FORESTRY QUARANTINE RISK OF CARGO IMPORTED INTO NEW ZEALAND

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ABSTRACT

Data from 2547 randomly selected consignments of part-container-load cargo imported into New Zealand were analysed to examine the incidence of quarantine interception of material that may affect forests, trees, and wood products in this country. Insect damage was found in 4.1% of the consignments, bark in 3.7%, insects in 2.7%, and fungi in 0.7%. Stone and slate, and goods in the "unknown" category had the highest rate of interception, as did other cargo packed in pallets, cases, and crates. Chemicals, food, textiles, cartons, and rolls of cloth or carpet backing had a low interception rate. Goods originating in Asia and Europe were more frequently infested than American or Australian cargo.

Keywords: quarantine; imports; risk.

INTRODUCTION

Forestry is extremely important to New Zealand's economy. Indigenous forests have high cultural and socio-economic values, and play a vital role in soil conservation and watershed control. Forestry exports of produce from exotic plantations contributed $1701 million, or 10.7%, to export earnings in 1991 (Ministry of Forestry 1992), and forestry and related industries comprised 4.3% of the national gross domestic product (Dept. of Statistics 1991). Over 90% of the 1.3 million ha of plantation forestry comprise a single species, *Pinus radiata* D.Don. That *P. radiata* plantations have only two introduced diseases of economic significance—Cyclaneusma needle-cast and Dothistroma needle-blight—and no major pests, may be the result not only of good fortune, but also of the quarantine system developed in the 1940s.

The benefits of an efficient quarantine system to protect forests, trees, and structural timber from attack by introduced pests and pathogens has been well recognised (New Zealand Forest Service 1964a, b; Thompson 1965; Foley 1980). The idea was first suggested in the State Forest Annual Report of 1923 (Foley & Barber 1968). Inspection of imported wooden products started in 1940 after discussion between the State Forest Service and the Australian CSIRO. The discovery of Australian subterranean termites in the late 1930s (Bain & Jenkin 1983) prompted inspection of imported Australian hardwoods, and inspections were subsequently extended to all wood imports and exports. The Forests Act 1949, Section

69 (Control of injurious importations and exportations), formed the legal basis for inspection and, along with the Forest Produce Import and Export Regulations (1966), provides the legislative force for timber inspection.

Overseas cargo vessels discharge at 12 major ports, and the cargo may be transhipped to other minor ports. Ministry of Forestry quarantine officers are situated at the major ports, and are responsible for inspecting all forms of timber and timber products entering the country, i.e., sawn timber, logs, cases, pallets. Any cargo containing insects or fungi must be treated. Bark is a prohibited import because bark-boring insects pose a significant threat to our exotic forests, and have a greater chance of arriving alive than foliage-borne insects. An agreement with MAFQual allows their agriculture border protection officers to inspect wooden material at international airports, and at international parcels branches of NZ Post offices but, clearly, all wooden material entering the country cannot be inspected. Most cargo is imported in full container loads (FCLs) or less-than-full container loads (LCLs),or as "bulk" non-containerised cargo. Bulk cargo is easily accessible and is 100% inspected. Each FCL usually consists of one cargo type and packaging for one consignee, whereas an LCL is often mixed cargo for a variety of consignees. As LCLs are unpacked at the port, all are inspected; with FCLs a 10% door inspection sample is required. The sampling procedure for FCLs is not random, but is based on perceived risk. Quarantine officers sample high risk cargo in preference to other cargo, "high risk" being defined by the officer's training and experience.

There has never been an objective scientific study of risk assessment although the idea has been mooted (e.g., Milligan 1970). In 1990, the Forest Health Advisory Committee formed a quarantine sub-committee to examine the risk associated with various cargo types. The aim was to quantify the effectiveness of the current inspection sampling system. This paper discusses the results of a survey of consignments of LCL cargo imported into New Zealand in 1989–91.

