FIDS Pest Report 92-39

DECEMBER 1992

SUSCEPTIBILITY OF WESTERN HEMLOCK TO PINEWOOD NEMATODE AND ITS WOOD BORER VECTOR

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INTRODUCTION

Pinewood nematode (PWN), Bursaphelenchus xylophilus, is a serious pest of pine forests in Japan. The possibility that PWN, occasionally found in low grade wood from Canada, could be transported to Europe, prompted the European Economic Community to institute a ban on the import of green lumber from Canada. Forestry Canada then initiated a study to examine the possibility that certain wood species could be exempted from this ban, especially those known not to be a regular host for Monochamus (the only wood borer in British Columbia suspected of vectoring PWN). Previous surveys by Forestry Canada's Forest Insect and Disease Survey (Bowers et al. 1992; Van Sickle 1991) and seedling inoculations (Sutherland et al. 1991) showed that western red cedar (Thuja plicata) and western hemlock (Tsuga heterophylla) are not hosts of PWN, and that Monochamus has never been found associated with western red cedar (Singh et al. 1992) and only rarely with western hemlock. Western hemlock was the main species examined in this study as an exemption for western red cedar has already been obtained.

Methods and Materials

Eleven sites throughout British Columbia were chosen by experienced FIDS field staff where a high incidence of Monochamus attack was previously recorded or expected (Map). These included sites in recently burned areas or near log decks and chip piles. Healthy trees were felled and moved to these 11 sites in late May or early June before the flight and oviposition period of Monochamus spp. Twenty five, 1 m long log bolts of western hemlock (wH) and 25 of lodgepole pine (lP), Pinus contorta, were laid side by side alternating the two tree species. The average diameter of wH was 24 cm and lP 23 cm. At some sites, the wH logs had to be transported several hundred kilometers due to its general absence in forests with the greatest wood borer populations.

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In September, after the flight period of wood borers, the log bolts were labeled and brought to the Pacific Forestry Centre, where the bark was carefully removed using a hand chisel. The cambium and bark were examined for insect (particularly wood borer) damage. Insect damage was classified relative to the surface area of cambium damaged as light (<33%), moderate (33-66%) or severe (>66%). Insects were identified and representative larvae were preserved in 70% ethanol. Log bolts attacked by insects (12 wH, 16 lP), are being held in a controlled environment rearing room to confirm the identity of any cerambycids, and to establish if Monochamus can complete its life cycle in wH.

All log bolts containing Monochamus and a minimum of 10 log bolts of each species per site were sampled for PWN. Samples were taken preferentially around insect boring holes and from areas stained by fungi. Three hundred log bolts were sampled for PWN (120 wH and 180 lP). Nematode extractions were made using the Baermann funnel technique, and nematodes other than PWN were identified to the order level. PWN found were put into test tubes containing TAF (Courtney et al. 1955) for preservation. When many PWN were present, about 50 were placed in a Petri plate, containing Botrytis cinerea Pers. growing on Difco PDA (potato dextrose agar), to propagate the nematodes.

Results

More than half (53%) of the lodgepole pine bolts were attacked by Monochamus spp. (Table 1). Of the 275 western hemlock log bolts, only 12% (32) contained Monochamus larvae. The number of Monochamus attacks per wH log bolt was low (average 3) compared to the heavily attacked lP (average 11). While most of the Monochamus larvae in lP had begun boring into the heartwood (some to a depth of 5 cm), those in wH were mainly in the cambium. Insects found, besides Monochamus, included other cerambycids (primarily Xylotrechus and Lepturinae), buprestids (mainly Melanophila), various genera of scolytids (e.g. Dendroctonus, Ips, and Hylurgops) and weevils (Pissodes). Attack intensity varied greatly among sites and between tree species.

Frequency and severity of attack by all insects was much greater in lP than wH. While 8% of the wH were not attacked by any insect and 66% were only lightly attacked, 56% of the lP were moderately or severely attacked. Buprestids and Lepturinae were found in both tree species at all sites. Scolytids were primarily in lP with particularly heavy attacks at Dome fire and Meziadin Lake. The Kitimat site had a severe attack of Xylotrechus in wH with populations so high that attack also occurred in lP, a less preferred host.

No PWN was extracted from any of the 120 wH log bolts that were sampled, while of the 180 lP sampled, 23 (13%) contained PWN. All 23 of these lP contained Monochamus larvae. Most of these lP log bolts came from one site near Canal Flats (Table 1). Fungi and insect associated nematodes other than PWN were extracted from 43% of the wH and 91% of the lP log bolts, demonstrating that the extraction method was effective.

