Biological control for invasive tree species

M. Kay*

ABSTRACT

The possibility of biological control of invasive forest tree species is presented as an efficacious and commercially advantageous method for the forest industry to take responsibility for capricious regeneration. Seed-destroying agents have been utilised successfully in the past to resolve conflicts of interest in the containment of beneficial plant species.

INTRODUCTION

New Zealand has a long history of introducing alien biota to 'enrich' or replace the endemic flora and fauna in an effort to develop a primary resource base for the economy. The wanton conversion of the indigenous forest to exotic grasslands for agriculture later necessitated some form of reafforestation, and the planting of fast-growing exotic forest species, initially for shelter and small woodlots, began about 1860. Although foresters cannot be held responsible for all forest tree introductions, small-scale plantings by the State between 1890 and 1922 preceded a planting boom in the 1920s and 30s, by both State and private forestry concerns, when areas of some 100 species, mostly conifers, were established (Weston 1957). Most exotic plantation species were primarily selected for viability, growth, and form. Little thought was given then, as now, to the potential invasiveness of exotic tree species. Their rapid growth rates and release from their usual competitors and herbivores provided a competitive ability to outperform or displace indigenous species in some habitats.

Invasive Species

Typically, small seeded conifers are pioneers, with natural regeneration common on exposed mineral soils (Grime 1981). In some areas of New Zealand, particularly those not subject to intensive land management, and adjacent to exotic production or protection plantations, the invasiveness of some species soon became apparent. Larch, Douglas fir, and various pine species, including *Pinus radiata*, are now seen as a threat to the uniqueness of South Island high country, National Parks and recreational areas (Hunter and Douglas 1984, Ledgard 1988). The precocious *P. contorta*, which is a potentially valuable tree in both production and protection montane plantations, has been declared a noxious weed in some counties.

Acacias are common ornamental species in New Zealand and represent a small 'alternative' hardwood resource. A number of acacia species have also acquired the status of weeds in New Zealand and other parts of the world (New 1984). Although some species utilise vegetative propagation, most rely on soil-stored seeds which remain viable for a considerable period. *Acacia melanoxylon, A. dealbata* and *A. mearnsii* all have a viable soil-stored seed-life of over 50 years and have the potential to become as persistent as gorse (*Ulex europaeus*) in the New Zealand landscape.

Current Costs of Control

The need for wilding tree species control usually arises from aesthetic ideals, as on Mt Tarawera; compliance with local or national legislation – the Department of Conservation DOC estate; or conflicting land management goals – the Ministry of Defence in the central North Island and the South Island high-country runholders. Some costs in the control of wilding conifers have been documented and similar costs could be expected for other forest species.

The recurrent cost of controlling wilding conifers for the afforestation option for sustainable land use in the South Island high country was put at $1.50/ha/ann (Belton 1991). Present control costs in the area are not documented but may be considered as management constraints (Gibson 1988). In smaller recreational areas control is often achieved with volunteer labour, with little direct cost tabulation. Organisational costs to DOC for such operations on Mt Tarawera amount to $122/ha (Pascoe pers. comm.).

Within commercial plantations releasing *P. radiata* from acacias is already practised in coastal Bay of Plenty, Northland and Canterbury, and natural regeneration of *P. radiata* may, in future, be seen as a threat to the identification, for management purposes, of genetically improved material.

The Potential of Biological Control

Seed production is the predominant means of natural regeneration and dispersal for the invasive tree species in New Zealand. Harper (1977) states that the probability of range expansion for seed-dispersing species is a function of dispersibility and seed production. In New Zealand the invasiveness of conifers appears inversely related to the terminal velocity of free-falling seed (Ledgard and Crozier 1990). Biological control programmes utilising seed-destroying insects have been used to resolve conflicts of interest in the control of invasive economic crops (Neser and Kluge 1986, Zimmerman 1991). Seed, or cone and flower destruction would appear to be an attractive way of restricting exotic species to the sites on which they were planted while still achieving the economic benefits of the exercise.

***Acacia mearnsii* adventive, Rotoehu S.F. Photo: H. Hemming**

* *Nod Kay. Scientist. Forest Research Institute, Private Bag 3020, Rotorua.*

Host-specific, seed-destroying agents, e.g. insects attacking any stage of seed production, from flower primordia onwards, have been recorded for our exotic species in their native habitats. These agents are capable of inflicting significant seed losses (Dewey & Jenkins 1980, Hedlin *et al.* 1980, de Groot 1986a, 1986b) and management systems have been developed for their control (Hoy and Haverty 1988). Imported into New Zealand without their natural predators and parasitoids, these agents should be able to realise their reproductive potential and be capable of inflicting even greater seed destruction than in their native range and may overcome host defence strategies such as irregular flower production.

