IMPROVING BORDER BIOSECURITY: POTENTIAL ECONOMIC BENEFITS TO NEW ZEALAND

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ABSTRACT

The number of alien species becoming established in New Zealand is steadily increasing. Assuming no improvements to New Zealand's border biosecurity systems, it is conservatively estimated that Biosecurity New Zealand will have to deal with more than 542 potential pest incursions, and 512 phytophagous species becoming permanently established from 2005 to 2017. These additional established pest organisms will cost the economy about NZ$921 million in direct impacts and on-going control costs. Assuming the rate at which unwanted new organisms are intercepted at the border is improved in 1% increments from 2007 leading to a total 10% improvement by 2017, Biosecurity New Zealand's total expenditure in responding to new incursions would be reduced by approximately NZ$16 million. If improved surveillance and eradication reduced the number of new pests that become permanently established over the same period by 15.5%, approximately NZ$96 million in direct pest impacts and mitigation measures would be saved.

Keywords: biological incursions, insect pests, economics.

INTRODUCTION

Invasive alien species are attracting increasing attention worldwide as the costs of restricting their movement across national and geographic borders escalate along with the costs of their eradication and control (Pimentel et al. 2000; Simberloff 2004). Pimentel et al. (2001) estimated that >120 000 species of alien plants animals and microbes had invaded Australia, Brazil, India, South Africa, the United States of America and the United Kingdom, and the management costs for these invasive alien species totalled US$314 billion annually (unless indicated otherwise, all dollar values quoted in this paper are in New Zealand dollars). This estimate did not include less quantifiable impacts from invasive alien species, such as modification of disturbance regimes that have been frequently shown to affect ecosystem services and ecological integrity (Mack & D'Antonio 1998).

In New Zealand, the number of incursions detected per year is steadily climbing. During 1990, the then Ministry of Agriculture and Fisheries (now Biosecurity New Zealand, BNZ) detected three new potential incursions, while in 2003 it detected over 30, and over this 14 year interval, a total of 212 separate incursions was detected (Wilson et al. 2004). The reasons for this steady increase in species detections are likely to be confounded between improved surveillance and diagnostic methods, as well as increases in trade and travel. The costs associated with each of these incursions varied widely depending on each organism's subsequent pest status, and on whether eradication was attempted. However, New Zealand's phytophagous insect pests have together been estimated to cost $880 million per year (Barlow & Goldson 2002).

The immense scale and complexity of the invasive species problem, along with difficulties in quantifying non-economic, ecological impacts of pests, create thorny prioritisation issues for policy makers, operational biosecurity agencies and research providers. For example, it is unclear how operational and research resources should be optimally divided between BNZ's pre clearance, post clearance and incursion response activities. Similarly, the ideal balance between efforts to exclude new pests from New Zealand and attempts to manage permanently established pests is also difficult to define. From the narrower perspective of scientists seeking financial support from industry and Government for biosecurity-related research, there is a clear need to develop a robust, conceptual framework for estimating potential returns from various research investments.

The present paper makes a small contribution primarily to this latter issue by presenting a simple model for quantifying the economic benefits that would arise from the implementation of a range of hypothetical, new measures for preventing additional, unwanted organisms from establishing in New Zealand. This paper assesses the likely costs of new incursions from terrestrial pests, and explores the potential economic benefits of reducing the rates at which new invaders (i) cross the border (through improved exclusion and interception); and (ii) become established (through improved surveillance and eradication). The research investment required to achieve these improvements is discussed in relation to the estimated economic benefits.

METHODS

Two different measures of the direct, economic costs of biosecurity breaches were developed. The first measure involved using BNZ data on its expenditure on responding to a range of recently discovered, unwanted new organisms to estimate an average BNZ response cost per unwanted new organism. The second measure involved using published estimates both of the cost of pests to the New Zealand economy, and of the number of unintentionally introduced species in this country, to estimate the average cost of each unwanted organism which has become permanently established in New Zealand. No attempt was made to quantify non economic, ecological pest impacts, although these are clearly also very significant.

Future rates of establishment of new pests were predicted by linear extrapolation from BNZ data on new, unwanted, organisms detected in New Zealand between 1990 and 2003, which excluded weeds and forestry pests. The 1990-2003 data of Wilson et al. (2004) have been supplemented with data for 2004, and a linear regression has been used to extrapolate these data from 2004 until 2017 (Fig. 1). These data included pest organisms that became established and were subsequently eradicated, as well as those that became permanently established.

A simple spreadsheet model was developed which used the estimates described above to quantify the economic benefits that would arise from a range of hypothetical improvements to New Zealand's border biosecurity systems.