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Additionally, 2300 hemlock logs were examined at 24 dry land sorts or log decks in six regions. Only 22% of the logs had evidence of current or old insect activity. Woodborers identified in 16% of the logs included Melanophila drummondi, Xylotrechus longitarsus, and Leptura spp., but none were Monochamus. None of the 117 wood samples extracted from insect-affected and non-insect-affected logs contained PWN, but 30% of the samples contained other fungi or insect associated nematodes in the orders Rhabditidae, Tylenchidae, and Dorylaimidae.

Discussion

The results of this and previous FIDS surveys demonstrate that wH is not a preferred host of Monochamus. Prior to this study, Monochamus had been found in only 1 of 575 wH logs examined (Van Sickle 1991). The larger number of Monochamus larvae found in these wH log bolts may be attributed to the log bolts of the two tree species being placed side by side in areas of very high wood borer populations. With the high attack incidence and intensity in lP (53% incidence, of which 23% were severely attacked) the adults may have been forced to oviposit in less preferred wood species. Most of the Monochamus larvae recovered from the wH logs appeared moribund and may not have normally been able to complete their life cycle. The log bolt rearings may confirm this, but results will not be available for several months. To date, the amount of wood shavings and frass coming from the log bolts suggests that Monochamus larvae in lP are continuing to develop while those in wH show very little activity.

The PWN is known to be present only in isolated trees in British Columbia (Van Sickle 1991). The absence of PWN in wH confirms the results of previous FIDS surveys (Magasi et al. 1990; Van Sickle 1991).

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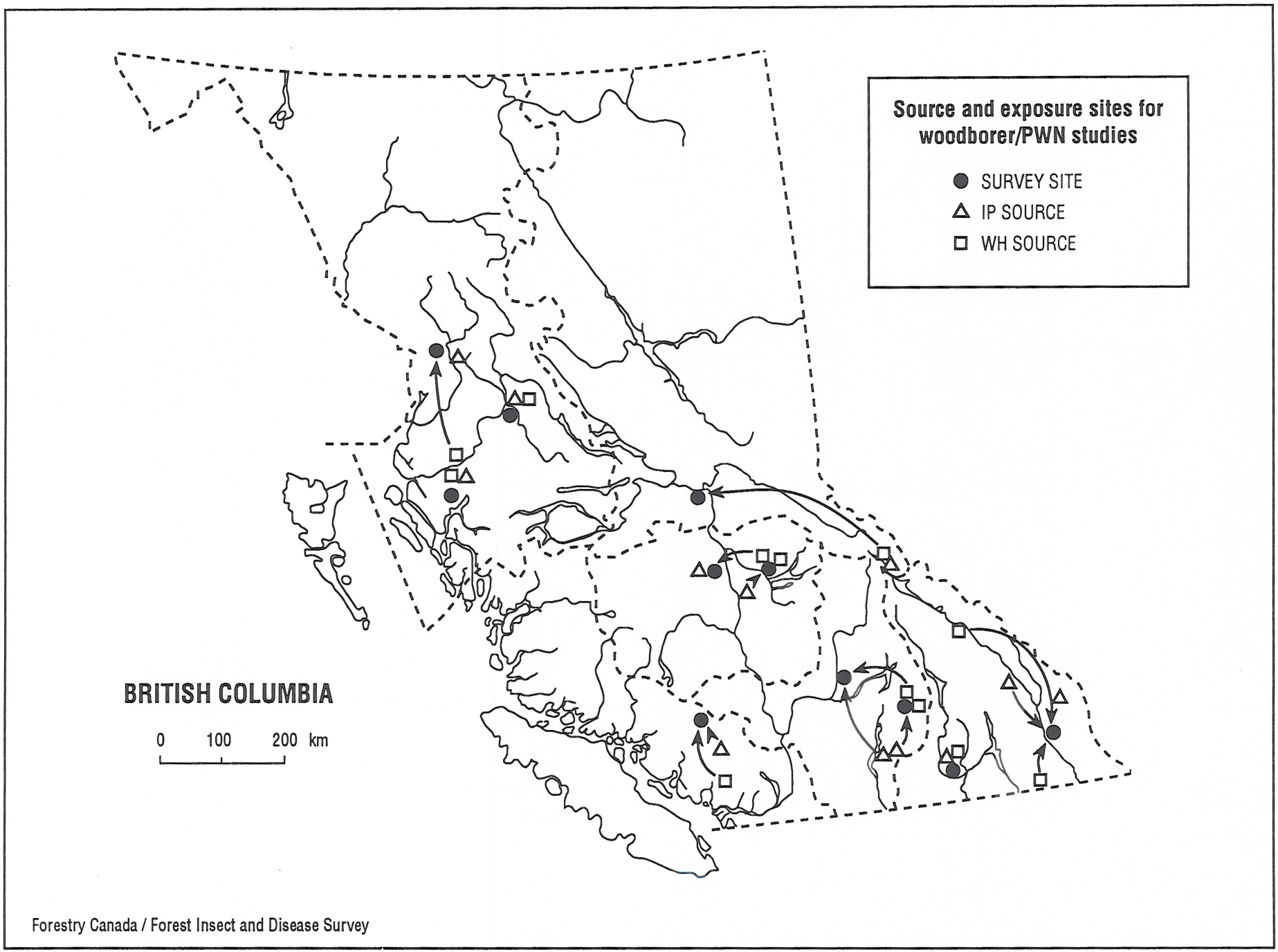
Source and exposure sites for woodborer/PWN studies
SURVEY SITE
IP SOURCE
WH SOURCE
BRITISH COLUMBIA
0 100 200 km
Forestry Canada / Forest Insect and Disease Survey