METHODS

Data Collection

Manifests of a random sample of LCL cargo from Auckland, Napier, New Plymouth, Wellington, Lyttelton, and Dunedin were examined and information on cargo type and quarantine interceptions was extracted. A quarantine interception is defined as the discovery in imported material of any organism with the potential to damage trees or wood products. The discovery of bark is also treated as a quarantine interception, because of the risk posed by bark-boring insects. Only manifests from LCLs were used because the information was readily and cheaply available. Since all LCLs are inspected, the sample was not biased by selection of "high risk" cargo types. Between August 1989 and February 1991, records from all consignments arriving during randomly selected weekly periods were requested. Data from a total of 2547 consignments were examined.

Data Type

The following information was collected:

(a) ship's name and voyage number;

(b) country of origin;

(c) port of loading;
(d) packaging and goods types;
(e) port of inspection;
(f) type of interception (insect, insect damage, bark, fungi).

Goods and package types are shown in Table 1. These categories were chosen to represent a realistic description of cargo entering the country.

TABLE 1–Goods and package types defined for the study

Packaging	Goods
Cases	Machinery
Cartons	Chemicals
Pallets	Paper
Skids	Textiles, clothing
Pieces	Glass
Rolls	Personal effects
Bales	Sawn timber
Packages	Stone and slate
Crates	Food
Other	General goods
Unknown	Unknown

Data Analysis

The number of interceptions from each goods and package type, ports of origin and destination, and country of origin, were tabulated. Since there was no significant difference in interception rate between port and country of origin, individual countries and ports of origin were grouped into geographical regions. The effect of each of four main factors (goods, packaging type, country of origin by region, and inspection port) on number of quarantine interceptions was determined. To avoid multiple counting, intercepted material (insects, insect damage, bark, or fungi) was grouped into one combined category.

It was necessary to make allowances for the influence of one factor on another. For example, 2.1% of consignments inspected at Napier contained prohibited material compared with the national average of 9.1%. More than half (62%) of the cargo entering Napier in this study was packed in cartons, which contain little wood, and therefore have few relevant incidences of bark, insects, insect damage, or fungi. A log-linear model was used to obtain the percentage of total interceptions as a function of the four factors. This enabled the effect of each factor to be adjusted for the other factors. An analysis of deviance table, produced during the fitting of the model, enabled the significance of each factor to be tested (McCullagh & Nelder 1989). After allowing for the disproportionate amount of cargo packed in cartons, the adjusted interception rate for Napier was 4.1%. As well as adjusting interception rates within factors, the model was used to predict rates for combinations of factors, i.e., slate from Central Asia packed in cases had a predicted interception rate of 49%.

RESULTS

Insect damage and bark were the most common quarantine interceptions, found in 4.1% and 3.7% of the consignments sampled, respectively. Insects were found in 2.7% of the

consignments, and fungal interceptions were rare at 0.7%. In total, 232 consignments (9.1%) contained either insect damage, bark, insects, fungi, or some combination of the four.

Quarantine interceptions were most common for stone and slate, machinery, paper, and unknown goods, and fewest for chemicals and food (Table 2). Crates contained significantly more prohibited material than bales, packages, pieces, rolls, and cartons (Table 3). There was a large variation in the proportion of interceptions at various ports of destination (Table 4). Dunedin had the highest level of interceptions at 24.4% (adj.), Lyttelton was the next highest at 11.8%, but there was no significant difference between New Plymouth, Wellington, Auckland, or Napier. Cargo originating in Central Asia had significantly higher interception rates than any other region (Table 5).

TABLE 2–Interceptions by goods type

Goods type	No. of consignments	Material intercepted				Infested consignments	
		Bark (%)	Insect damage (%)	Fungi (%)	Insects (%)	Actual mean (%)	Adjusted mean (%)
Unknown	40	17.5	20.0	2.5	7.5	35.0	39.9a
Stone, slate	19	5.3	5.3	5.3	15.8	26.3	21.3ab
Paper	171	7.6	5.3	1.2	0.6	12.9	16.2 b
Machinery	593	6.7	8.1	0.8	2.5	13.5	14.2 b
Personal effects	147	2.7	4.1	0.0	6.1	11.6	11.6 b
Glass	52	1.9	5.8	3.8	0.0	11.5	10.9 bc
General goods	906	2.2	2.3	0.6	3.0	7.0	10.3 bc
Textiles	325	0.6	0.9	0.3	2.5	4.0	8.3 bc
Sawn timber	16	0.0	6.3	0.0	0.0	6.3	7.4 bc
Chemicals	223	2.2	2.2	0.9	1.3	4.9	5.5 c
Food	55	0.0	0.0	0.0	0.0	0.0	0.2 c
TOTAL	2547	3.7	4.1	0.7	2.7	9.1	

Adjusted means with the same letter not significantly different at the 5% level. Goods types are regarded as significantly different if the standard error of their difference exceeds twice the difference of the means.

