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Analysis

Economic valuation of the influence of invasive alien species on the economy of the Seychelles islands

P. Mwebaze [a,*,1], A. MacLeod [a], D. Tomlinson [a], H. Barois [b], J. Rijpma [b]

[a] Food and Environment Research Agency, Sand Hutton, York, YO41 1LZ, UK
[b] United Nations Development Programme, Seychelles, P.O. Box 310, Victoria, Seychelles

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ABSTRACT

Biodiversity underpins most economic activities in Seychelles, and loss of biodiversity as a result of invasive alien species (IAS) could result in major negative economic impacts for the country. This paper assesses the value of impacts of IAS on biodiversity, natural resources and the national economy, using the principles of total economic value (TEV). The contingent valuation method was used to obtain a willingness to pay (WTP) estimate for a policy to protect important biodiversity from IAS. Tourists indicated a mean WTP of US$52–US $58 on top of their usual expenditures to fund conservation policy. At present approximately US$0.25 million per year is spent on IAS control while the economic damage associated with 4 key IAS is approximately US $21 million per year. Comparing the benefits from eradication with the costs involved gives a benefit-cost ratio greater than unity, indicating that the policy of eradicating IAS is economically justified. However, there is a long way to go before the resources devoted to the problem will be in proportion to the risks.

1. Introduction

Invasive alien species (IAS) are introduced plants, animals and organisms whose establishment and spread threatens ecosystems, habitats and other species (CBD, 2001). IAS cost the Seychelles economy several millions of dollars annually, represent a major threat to the country's unique biological diversity and could have severe negative impacts in the long run if unchecked (Ikin and Dogley, 2005). The potential impacts on global biodiversity are also significant with the islands of Seychelles being part of a 'biodiversity hotspot' (Myers et al., 2000; Mathieu et al., 2003). Additionally, the native biodiversity of Seychelles is one of the most threatened globally. For example, Fregate Island is home to approximately 50% of the world's population of the Seychelles Magpie-Robin (SMR) (*Copsychus sechellarum*), which today is recognised as a critically endangered bird species (Shah, 2001).

IAS primarily gain entry into new geographic areas through human activities, either deliberately or unintentionally (Vitousek *et al.*, 1997; McNeely, 2001; Koo and Mattson, 2004). Economic activity, particularly globalization through trade, is the fundamental human cause of IAS introductions (Perrings *et al.*, 2000, 2002; Pimentel, 2002; Taylor and Irwin, 2004; Koo and Mattson, 2004). It has been argued that the more open economies are, the more vulnerable they are to biological invasions (Dalmazzone, 2000; Vila and Pujadas, 2001; Levine and D'Antonio, 2003). This may be true for Small Island Developing States (SIDS), which are more dependent on imports than continental countries. Dalmazzone (2000) estimated that the average share of imports in the GDP was 43% for island countries compared to 32% for all countries and only 26.8% for continental countries. Island economies also tend to be ecologically more vulnerable to invasions than continental ecosystems (Perrings et al., 2000). The likelihood of invasion by IAS increases as tourism, fisheries, agriculture and forestry become a larger proportion of a countries economy (FAO, 2001).

Over recent decades, the rate of introductions has increased around the world presenting growing environmental and economic threats. IAS are now ranked as the second most serious threat to global biodiversity loss after direct habitat destruction (Pimentel, 2000). However, published figures on the economic costs of IAS are scarce and the few studies available largely focus on the USA. A widely quoted report by the US Congress Office of Technology Assessments (OTA, 1993) estimated monetary costs of about US$5 billion annually. Pimentel et al. (2000, 2002, 2005) revised the OTA estimates and extended the analysis beyond the US context. The second of their papers included estimates for other countries. They calculate that IAS cause damage equal to 53% of agricultural GDP in the US, 31% in the UK and 48% in Australia, but 96%, 78% and 112% of agricultural GDP in South Africa, India and Brazil, respectively. Since these costs represent an externality of trade (and if they are of the correct order of magnitude), they indicate a significant economic problem exists.

Perrings et al. (2002) argue that the primary driver of alien species entry, resulting in some becoming invasive, is economic. Therefore,

* Corresponding author. The Food and Environment Research Agency (FERA), Sand Hutton, York, YO41 1LZ, UK. Tel.: +44 1904462000; fax: +44 1904462111.
E-mail addresses: mpaul48@hotmail.com, paul.mwebaze@anu.edu.au (P. Mwebaze).
[1] Current address: Environmental Economics Research Hub (EERH), Crawford School of Economics and Government, The Australian National University, Canberra, ACT 0200, Australia. Tel.: +61 2 6125 54443; fax: +61 6125 5448.

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any analysis of the process from potential entry to invasiveness must consider the economic infrastructure to provide long-term solutions. Economic analyses of IAS have the potential to aid decision-making and hence the allocation of scarce resources to the management of IAS. Seychelles has taken impressive measures to eradicate IAS from both small islands and large islands, and to restore island ecosystems where costs permit. However, a major constraint is the lack of economic valuation of the impacts of IAS, mainly because the biodiversity impacted upon by IAS are often not valued. Given the very high financial costs of control and eradication measures associated with IAS (e.g. the cost per hectare of removing invasive plants was about US$16,500 in 2004), with impacts only materialising in the long-term, policy makers often do not see the need to manage IAS (Kueffer and Vos, 2004). More significantly, the lack of economic data on the costs and benefits of IAS control constitutes a major constraint for the effective mainstreaming of prevention and control efforts (Ikin and Dogley, 2005).