(Interestingly, the only exotic conifer seed predator accidentally introduced into New Zealand is *Megastigmus spermotrophus* on Douglas fir. This chalcid is one of a complex of seed insects occurring in the natural range of Douglas fir. It has been little studied in New Zealand but is considered an important cause of seed loss only in years of low seed production (Bain 1977). It was, nonetheless, considered worth controlling and the pteromalid *Mesopolobus spermotrophus*, an ectoparasite of *Megastigmus* larvae, was released in 1955. The parasitoid, however, has not been recovered from release sites and is not considered established (Nuttall 1989)).

Given the sophistication of New Zealand plantation forestry in utilising propagules from seed orchards, cuttings, and possibly tissue culture and 'somatic embryogenesis' in the future, the destruction of seed resulting from indiscriminate pollination could be seen as a valuable adjunct to wilding control.

Seed orchards for valuable commercial species are already the major source of genetically improved material, and orchards can be established at any time for any desirable species, to accommodate changes in fashion which befall commercial enterprises. These orchards are discreet plantings isolated from plantations to maintain the genetic integrity of pollination. Their isolation would provide a degree of escape from seed predators, and the proven control measures available for flower and seed insects could be easily integrated into the management of such orchards. Control methods may include prescribed burning (Miller 1978), 'environmental architecture' (Prevost 1990), pheromone trapping or mating disruption (Grant 1990), or the use of insecticides (Fogal and Plowman 1989).

With a successful biocontrol programme in plantation forests, orchard managers would control the quantity and quality of seed for future plantings. Seedlings grown from genetically improved seed within plantations would not be competing with natural regeneration and silviculturists would be spared the harrowing task of selecting improved from unimproved seedlings in the field.

CONCLUSION

The lack of seed predation may well be responsible for the rate of invasiveness of exotic plantation species in New Zealand. Seed predation by introduced organisms could lessen the spread of these species and may be the only acceptable method of control in environmentally sensitive areas. Biocontrol systems using host-specific, seed-destroying insects have been used elsewhere with success when conflicts of interest have arisen in the control of potentially valuable plant species. A possible conflict of interest with the fledging pine nut industry in New Zealand could be avoided by utilising host-specific agents.

By embracing a biocontrol solution for wilding pines and other exotics, the forest industry would be seen to be taking a responsible attitude to a problem it has ignored to date, while possibly gaining commercial advantages. Control of seed production would obviously be commercially advantageous to owners of propagative enterprises, such as seed orchards, and may minimise the industry's own losses to wilding competition. The quality of the future forest estate could be more rapidly upgraded and respectability could be restored to some potentially useful species.

***Pinus contorta* invading *Dracophyllum* shrubland, Rangitaiki S.F. Photo: C. Ecroyd**

As seed of most plant species can be brought into New Zealand without the constraints associated with faunal imports, some thought should be given to the invasiveness of future selections of forest tree species.

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INSTITUTE NEWS

President's comments

Resource management and the environment

The current concerns about resource management and planning have led to a rather undue, overdone and almost hypocritical fervour for the environment and "sustainability". Our profession has expressed, over the years, the ethic of stewardship in this respect. In many quarters there has been an expression of surprise and hurt that the populace in general does not appreciate that this ethic rules foresters' behaviour. The indigenous forest debate has been an example of this reaction with an associated defensive attitude to our involvement in management. Too often the actions of a few are made the basis for discussion more characterised by heat than informed debate.

At a recent Resource Management Law Association conference there was surprise expressed at the thought that there are between 600,000 and 1,000,000 more hectares of indigenous forest in New Zealand since the cessation of the Land Development Encouragement Loan scheme in 1985. As part of this reversion process, hill-country pastoral farming is characterised by a quiet forest increase through the process of fern, scrub and secondary hardwood forest growth.

This phenomenon is historically well understood in older societies' although

Peter Olsen

Americans are surprised to be told that there is now more forest in the Eastern USA than 130 years ago, due to natural forest reclaiming pasture and cotton lands. Any environment where a forest is the natural climax vegetation will be characterised by this phenomenon and New Zealand is a classic example for over 90% of the land used for farming.

Therefore woe betide a planning process which seeks to set in stone the characteristics of the current landscape and ignores the dynamics of the natural environment and the economic frailty of processes of change to pastoral, horticultural, or other land uses.

It was pleasing at the above conference to note Minister for the Environment Simon Upton's remarks, as the keynote speaker, wherein the Resource Management Act was expected to yield sustainable land use for the economic benefit of people. It is unusual to have a Minister of the Crown speak on such a complex subject in as erudite a manner as he did before some 200 lawyers and planners.

It is in this context that the Council encourages the formation of an Environment Working Group under Tim Thorpe as an additional capacity to that involved on Indigenous Forest under Dave Field. We need to have good sources of data from which to draw conclusions as to the profession's view on these topics and to join the debate from a platform of informed and dispassionate knowledge.

I look forward to results being as useful as those from the recent Forest Valuation working group in the draft Forest Valuation Guidelines.

Peter Olsen