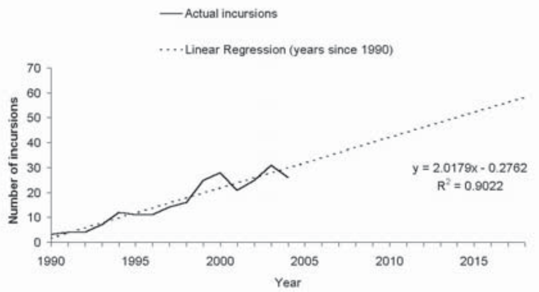

FIGURE 1: Linear extrapolation of the annual number of new to New Zealand incursions taken from Wilson et al. (2004) and supplemented with figures for 2004 from BNZ (J.A. Wilson, unpubl. data).

RESULTS

BNZ response cost per new organism detected

Based on data from incursions that have been detected over the last decade, 97% of newly detected organisms have been determined by BNZ to either present only minor risks to New Zealand's economy and environment, to be too widely established to warrant further action, or to be endemic species that are new to science. In such cases, BNZ responses cost an average of $50,000 each, though it is frequently less than this figure (J.A. Wilson, unpubl. data). In contrast, unwanted new organisms that have presented greater risks and have warranted much greater expenditure have been discovered approximately once every two years during the last decade. Examples include incursions by white spotted tussock moth, painted apple moth and Varroa bee mite which have each cost $8–$50 million. On average, BNZ expenditure in such cases was $16.5 million. Assuming 97% of newly discovered pest organisms cost BNZ $50,000, and 3% cost $16.5 million, the weighted average BNZ response cost per new unwanted organism is $540,000.

Average cost to New Zealand of each pest organism that becomes established

The limited information available on this topic meant this estimate could be based only on data for phytophagous insects. Barlow & Goldson (2002) estimated the total cost associated with all phytophagous insect pests in New Zealand as $880 million per annum, while Emberson (2000) estimated that 2600 exotic invertebrate species were present in New Zealand. Using these two figures, the average cost of controlling each invertebrate pest was estimated as $338,000 per species per year. Since some New Zealand endemic species such as grass grub, leaf rollers and porina are also pests, this was rounded down to $300,000 per exotic species per year.

Predicted future costs of new, permanently established pests

Around 5% of newly identified pest species are practically eradicable (B.P. Stephenson, pers. comm.). The cumulative total number of new species expected to become established if the proportion of newly detected species that is eradicable is assumed to be 5% is shown by the upper solid (black) line in Figure 2. Under this scenario, a total of 514 unwanted species apart from weeds will become permanently established in New Zealand between 2005 and 2017 (Fig. 2). Using the estimated annual cost of permanently established pests of $300,000 per exotic species, the total accumulated cost of the 514 exotic species predicted to become established in New Zealand between 2005 and 2017 will be NZ$921 million**.**

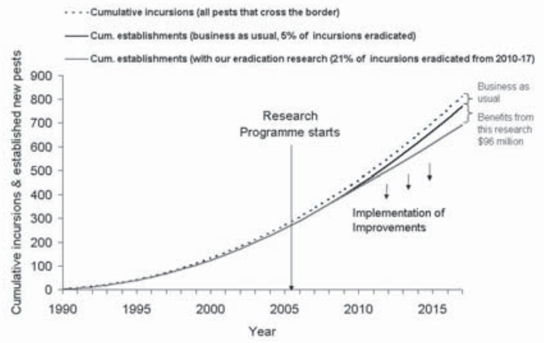

FIGURE 2: Historical and projected linear extrapolation from 1990-2003 BNZ data of Wilson et al. (2004) plus 2004 updates, comparing cumulative totals of new incursions (upper dotted line) with (i) established new species in New Zealand assuming a 5% eradication rate (upper, solid, black line) and (ii) established new species in scenario with conservative improvements to New Zealand's biosecurity systems from this research (lower, solid, grey line).

Economic benefits arising from a range of hypothetical improvements to New Zealand's biosecurity systems

A simple model was used to quantify the overall economic benefits that would arise from the staggered implementation of a range of small, hypothetical improvements to New Zealand's biosecurity systems. For the purpose of illustration, just one plausible scenario is described here, and it involves the following hypothetical improvements:

- The establishment rate of pest organisms is reduced by 1% in 2007, and thereafter it is reduced by additional annual 1% increments, leading eventually to an overall reduction of 10% in 2017. This improvement might arise, for example, from the gradual implementation of a range of technologies which increases border interceptions of pest organisms associated with imported goods, incoming mail and passenger arrivals.
- Pest establishment rates are reduced by 10% in 2010 due, for example, to the implementation of a nationwide surveillance system that monitors for a wider range of high-risk taxa than currently occurs. Improved surveillance might increase eradication rates because newly established populations should be more frequently detected while they are small enough to be eradicated.
- Pest establishment rates are reduced by a further 5% in 2012 due, for example, to the implementation of a new eradication technology.

