12

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

JAMES SPURGEON
Jacobs Babtie, UK

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.
Published by Cambridge University Press. © Zoological Society of London 2006.

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

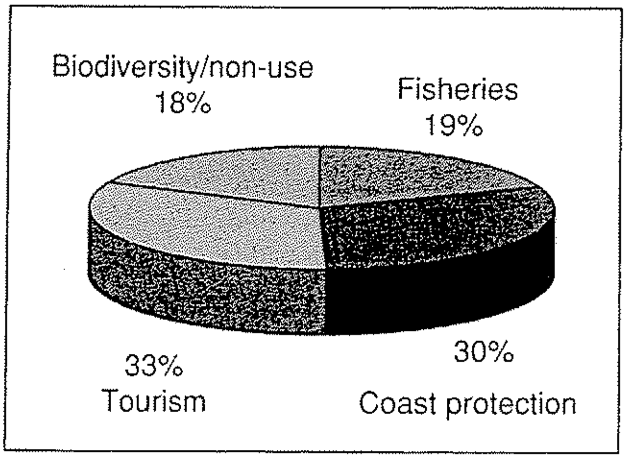


Figure 12.1 Relative contribution of various goods and services to the global value of coral reefs. (Modified from Cesar *et al.*, 2003.)

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

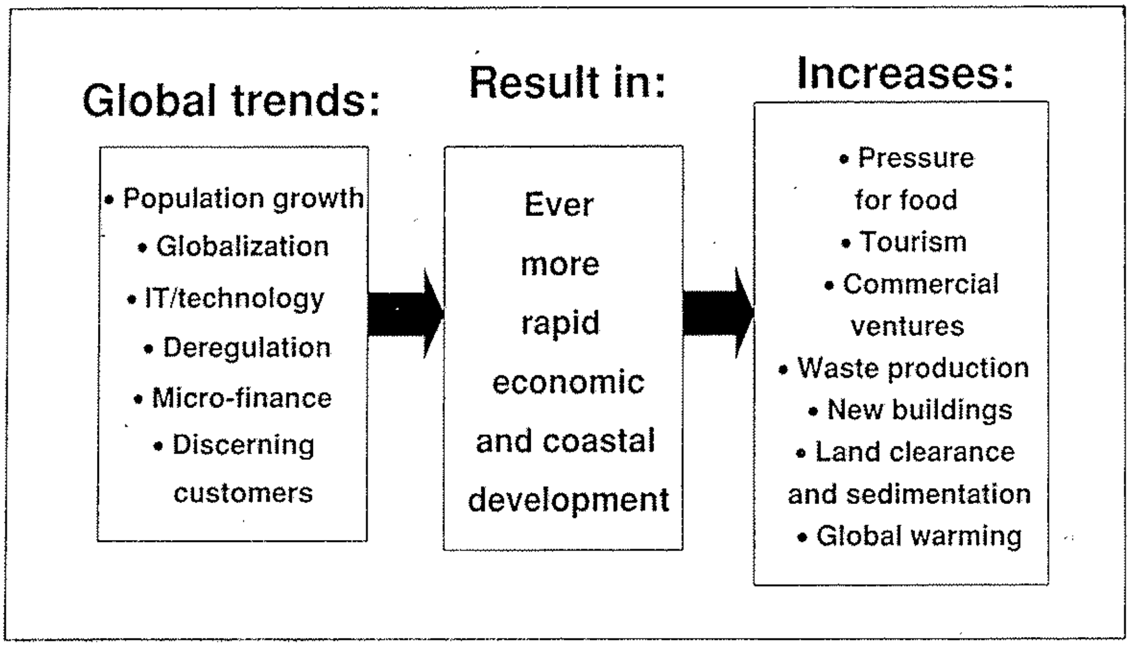


Figure 12.2 Key global trends likely to have adverse effects on coral reefs.

