ENVIRONMENTAL SCIENCE & POLICY 39 (2014) 65–76

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/envsci

Cost–benefit analysis of managing the invasive African tulip tree (*Spathodea campanulata*) in the Pacific

P. Brown, A. Daigneault [*,1]

Landcare Research, New Zealand

ARTICLE INFO

Article history:
Received 6 January 2014
Received in revised form
13 February 2014
Accepted 16 February 2014
Available online 22 March 2014

Keywords:
Invasive alien species
Cost–benefit analysis
Non-market valuation
Spathodea

ABSTRACT

Invasive alien species such as *Spathodea campanulata* (African tulip tree) threaten biodiversity in the Pacific islands as well as the economic, social, and cultural wellbeing of Pacific peoples. Despite the potential magnitude of these threats, our scientific understanding of the ecology and management of the African tulip tree is nascent. In this paper, we use data from novel surveys of households and communities to document the direct and direct impacts of African tulip tree in Fiji, focusing on those impacts which may be monetised. We use the same data to describe current management approaches and then describe a state-of-the-science, ''integrated'' management approach that employs different strategies for trees of different ages and sizes. These two approaches are then compared in a comprehensive cost–benefit analysis. We find strong arguments for pursuing the integrated management approach, which derives *monetised* benefits of $3.7 for each $1 spent. However, the less costly current approach is also strictly preferred to the baseline, ''do nothing'' approach, with monetised benefits of $2.7 for each $1 spent. Results of this analysis clearly show that managing African tulip tree is cost effective, even without explicitly considering biodiversity, culture, and other non-monetised benefits of control.

© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

Natural resources are critical to Pacific Island economies. At a regional level, the Pacific is among the most productive fishing grounds in the world (Seidl and Lal, 2010). At the national level, primary industries such as agriculture, fishing, and forestry constitute as much as 25% of GDP in Kiribati and 33% of GDP in the Solomon Islands (Pacific Regional Statistics, 2013), and natural resources dominate the manufacturing and processing sectors across the region.

Natural resources are also fundamental to social development in the Pacific, supporting national identity and culture. For example, the word for ''land'' in New Zealand Māori (*whenua*) is the same as that for ''placenta'', and the word for ''land'' in both Tuvaluan (*fenua*) and Fijian (*vanua*) refers to the land itself, to the people living on the land, and to the customs and value systems of those people.

Unfortunately, natural resources in the Pacific are under threat from pests and invasive alien species (IAS), which pressure agriculture, livestock, fisheries, and forests, and thus the economic, social, and cultural wellbeing of Pacific peoples. Given the magnitude of the potential problems caused or exacerbated by IAS, it is notable that data pertaining to their

* *Corresponding author*. Tel.: +64 3 321 9809

[1] Brown and Daigneault co-led the data collection, analysis, and write-up of this project. Following convention in the economics discipline, the authors are listed alphabetically.

http://dx.doi.org/10.1016/j.envsci.2014.02.004
1462-9011/© 2014 Elsevier Ltd. All rights reserved.

biological characteristics, the damages that they cause, and the effectiveness of management options is so scarce.

For example, despite the fact that *Spathodea campanulata* (African tulip tree) is considered to be among the 100 worst IAS by the International Union for the Conservation of Nature (Lowe et al., 2004), there are relatively few articles in the scientific literature that document its establishment and spread, its biological characteristics, or options for effective management, particularly in the Pacific. While local knowledge for managing the African tulip tree is abundant, this knowledge has not been harnessed, and there is little consensus on the physical effectiveness of various management strategies, even between neighbouring communities.

If the natural science literature on the African tulip tree is sparse, studies that describe the ecological, economic, social, and cultural impacts of this species in the Pacific are virtually non-existent. The costs of management are also poorly quantified, and as such, governments in the Pacific have done little to control its spread, putting livelihoods at risk and leaving individuals responsible for management.

Yet, evidence demonstrates that IAS may be managed and that their impacts may be avoided through prevention, eliminated through eradication, or reduced through control (Veitch et al., 2011). Quantifying the threat posed by African tulip trees, documenting practices for controlling the species, and understanding the costs and benefits of various management options could thus help decision makers to understand the threat posed by African tulip tree and to make more informed policies for managing this species.

