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## METHODS

# Valuing ecosystem goods and services: a new approach using a surrogate market and the combination of a multiple criteria analysis and a Delphi panel to assign weights to the attributes

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### Abstract

A new approach to valuing ecosystem goods and services (EGS) is described which incorporates components of the economic theory of value, the theory of valuation (US ~ appraisal), a multi-model multiple criteria analysis (MCA) of ecosystem attributes, and a Delphi panel of experts to assign weights to the attributes. The total value of ecosystem goods and services in the various tenure categories in the Wet Tropics World Heritage Area (WTWHA) in Australia was found to be in the range AUD\$188 to \$211 million year<sup>-1</sup>, or AUD\$210 to 236 ha<sup>-1</sup> year<sup>-1</sup> across tenures, as at 30 June 2002. Application of the weightings assigned by the Delphi panelists and assessment of the ecological integrity of the various tenure categories resulted in values being derived for individual ecosystem services in the World Heritage Area. Biodiversity and refugia were the two attributes ranked most highly at AUD\$18.6 to \$20.9 million year<sup>-1</sup> and AUD\$16.6 to \$18.2 million year<sup>-1</sup>, respectively.

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### 1. Introduction

Ecosystems are being degraded and destroyed worldwide due to human activities at a rate unprecedented in human history (Daily, 1997; Ponting, 1998). Closed tropical rainforests only occupy 7% of the earth's land surface yet they contain more than half the world's biota. They will mostly disap-

pear or be converted to secondary forests within the next century (Wilson, 1988a). Habitats are being clear-felled, paved over, flooded, ploughed under, rained on with acid, invaded by exotic organisms, overgrazed, and having their climate changed (Ehrlich, 1988). Destruction of forests also causes changes in the hydrological cycle leading to desertification, soil salinity, floods and erosion (Winpenny, 1991). Wholesale eradication of populations and species of organisms have a critical and fundamental impact on the provision of ecosystem goods and services that are essential as planetary life support

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systems, and not only for humans (Nunes and van den Bergh, 2001). The extraordinary variety of life on earth had been imagined through the work of luminaries such as Erwin (1988) and Wilson (1988b, 2002), however, the growth of the study of biological diversity as a field of scientific endeavour is revealing an even greater variety of life-forms and inter-connected evolutionary niches. Ignorance of these interactions and their connotations with respect to nature's services, such as the contribution of soil organisms to atmospheric composition, indicates that humans still lack basic understanding of the contributions made by the natural environment to planetary life support (Beattie and Erlich, 2001). The genetic diversity within species is declining rapidly and it is largely irreplaceable. Protected areas or reserves may no longer be the solution to preserving genetic diversity, as climate change could cause forest migration and desertification and many existing natural populations of wild organisms will no longer be able to survive within their present ranges (Peters, 1988). An alternative would be for human modified areas to be made more environmentally hospitable and a balance maintained between wildlife habitat areas and areas designated for human habitation and food production (Winpenny, 1991). Scheffer et al. (2000: 451) argue that: "good ecosystem models, institutionalised ecosystem valuation, and innovative tax-setting schedules are essential to achieving a socially fair and sustainable use of ecosystems by societies". Ecosystem goods and services (EGS) can only support human life if a well-functioning and rich variety of systems are spread over most of the Earth's surface (Meffe and Carroll, 1997). Impairment of the ability of ecosystems to provide a sustained flow of beneficial services suggests the loss of a valuable resource (Howarth and Farber, 2002). Ecosystem services may be defined as the products of the role that ecological systems play in providing a sustainable environment for life support, such as clean air, clean water, food, habitat and recreational opportunities (Table 1). In this paper, a new method to value the environment will be described. Relying on valuation theory and the property market as a surrogate market, the total value of the Wet Tropics World Heritage Area (WTWHA) in Australia is determined. A multiple

Table 1

Ecosystem attributes used in the multi-model multiple criteria analysis (adapted and modified after Costanza et al., 1997a; Cork and Shelton, 2000)

Group	Type
Stabilisation services	Gas regulation (atmospheric composition)
	Climate regulation (temperature, rainfall)
	Disturbance regulation (ecosystem resilience)
	Water regulation (hydrological cycle)
	Erosion control and soil/sediment retention
	Biological control (populations, pest/disease control)
Regeneration services	Refugia (habitats for resident and transient populations)
	Soil formation
	Nutrient cycling and storage (including carbon sequestration)
	Assimilation of waste and attenuation, detoxification
	Purification (clean water, air)
	Pollination (movement of floral gametes)
Production of goods	Biodiversity
	Water supply (catchment)
	Food production (that sustainable portion of GPP)
	Raw materials (that sustainable portion of GPP, timber, fibre, etc.)
Life fulfilling services	Genetic resources (medicines, scientific and technological resources)
	Recreation opportunities (nature-based tourism)
	Aesthetic, cultural and spiritual (existence values)
	Other non-use values (bequest and quasi option values)

criteria analysis (MCA) combined with a Delphi Inquiry is then used to assign shadow prices to the individual EGS and groups of goods and services provided by the World Heritage Area.

## 2. Background

There is still a fundamental lack of confidence in the outcomes of attempts to value the environment. The seminal paper by Costanza et al. (1997a) published in *Nature* pulled together many social studies of diverse ecosystems to arrive at a gross value for the earth's EGS at US\$33 trillion. Yet despite this notable attempt, ecosystems are still being degraded partly from the want of a simple and practical method to assign values to individual

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