TABLE 3–Interceptions by packaging type

Packaging type	No. of consignments	Material intercepted				Infested consignments	
		Bark (%)	Insect damage (%)	Fungi (%)	Insects (%)	Actual mean (%)	Adjusted mean (%)
Crates	136	5.1	6.6	3.7	10.3	20.6	22.3a
Cases	613	4.7	5.9	0.3	4.7	13.7	16.3ab
Pallets	576	5.4	4.9	1.0	2.8	12.2	15.3 b
Skids	41	4.9	4.9	2.4	0.0	9.8	13.2 b
Others	230	7.8	9.6	0.4	0.0	10.0	12.8 b
Bales	75	0.0	0.0	1.3	8.0	8.0	9.8 bc
Packages	99	2.0	2.0	0.0	3.0	6.1	6.6 bc
Pieces	37	0.0	0.0	5.4	0.0	5.4	3.5 bc
Rolls	32	0.0	0.0	0.0	3.1	3.1	3.7 bc
Cartons	708	0.6	0.8	0.1	0.0	1.1	2.1 c
TOTAL	2547	3.7	4.1	0.7	2.7	9.1	

Adjusted means with the same letter not significantly different at the 5% level. Goods types are regarded as significantly different if the standard error of their difference exceeds twice the difference of the means.

TABLE 4–Interceptions by destination port

Inspection port	No. of consignments	Material intercepted				Infested consignments	
		Bark (%)	Insect damage (%)	Fungi (%)	Insects (%)	Actual mean (%)	Adjusted mean (%)
Unknown	40	17.5	20.0	2.5	7.5	35.0	39.9a
Dunedin	467	7.1	10.9	2.8	1.1	20.6	24.4a
Lyttelton	662	4.5	5.3	0.3	3.3	9.2	11.8 b
New Plymouth	236	0.0	0.0	0.0	11.0	11.0	6.7 c
Wellington	246	2.4	4.1	0.4	1.2	6.9	5.4 c
Auckland	365	3.8	0.8	0.3	3.0	5.5	4.6 c
Napier	571	1.8	1.1	0.4	0.4	2.1	4.1 c
TOTAL	2547	3.7	4.1	0.7	2.7	9.1	

Adjusted means with the same letter not significantly different at the 5% level. Goods types are regarded as significantly different if the standard error of their difference exceeds twice the difference of the means.

TABLE 5–Interceptions by regional groupings of country of origin

Country of origin	No. of consignments	Material intercepted				Infested consignments	
		Bark (%)	Insect damage (%)	Fungi (%)	Insects (%)	Actual mean (%)	Adjusted mean (%)
Central Asia	123	1.6	3.3	0.0	12.2	15.4	25.7a
SE Asia	662	2.1	1.4	0.3	4.5	6.3	16.9 b
Europe	487	5.5	7.0	1.2	2.1	14.4	12.6 bc
North Asia	534	5.1	5.8	0.2	0.6	6.9	10.2 cd
UK	354	2.8	3.7	1.1	1.7	9.0	8.8 cd
Unknown	38	0.0	0.0	0.0	2.6	2.6	7.7 cd
Australia	217	4.6	4.1	1.4	1.4	8.8	7.3 cd
North America	132	2.3	3.8	2.3	0.8	9.1	7.0 cd
TOTAL	2547	3.7	4.1	0.7	2.7	9.1	

Adjusted means with the same letter not significantly different at the 5% level. Goods types are regarded as significantly different if the standard error of their difference exceeds twice the difference of the means.

The analysis of deviance (Table 6) generated by the log-linear model shows that port of inspection had the greatest effect on the predicted interception rates, but region of origin, goods, and packaging type also contributed.