Combining primary-source data collected via matched household and community surveys with expertise on the biology and ecology of African tulip tree, we quantify the monetisable costs and benefits of various management regimes in Viti Levu, Fiji, where this IAS is well established in farmed fields and on other disturbed lands (Auld and Nagatalevu-Seniloli, 2003). While multi-decision criteria analysis has recently been advocated for selecting among competing options in managing IAS (e.g., Born et al., 2005), few economic studies have adopted this approach. Accordingly, in this analysis, we employ cost–benefit analysis (CBA) – which is noted for its tractability, methodological transparency, and wide adoption among governments and makers of environmental policy (Pearce et al., 2006) – to rank management options.

The remainder of this paper is organised as follows: Section 2 describes the ecology of the African tulip tree; Section 3 summarises the use of CBA in the IAS literature; Sections 4 and 5 describe the survey research methods and results, respectively; Sections 6 and 7 present our approach to CBA and the results, respectively; and Section 8 concludes.

2. Ecology of the African tulip tree

In 1936, the African tulip tree was introduced as an ornamental plant to Fiji, where it thrived in gardens due to its preference for moist soils in sheltered tropical areas in elevations up to 1200 m (Smith, 1985; PIER, 2002). Its invasive characteristics, wind-blown seed, and vegetative propagation allowed the African tulip tree to escape quickly (World Agroforestry Database, 2014), and it now dominates disturbed lands – including agricultural areas and forest plantations as well as natural ecosystems. Mature stands typically contain up to 4000 plants per hectare (Francis, 1990), and stands of 12,000 plants per hectare have been recorded.

Mature African tulip trees, which have buttressed trunks and thick branches, grow to heights of 25 m or more. Native plants are eliminated by the shading effect of the large leaves, resulting in reduced biodiversity under the tree canopies (Weber, 2003).

Showy red flowers produce capsules containing tiny winged seeds that are dispersed by air, with mature trees producing thousands of seeds each season. Although the viability of seeds deteriorates quickly in Fiji's humid climate (World Agroforestry Database, 2014), seeds have been recorded as having viability rates of up to 80% (Fosberg et al., 1979), with higher germination rates in semi-shaded and highly disturbed areas such as farms and forest edges (Weber, 2003). Reproduction also occurs via suckering and via new growth from stem or trunk sections that have prolonged contact with soil (Space et al., 2004). Regrowth is especially vigorous from any trees cut at stump level and not treated with suitable herbicide.

The population of African tulip tree follows a logistical biological growth curve until it reaches a carrying capacity of about 4000 trees per hectare approximately 40 years after establishment (Lugo and Helmer, 2004). Half of the total carrying capacity is reached 20–25 years after forest establishment (Lugo and Helmer, 2004), indicating a population growth parameter of 0.18 (Daigneault and Brown, 2013). That is,

$$N_{t+1} = N_t + 0.18\left(1 - \frac{N_t}{4000}\right), \quad (1)$$

where N is the number of stems per hectare and t is the time period measured in years. The African tulip tree is notoriously difficult to control, although seedlings and small trees may be successfully pulled or dug out (Englberger, 2009). For larger trees and stumps, Englberger, 2009 suggests spraying glyphosate into 1-inch notches cut into the cambium while Motooka et al., 2003 suggests applying 2,4-D and triclopyr to basal bark of saplings. Traditional methods for controlling African tulip trees diverge considerably from these recommendations, as detailed in Section 5, and regrowth from the cut stumps, roots, and any plant material left in contact with the ground is pervasive.

Given the difficulty and expense of management, some farmers in the Pacific resort to clearing additional areas of natural forest and bush. While this solves the problem of encroaching trees in the short term, this practice ultimately provides additional disturbed land that the African tulip tree may colonise.

3. Cost–benefit analyses of managing invasive alien species

While we are unaware of existing studies that undertake rigorous economic analyses of managing African tulip tree in the Pacific or elsewhere, there exists a nascent literature on

Download English Version:

https://daneshyari.com/en/article/7467836

Download Persian Version:

https://daneshyari.com/article/7467836

Daneshyari.com