The combined effects of these improvements are shown by the lower (grey) line in Figure 2. During 2005-2017, their combined effects would be:

- To reduce the number of incursions requiring a BNZ response from 542 to 512 species. This would reduce BNZ's incursion response costs by $16 million.
- To reduce the total number of pest organisms that becomes permanently established in New Zealand from 514 (assuming 5% eradication rate) to 436 species. This would reduce New Zealand's pest management costs by a cumulative total of $96.2 million.

Therefore, the plausible scenario described above could return a total of more than $112 million to the New Zealand economy by 2017. The possible costs of achieving such improvements are discussed below.

DISCUSSION

The estimates used in this analysis are probably conservative because of the following assumptions:

- Only direct economic costs were considered, and no attempt was made to include ecological pest costs in these estimates. The enormous value of the many aspects of New Zealand's environment which are negatively impacted by pests, such as biodiversity, did not contribute to the benefits that were estimated to arise from biosecurity improvements.
- The rate of establishment of pest organisms has been assumed to increase only linearly with time. However, rapidly increasing trade and tourism suggests establishment rates could well increase more quickly.
- The estimate that 5% of pest organisms are eradicable at the time of their discovery in New Zealand is optimistic and the real figure is probably lower. In the scenario described above, benefits from improvements to New Zealand biosecurity are increased if the proportion of new incursions which is assumed to be eradicable using currently available technologies is reduced.

Turner et al. (2004) quantified potential returns from improvements to forest biosecurity using hypothetical improvements to detection and eradication as was done in the present paper, but calculated much larger potential benefits. In their analysis, Turner et al. (2004) found that the net present benefits from forest-related biosecurity and forest health research ranged from $3,519 million to $5,888 million for an annual investment of $3.5 million. The three main differences between these two analyses are:

- Turner et al. (2004) estimated MAF's response cost using data from three eradication campaigns: *Orgyia thyelliana* ($10 million), *Teia anatoides* ($100 million) and *Ophiostoma novo-ulmi* ($4 million), whereas the present paper used a wider range of examples that included many responses that did not involve eradication campaigns. The response cost estimate in the present paper was, therefore, two orders of magnitude lower than that of Turner et al. (2004) ($0.54 million cf. $55 million).

- To estimate pest management costs, Turner et al. (2004) included values from a wide range of examples from the USA where the total value of commercial forestry is much larger than in New Zealand. Forestry in the USA has therefore suffered much larger pest impacts than are likely to occur in New Zealand (e.g. *Ips typographicus* costing US$201 million–$1500 million, USDA Forest Service 1991).
- Turner et al. (2004) estimated biosecurity costs associated with plant pathogens and urban trees, while the present paper did not, mainly because such impacts were not considered by Barlow & Goldson (2002).

The first two differences noted above therefore also suggest that the present analysis was very conservative. Nevertheless, due to the enormous costs of pests to New Zealand, both models demonstrate that small reductions in the rate that new pests become permanently established can provide very large economic returns.

The Foundation for Research, Science and Technology (FRST) is making a 12 year (2005-2017) investment in research aimed at reducing the rate at which new plant pests are becoming permanently established in New Zealand. This is a collaborative research venture, known as ‘Better Border Biosecurity’ or ‘B3’, which involves five research providers (AgResearch, Crop & Food Research, Forest Research, HortResearch and the National Centre for Advanced Bioprotection Technologies), as well as key biosecurity stakeholders (Biosecurity New Zealand, Department of Conservation, the Environmental Risk Management Authority and the Forest Biosecurity Research Council). Using the conceptual framework described in this paper, B3 contended to FRST that its new collaborative research programmes, costing $25 million over 12 years, should be able to achieve biosecurity improvements at least equal to those described in the Results section above, thus returning $87 million in direct net economic benefits.

It is notoriously difficult to accurately measure the costs of established pests, and even more challenging to predict the future ecological, social and economic impacts of new unwanted organisms. New Zealand is perhaps better-placed than most countries to make such an assessment because it is a small island state with well-defined borders and an advanced system for identifying new unwanted organisms. In time it should be possible to amass examples of the costs of developing improvements to the biosecurity system and also the value from implementing these systems. The challenge will be to ensure that the management systems at BNZ collect information in a manner suitable to be analysed for this purpose. The model presented in this paper could also perhaps benefit from a more granular analysis of pest incursion, detection and eradication rates, and impacts on a sector by sector basis, identifying direct and indirect control costs and impacts in the manner that Turner et al. (2004) have done.

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