TABLE 6–Accumulated analysis of deviance for region, goods, packaging, and port

	df	Deviance	Mean deviance	Deviance ratio
Region	7	31.2	4.46	5.10
Goods	10	106.8	6.29	8.65
Packaging	9	87.6	9.73	11.13
Port	5	110.5	22.10	25.27
Residual	618	540.5	0.87	
TOTAL	649	845.4	1.30	

The main differences between actual and adjusted means were in paper goods (an increase from 12.9% to 16.2%), textiles (4.0% to 8.3%), skid packaging (9.8% to 13.2%), Central Asian cargo (15.4% to 25.7%), South-east Asian cargo (6.3% to 16.9%), and unknown goods (35.0% to 39.9%).

The predicted interception rates for combinations of region of origin, packaging, and goods types are available from the author. The highest interception rates (18% to 79%) were in slate, machinery, and paper from Central Asia or Europe that was packed in cases, crates, and pallets, or goods in the "unknown" category. Chemicals and textiles contained in rolls and pieces, also food in any packing, or any cargo packed in cartons had the lowest values (0% to 6%), regardless of origin. Less than 10% of consignments had a 20% or greater probability of carrying prohibited material.

DISCUSSION

The analysis has identified particular cargo types among LCLs that contain a high proportion of material which poses a threat to forestry interests. The study made no attempt to classify the material by degree of risk. Central Asian and South-east Asian cargo had the highest rates of interceptions but the risk of establishment of tropical organisms is probably low, their potential for damage slight. On the other hand, North American and European organisms, because they come from temperate zones, have a higher potential for causing serious damage to forest trees and wood products.

The analysis of deviance (Table 6) showed that there were significant differences in interception rates within factors (goods and packaging type, region, and port). Packaging composed of wood (i.e., crates, cases, and pallets) carried more prohibited material than non-wooden packaging such as rolls and cartons. Stone, slate, machinery, and paper are packed in robust, wooden material whereas food and textiles are generally packed in cartons or rolls. This would account for the higher interception rates for stone, machinery, and paper. The difference in interception rates between inspection ports was unexpected. After adjusting for effects of region of origin, goods, and packaging, there was still a significantly higher rate at Dunedin than the other ports. The study was not designed to test port efficiency, and factors not considered here could have contributed to apparent differences. The high level of interceptions at Dunedin does not invalidate the study, as the range of cargo types was similar and Dunedin data increased the mean number of interceptions for each cargo type without affecting relative rankings.

The relative proportions of prohibited material in particular cargo types as identified by this study could be used as guidelines by inspection staff. Further research needs to be carried out to find out if inspections based on the high risk cargo types identified in this study are more effective than continuing the status quo.

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REFERENCES

BAIN, J.; JENKIN, M.J. 1983: *Kalotermes banksiae, Glyptotermes brevicornis*, and other termites (Isoptera) in New Zealand. *New Zealand Entomologist 7(4)*: 365–70.

DEPARTMENT OF STATISTICS. 1991: "New Zealand Official Yearbook". Government Printer, Wellington

FOLEY, T.A. 1980: Interception of foreign pests and diseases. Paper presented at Eleventh Commonwealth Forestry Conference.

FOLEY, T.A.; BARBER, W.M. 1968: Forest products quarantine regulations in New Zealand. Paper presented at Ninth Commonwealth Forestry Conference, India.

MILLIGAN, R.H. 1970: Overseas wood- and bark-boring insects intercepted at New Zealand ports. *New Zealand Forest Service Technical Paper No. 57.*

MINISTRY OF FORESTRY 1992: "Forestry Statistics SR/1992". Government Printer, Wellington.

McCULLAGH, P.; NELDER, J.A. 1989: "Generalized Linear Models". 2nd ed., Chapman and Hall. 511 p.

NEW ZEALAND FOREST SERVICE 1964a: Quarantine inspection of timber and forest produce in New Zealand. FAO/IUFRO Symposium on "Internationally Dangerous Forest Diseases and Insects", Oxford, 20–30 July.

———1964b: Specifications for improved quarantine. FAO/IUFRO Symposium on "Internationally Dangerous Forest Diseases and Insects", Oxford, 20–30 July.

THOMSON, A.P. 1965: Report on the FAO/IUFRO Symposium on "Internationally Dangerous Forest Diseases and Insects", Oxford, 20–30 July.