There are few economic assessments of biodiversity in Seychelles. A preliminary study by Emerton (1997) to calculate the total biodiversity value of Seychelles considered direct and indirect use values in different sectors. A few other papers have used the contingent valuation method (CVM) and travel-cost method (TCM) to estimate the economic value of marine biodiversity in Seychelles (e.g. Mathieu et al., 2003; Cesar et al., 2004). Veríssimo et al. (2009) used the choice experiment (CE) approach to determine attributes that are important for raising funds for conservation. Murray and Henri (2005), taking into account the direct and indirect use values of biodiversity, placed a total approximate biodiversity value of US $0.434 billion in Seychelles in 2003. Taking the GDP in 2003 (US $0.847 billion from IMF) as the numeraire, their estimates indicate that biodiversity accounted for 51% of the GDP in Seychelles. The study concluded that biodiversity underpins most economic activities in Seychelles, and loss of biodiversity as a result of IAS impacts could result in major negative economic impacts for the country.

The aim of this paper is to provide an estimate of the magnitude of the economic costs associated with the management of IAS in Seychelles. The analysis seeks to provide some indication of the costs and benefits of management of IAS in ecologically important islands, and make recommendations for adopting cost-effective measures in policy and regulatory change. Given the short confines of this study, we focus on alien mammal predators (notably rats and feral cats), which have colonised most of the islands of Seychelles (Hill et al., 2000). Within the granitic islands, only four islands were considered cat and rat free before 1995 (Shah, 2001): Cousin, Cousine, Ile aux Récifs and Aride. Alien mammals can impose a range of impacts. For example, rats act as vectors of serious human diseases (especially *Leptospirosis*) that kill several people every year in Seychelles. They are also responsible for the destruction of crops and all sorts of goods, damage to telephone wires, etc. In addition, rats and cats pose a serious threat to island ecosystems: Norway rat (*Rattus norvegicus*) was accidentally introduced to Fregate Island in 1995 (Shah, 2001), and it quickly became established posing a huge threat to the critically endangered SMR.

The remainder of the paper is structured as follows. Section 2 describes the general approach used in the study, methods, criteria for selecting IAS/islands, and data collection. Section 3 starts with general costs associated with all IAS in Seychelles and then focuses on alien mammal predators. The final section gives a multi-species CBA of control and eradication measures, and concludes the paper.

2. Methods

2.1. General Approach

This study followed an approach based upon data availability, surveys, stakeholder consultations, questionnaire surveys and economic modelling. The general approach for the valuation of the influence of IAS in Seychelles involved a five-step procedure:

1. Identify the potential IAS that pose a significant threat to important biodiversity in Seychelles.
2. Assess the costs for managing the potential IAS. We followed the approach in Bigsby et al. (2003) and Born et al. (2005), whereby the costs of IAS depends on the stage of the invasion process. The invasion stages are introduction, establishment, colonisation and invasion, according to Born et al. (2005). The CBD requires a hierarchical application of the following three strategies: (i) prevention (ii) eradication and (iii) control. Prevention is defined as any official procedures having the purpose to prevent the introduction and or spread of IAS (FAO, 2006). Control is defined to include suppression, containment or eradication of a population while eradication is the application of measures to eliminate IAS from an area (CBD, 2001; FAO, 2006). Prevention should take place before introduction, eradication can be applied at all stages (especially establishment), and control aims to keep the population below the economically damaging threshold level (Born et al., 2005). In the analysis, costs were assigned to one of the three management strategies.
3. Assess impacts of the selected IAS. As noted, some of these impacts have non-market values. Such impacts can be quantified by applying a range of valuation techniques (Nunes and Van den Bergh, 2004, pp. 519). However, given the wide range of direct and indirect impacts caused by IAS, we were unable to capture the full spectrum of biodiversity impacts. Based on the ecological literature (e.g. Diamond, 1985; Fitzgerald, 1990; Watson et al., 1992; Amarasekare, 1993; Pimentel et al., 2005) and expert consultation with stakeholders in Seychelles, the study focussed on two species that were considered to be at high risk from alien mammal predators; the SMR and the green sea turtle (*Chelonia mydas*). The literature suggests that both species are highly endemic, threatened and cannot coexist with alien mammals on the same islands (e.g. Shah, 2001; Ikin and Dogley, 2005). These two species and the few islands they occupy became the focus of the valuation exercise.
4. Identify monetary values for the selected biological resources impacted upon by the IAS.
5. Apply our findings in a cost-benefit analysis (CBA) to identify the level at which management of IAS is cost-effective. The CBA followed the framework outlined in Nas (1996) and Boardman et al. (2006). The equation to calculate the benefit-cost ratio (BCR) can be simply written as:

$$BCR = \frac{Avoided\ impacts\ by\ IAS(\$)}{Cost\ of\ IAS\ management(\$)}. \quad (1)$$

In addition to calculating the BCRs, the net social benefits (NSB) in terms of the avoided damage by the IAS were also calculated. In order for the protection or conservation policy to be economically justified, the net benefits of the policy must be greater than zero. Net benefits were calculated using the equation:

$$NSB = \sum_t \sum_i \frac{(B_{it} - C_{it})}{(1+r)^t} \quad (2)$$

where: *NSB* is the Net Social Benefit, *B* is a measure of monetary benefits, *C* represents the monetary cost, *r* is the discount rate, and *t* indexes time. When all the market and non-market costs and benefits are measured in monetary values the aggregation is straightforward: the discounted value of the total costs over time is subtracted from the total benefits also discounted over time. If the $NSB \geq 0$ (benefits exceed costs), it indicates that the protection policy is economically justified. But if the$NSB \leq 0$, (costs are larger than benefits) then protection program is not economically justified, unless there are strong non-monetised benefits to consider.