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Solid Wood Packing: global phytosanitary concerns

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Abstract
When organisms are moved from their natural range to new ecosystems, they are considered "non-indigenous", "invasive", or "exotic" species. Historically, Canada has felt the effects of non-indigenous species introductions that have had serious economic and ecological impacts. With changes in global trade patterns novel introductions continue to occur. International quarantine standards are being developed to minimize the risk associated with solid wood packing materials, a major entry pathway for non-indigenous organisms.

Introduction

When plants, animals and microbial organisms are accidentally or intentionally moved by man beyond their natural ranges, they are considered "non-indigenous", "invasive" or "exotic" species. Increased rates of exotic introductions are occurring that are largely the result of global commerce. Introduction frequency is increasing with the diversity of trading partners and the efficiency by which trade goods are transported.

The introduction of non-indigenous species can have serious effects on ecosystem structure and function and have profound economic implications (Liebhold et al. 1995, Wallner, 1996). This presentation discusses the nature of invasive species in Canadian forests and some of the phytosanitary issues involved in the problem.

What exotic pests threaten our forests?

This question has no simple answer. The number of organisms not native to Canada that could damage our forest species likely numbers in the thousands. In general, however, it is reasonable to assume that organisms from other north temperate forests could be problematic should they establish here. Many documented exotic species introductions have occurred in the past century, some with devastating effects on forest ecosystems (Table 1, 2). We are likely more aware of more insect introductions because of their increased visibility, ease of detection and relative ease in interception. Disease organisms, particularly those that are cryptic or do not result in serious economic damage are less likely to be detected (Uzunovic et al. 1999).

An example of the number and kind of pests entering Canada was demonstrated by a Canadian Forest Service (CFS) study that examined non-indigenous species associated with green Norway spruce (*Picea abies* (L.) Karsten) bolts used to brace imported blocks of granite from Norway. In July 1998, live beetles were found associated with shipments of granite from Norway. The shipments had entered Canada at the port of Montreal and had been shipped by rail to Vancouver, where the containers were unpacked and the dunnage discarded. Green spruce bolts had been used to brace large granite blocks inside shipping containers. The intercepted dunnage was brought to the CFS quarantine facility in Victoria and held under containment for emergence of the insects. More than 2500 adult insects representing more than 40 species of bark beetles, woodborers and their associated parasitoids, predators and scavengers, bluestain fungi and nematodes were recovered from 29 log bolts.

How are exotic pests entering into and moving within Canada?

Analyzing the pathways by which non-indigenous species enter and move within the country is critical to developing monitoring and control strategies. This involves an understanding of trade commodities, the countries from which they originate, the packing material with which they are shipped, and how they are handled upon arrival. Assessing trade patterns and shipping methods is key to the development of meaningful pest risk assessments.

In recent years, the importance of non-manufactured solid wood packing materials as a pathway for non-indigenous species has become evident. This has required quarantine officials to rethink how imported materials are surveyed since historically, risk assessments and quarantine regulations focused on commodities rather than the packaging accompanying them. Until recently, wood packing material (crating, pallets, dunnage) was unregulated as a quarantine concern. The establishment of the Asian long-horned beetle (*Anoplophora glabripennis* (Motchulsky)) in the US and concerns about its establishment in other countries, stimulated the formation of regulations specifically aimed at controlling the importation of wood packing materials (CFIA 1998; Cavey, 1998). Further efforts are being made to develop an international standard for the movement of wood packing material that has been treated to minimize phytosanitary risk.