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

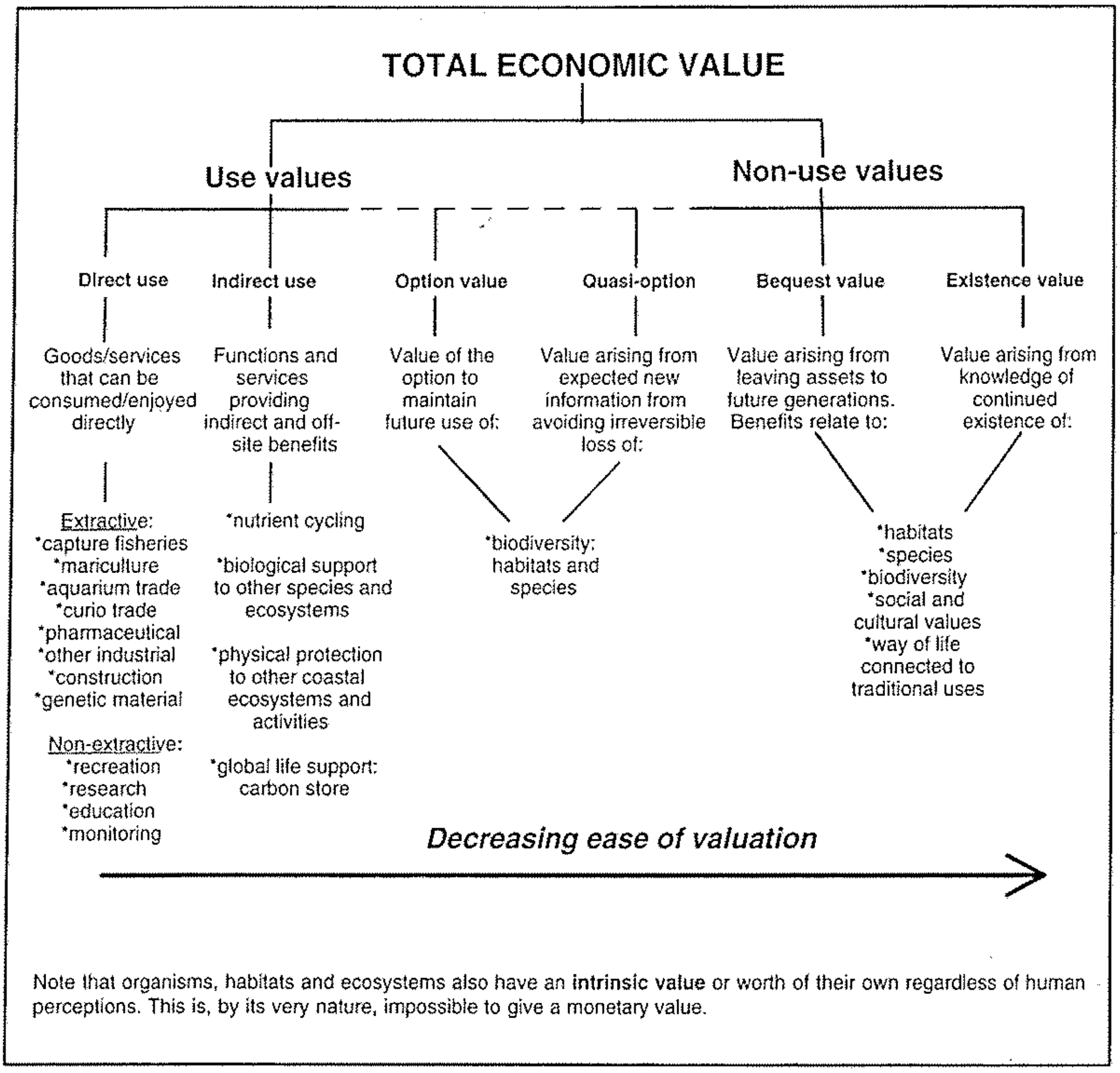


Figure 12.3 The concept of total economic value. (Based on Spurgeon (1992) and Barton (1994).)

