g. the Global Coral Reef Monitoring Network's *Socio-Economic Manual for Coral Reef Management* (Bunce *et al.*, 2000) and the Conservation Finance Alliance's (2004), *Conservation Finance Guide* and should highlight both current and potential best practice and strategies for implementing effective change.

(4) Seek to better understand and address the root causes of coral degradation, in particular through modification of incentive structures and institutional arrangements. A more coordinated and strategic approach to identifying the most critical root causes of degradation and putting in place an optimum achievable portfolio of local, regional and international measures to address them is required. A key focus should be to analyse current incentive structures (from behavioural and market perspectives associated with both consumers and producers) and determine the necessary behavioural, market and institutional changes required to rectify the problems.

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