It is difficult to make generalizations about risks associated with solid wood packing materials. Some are constructed from hardwoods, others softwoods, sometimes they are mixed. They are often made from low-grade wood, the left-overs from lumber processing, but sometimes kiln-dried wood is used where the packing, pallets for example, is intended to be reused. The level of infestation in the wood is also difficult to predict. If a major forest disturbance event occurs, such as a large-scale wind-storm, insect infestation or fire, packing materials may, for a period of time, be constructed using highly infested wood from these sources. When the use of less infested wood resumes, phytosanitary risks are reduced. The commodity associated with the packing material can also contribute to its risk. In some cases low quality steel cable, intended for single use in forestry operations, is shipped on wooden spools. It is not uncommon for the spools when empty to be discarded into the forest where, being largely biodegradable, they slowly rot. However, if the spools are infested with non-indigenous organisms this turns out to be an unintentional method of delivering the organisms directly to the resource which they threaten. A 1997 CFS audit of 50 Chinese wire rope spools revealed that 24% of the spools examined still contained live woodborers while a total of 31% of the spools had some evidence of past woodborer activity. Six species of longhorned woodborers (Cerambycidae) were reared from these spools. When these spools entered Canada is not known, but it was likely that they had been in the country for at least two years. In 1998, 16 additional Chinese-made spools that had recently arrived in Canada were examined. These showed similar levels of infestation to the 1997 spools, 22% had live insects associated with them. There was often no visible external evidence of the presence of live woodborers in these spools: only 63% showed external signs of woodborer activity while all were found to have some evidence of past insect activity when disassembled. Forty-one Canadian-made spools were examined from suppliers in Vancouver, Edmonton, Sault Ste. Marie and Fredericton. These were found to be of superior construction and used higher quality materials than the Chinese spools. Less evidence of insect activity was visible and no live insects were found.

Historically, most establishments of exotic pest populations occurred in or near shipping ports. Recently, with the shift to the use of containers in the transport of trade goods, a sealed container may be offloaded at a port, then moved long distances by truck or rail before being opened anywhere in Canada. This provides much more opportunity for non-indigenous organisms to successfully establish in ecosystems remote from port areas. Quarantine inspection of import goods is also more difficult as activities can not be focussed at ports alone. Notwithstanding the above, forest landscapes at the highest risk tend to be at the urban-forest interface. Where people and the goods that they import coincide is where non-indigenous organisms are introduced and have a chance to become established (Humble and Allen 1999).

What threat do non-indigenous pests pose to our forests and forest economies?

Introduced species that are perceived to cause harm do so in a variety of ways (Krcmar-Nozic et al. 2000a, 2000b). The most commonly cited are direct, measurable economic costs. These include damage to timber resource value: tree mortality or reductions in growth or wood quality, costs of control and the implementation of regulations, unrealized revenue from recreation and tourism opportunities and reductions in property value (especially in urban-forest situations). Estimates of economic losses although difficult to calculate, have been developed for some forest pests (USDA 1991, 1998).

Economic losses also occur through lost trade due to international trade restrictions. Such restrictions may be applied by countries importing Canadian forest products if they are concerned about the introduction of native Canadian organisms to their forests. An example is the regulations imposed by the European Union concerning the possible movement of pinewood nematode (*Bursaphelenchus xylophilus* (Steiner & Buhrer) Nickle) associated with Canadian wood products (Dwinell and Nickle 1989, ECC 1992). These regulations have had a profound effect on Canada's forest product exports to Europe. Similar concerns are being expressed by Australian plant quarantine officials regarding the importation of green lumber from Canada. More than 1800 interceptions of native Canadian insects were made on lumber shipments between 1985 and 1998 (AQIS 1998). Treatment requirements to reduce the risk associated with such movements could jeopardize Canada's share in this market.

Similarly, trade restrictions may also be enacted over concerns by our trading partners about the movement of exotics that have established in Canada. In 1999, the US imposed regulations on the movement of goods from British Columbia to the western states over concerns about a population of gypsy moth in Victoria.

In addition to direct economic impacts, serious ecological effects to forest ecosystems can result from non-indigenous introductions. These may be as dramatic as the extirpation of species (e.g. chestnut blight), changes in ecosystem structure and interspecies dynamics (e.g. white pine blister rust) and changes (increases or decreases) in biological diversity. Other impacts include social consequences (job losses) and degradation of aesthetic values.