Table 1. Summary table of *Monochamus* and PWN found in FIDS log bolt study - 1992

Region	Site	Site Description and Stand Composition	Tree Species	# bolts with Monochamus n=25 (%)	Other insects found	# bolts with PWN/ # bolts sampled (%)	% extracted bolts with nematodes other than PWN
Cariboo 1	Horsefly Peninsula	Road right-of-way clearing - dF, lP, wH	wH	19 (76)	Bups & Xylo	0/19 (0)	26%
			lP	25 (100)	Bups	1/25 (4)	100%
Cariboo 2	Narcosli	Logged blow-down area - lP	wH	2 (8)	Bups, Lept & Xylo	0/10 (0)	70%
			lP	22 (88)	Scol, Bups & Lept	1/22 (5)	100%
Kamloops-North	Dome Fire	1991 wild fire area - pP	wH	2 (8)	Xylo, Scol, Bups & Lept	0/10 (0)	30%
			lP	24 (96)	Scol	0/24 (0)	96%
Kamloops-South	Mabel Lake	Bush in blow-down area - alF, eS	wH	3 (12)	Bups, Lept & Xylo	0/11 (0)	55%
			lP	8 (32)	Scol, Bups & Lept	1/10 (10)	100%
Nelson-East	Canal Flats	Landing unused for 2 years - dF, lP	wH	3 (12)	Xylo, Bups & Lept	0/10 (0)	80%
			lP	25 (100)	Scol, Bups & Lept	18/25 (72)	100%
Nelson-West	Deer Park	Bush in partially cut stand - dF, lP, wH, wrC	wH	0 (0)	Bups & Xylo	0/10 (0)	20%
			lP	20 (80)	Scol	1/23 (4)	96%
Prince George	Prince George	Mill yard - alF, lP, wS	wH	0 (0)	Bups	0/10 (0)	10%
			lP	5 (20)	Scol & Bups	1/10 (10)	90%
Prince Rupert-East	Carnaby	Mill yard - lP, wS	wH	0 (0)	Xylo, Bups & Lept	0/10 (0)	40%
			lP	0 (0)	?Ceram, Lept & Scol	0/10 (0)	100%
Prince Rupert-West	Kitimat	Mill yard - sS, wH, wrC	wH	0 (0)	Xylo, Bups & Lept	0/10 (0)	20%
			lP	0 (0)	Xylo, Bups, Lept & Scol	0/10 (0)	30%
Prince Rupert-West	Meziadin Lake	Bush near year-old log deck - alF, lP, wH	wH	0 (0)	Xylo, Bups & Lept	0/10 (0)	80%
			lP	11 (44)	Scol	0/11 (0)	100%
Vancouver	Pemberton	Landing in 1990 fire area - dF, wH, wrC	wH	3 (12)	Bups	0/10 (0)	50%
			lP	7 (28)	Bups	0/10 (0)	40%
		Total wH		**32/275 (12)**		**0/120 (0)**	**43%**
		Total lP		**147/275 (53)**		**23/180 (13)**	**91%**

Bups = Buprestidae (mainly *Melanophila*); Lept = Lepturinae; Scol = Scolytidae (mainly *Ips*, *Dendroctonus* & *Hylurgops*); Xylo = *Xylotrechus*