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

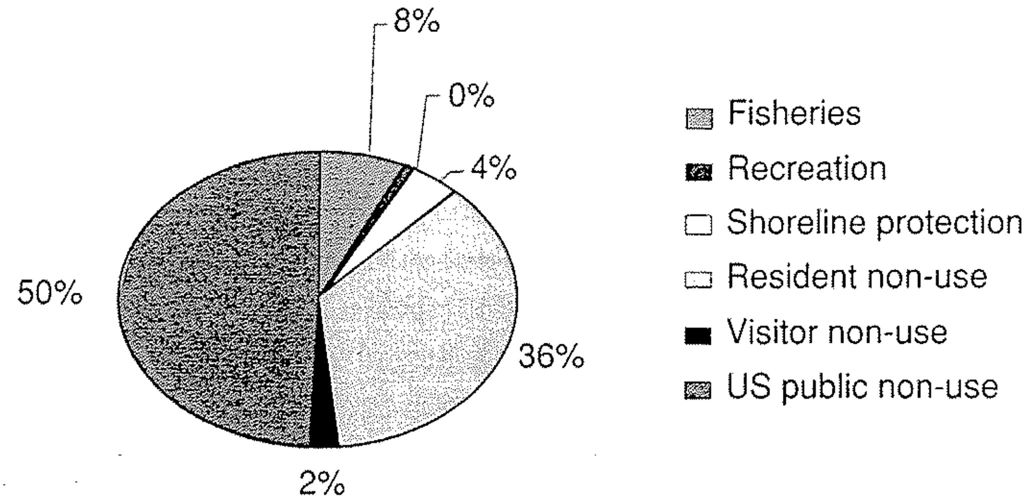
Aim The study aimed to determine the total economic value of coral reefs and mangroves for all five main islands of American Samoa (Pacific Ocean). By estimating different current and potential values it was hoped that this would assist with the design and implementation of an Integrated Coastal Zone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

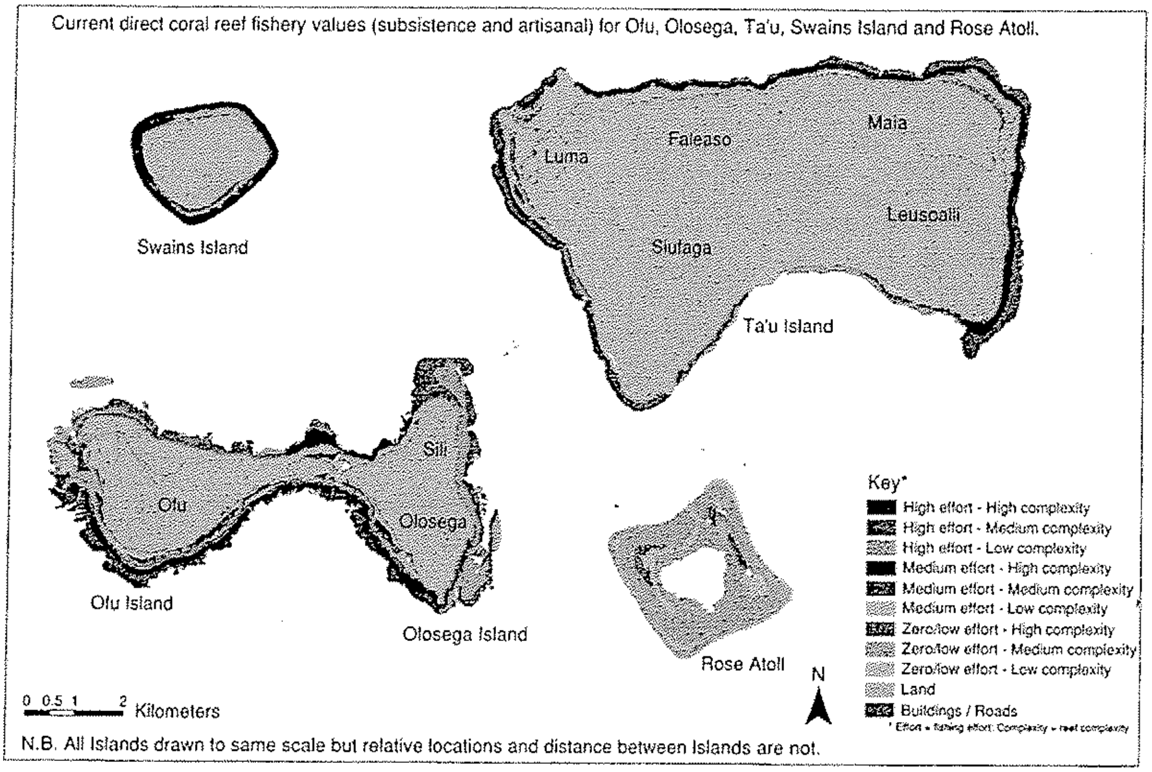


Figure 12.4 Map showing spatial variation in direct use fishery (subsistence and artisanal) values for four islands in American Samoa. (From Spurgeon *et al.*, 2004.) (See also Plate 12.4 in the colour plate section.)

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.