What is being done to reduce the risk from non-indigenous pests?

As a consequence of the serious impacts historical non-indigenous introductions have had on agricultural and forest economies, most countries have plant quarantine agencies part of whose job it is to monitor the influx of non-indigenous organisms, identify the pathways by which they are entering, and attempt to prevent their entry. Inspection and quarantine systems have been implemented by most nations to prevent introductions of new harmful invasive species or to limit the spread of already established species. In Canada, this task falls to the Canadian Food Inspection Agency. This organization, in cooperation with the Canadian Forest Service and similar regulatory and research groups around the world, has been analyzing exotic pest risks for more than a decade. Recently, expanded efforts have been made to identify pathways by which exotics are entering and to quantify their risk. This type of analysis has clearly identified solid wood packing material (SWPM) as a key, under-regulated pathway. In response, plant protection organizations around the world are working on the development of international standards to decrease the phytosanitary risks associated with SWPM.

Recent initiatives in this regard are being carried out under the International Plant Protection Convention (IPPC), an international treaty that has been deposited with the Food and Agriculture Organization of the UN (FAO). A global standard for the treatment of wood packing has been drafted by an IPPC working group and is currently under review by the global phytosanitary community. The standard could be adopted as early as mid 2002 and will propose that countries adopt universal import requirements, treatment and certification systems. The IPPC International Standard will apply to all species (softwood and hardwood) of non-manufactured wood from all countries. The standard identifies heat treatment (heating of wood to a core temperature of 56° C for 30 minutes) as a “general measure”. Wood that has been treated by other means and in the process has achieved the 56°/30 minute treatment will be acceptable (for example chemical pressure impregnation). The standard states that other treatments such as fumigation, chemical pressure impregnation, chemical dip, and irradiation may be considered on their own should they demonstrate an equivalent level of phytosanitary protection and are technically and operationally feasible to apply.

Current regulations in Canada recognize only one chemical preservative (CCA) for offshore treatment of imported wood packaging (CFIA 2001). However, this treatment method is coming under increasing scrutiny given the nature of wood packing and the difficulty in predicting all end uses (e.g. foodstuffs). In contrast, the Australian Quarantine Inspection Service has approved several more preservatives, both fungicides and insecticides, and specified the treatment levels required for treating wood packaging or container components (Table 3). The European Union's importing regulations allow chemically impregnated wood treatments but the list of which preservatives are permissible is not finalized. It appears that countries within the EU are not in agreement, for example some do not wish to receive CCA treated wood packaging materials.

More information is required on preservatives as a substitute for heat treatment or fumigation for phytosanitary use. For example there is a need to know:

- To what degree does pressure treatment with preservatives penetrated insect galleries and kill existing infestation?

- Do the standardized levels of preservative treatment for wood in service control pests in packaging materials or can we reduce the levels of treatment?
- Are pests which can colonize preservative treated wood of phytosanitary concern?
- How does the industry deal with disposal of treated wood after its service life?

It is clear that there are situations where chemical preservatives are the treatment of choice. However, they are unlikely to be authorized until efficacy and environmental impacts under the conditions of service that are unique to certain applications of wood packing are evaluated. The wood packing and wood preservation industries can play a key role in initiating and supporting the scientific research in these areas.

There is a clear need for government agencies, universities and industry to conduct the scientific studies necessary to test existing technologies and to develop new strategies. Although the implementation of a global wood packing standard will result in added costs to shipping and packing industries, it is clear that the phytosanitary benefits of such a program be worthwhile. This type of approach, in conjunction with enhanced surveillance using improved detection tools and inspection methods will greatly reduce the negative impacts of non-indigenous species.

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Table 1. Significant forest diseases introduced into Canada (after Anon. 1999)

Disease	Year introduced	Primary hosts
Beech bark disease (*Nectria coccinea var. faginata*) and beech scale (*Cryptococcus fagisuga*)	1890	American beech
Dothichiza canker (*Cryptodiaporthe populea*)	pre-1900	poplars
Chestnut blight (*Cryphonectria parasitica*)	post-1904	American chestnut
White pine blister rust (*Cronartium ribicola*)	1910	white pine
Willow blight (*Venturia saliciperda*)	ca. 1925	willows
Dutch elm disease (*Ophistoma ulmi*)	1944	elms
Scleroderris canker (European race) (*Gremmeniella abietina*)	1978	pines
European larch canker (*Lachnellula willkommii*)	1980	larches
Butternut canker (*Sirococcus clavigignenti*)	1991	butternut

Table 2. Significant forest insect pests introduced into Canada (after Anon. 1999).

Insect	Year introduced	Primary hosts
Larch sawfly (*Pristiphora erichsonii*)	1882	larches
Browntail moth *(Euproctis chrysorrhea)*	1902	all deciduous species
Poplar sawfly *(Trichiocampus viminalis*)	1904	trembling aspen, largetooth aspen, balsam poplar
Larch casebearer (*Coleophora laricella*)	1905	larches
Late birch leaf edgeminer (*Heterarthus nemoratus*)	1905	birches
Balsam woolly adelgid (*Adelges piceae*)	1908	balsam fir, grand fir, subalpine fir, Pacific silver fir
Satin moth (*Leucoma salicis*)	1920	poplars
European spruce sawfly (*Glipinia hercyniae)*	1922	spruces
Gypsy moth (*Lymantria dispar*)	1924	oaks, birches, larches, willows, basswood, Manitoba maple
European pine shoot moth (*Rhyacionia buoliana*)	1925	red pine, jack pine, Scots pine
Winter moth (*Operophtera brumata*)	1920s	oaks, maples, willows
Mountain-ash sawfly (*Pristiphora geniculata*)	1926	Mountain-ash
Birch leafminer (*Fenusa pusilla*)	1929	birches
Introduced pine sawfly (*Diprion similis*)	1931	pines
Birch casebearer (*Coleophora serratella*)	1933	poplars
European pine sawfly (*Neodiprion sertifer*)	1939	red pine, Scots pine
Elm leaf beetle (*Pyrrhalta luteola*)	1945	elms
Smaller European elm bark beetle (*Scolytus multistriatus*)	1946	elms
Ambermarked birch leafminer (*Profenusa thomsoni*)	1948	birches
Apple ermine moth (*Yponomeuta malinella*)	1957	apple
European pine needle midge (*Contarinia baeri*)	1964	red pine, Scots pine
Early birch leaf edgeminer (*Messa nana*)	1967	birches
Pine false webworm (*Acantholyda erythrocephala*)	1961	pines
Pear thrips (*Taeniothrips inconsequens*)	1989	sugar maple, red maple
Brown Spruce Longhorn Beetle *(Tetropium fuscum)*	1990	pines, spruces, true firs
Pine shoot beetle (*Tomicus piniperda*)	1993	pines, spruces

Table 3. AQIS-approved (Australian Quarantine Inspection Service) preservatives for the treatment of wood packaging (AQIS 2001)

Preservative Type	Chemical	Number of Formulations
Waterborne Preservatives		
	Chromated Copper Arsenate	86
	Copper Chromium Boron Salts	0 (recently withdrawn)
	Ammoniacal Copper Quaternary 2100	2
	Boron/Alkyl Ammonium	1
	Copper Azole	1
	Cu-HDO and boric acid	2
	Copper Boron and Polymeric	
Non Water-bornes		
	Permethrin	10
	Deltamethrin	2
	Fenvalerate	?
	Tributyltin oxide	0 (recently withdrawn)
	Nideo-Woodgard	1 (about to be withdrawn)
	Sumithion	1 (under assessment)
Glue-line treatments for panels		
	Phoxim	9 (under assessment)
	Chlorfenapyr	2

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