Natural Resources Canada | Ressources naturelles Canada

Bulletin 59

FRONTLINE EXPRESS

Canadian Forest Service – Great Lakes Forestry Centre

Population of a non-indigenous woodwasp found in pine trees in Ontario

INTRODUCTION

The woodwasp *Sirex noctilio* Fabricius (Hymenoptera: Siricidae), which is native to Europe, Asia and northern Africa and attacks most species of pine trees, has been found in Canada and the United States. This is not the first time this species has been found outside of its native range. It was accidently introduced into several countries in the southern hemisphere including Argentina, Brazil, Chile, Uruguay, South Africa, Australia and New Zealand. Currently, there are at least 20 species and subspecies of native woodwasps in North America. Most of these species feed on conifers and none of them are of economic concern.

There are several reasons for being concerned about the presence of the alien insect *S. noctilio* in North America. First, it can attack and kill living pines, whereas native species of woodwasps attack only dead and dying trees. Generally not a primary tree killing insect, epidemic populations can cause serious damage in commercial forests. Stressed and dying trees are often attacked first, but as populations build in an area, healthy trees can also be colonized. Second, *S. noctilio* has a history of being a successful invader of North American pine species planted in commercial settings throughout the southern hemisphere. It is currently unknown how *S. noctilio* will behave in North America. Will its behaviour be aggressive, as it is in the southern hemisphere, or will there be little impact, as in its native range. In its native range, endemic populations are regulated by parasitic insects and nematodes, avian predators, and by other species of insects and fungi that compete for the same habitat and that are typically absent in its introduced range. However, in North America there is a diverse community of native parasitoids, predators, and competitors similar to that present in *S. noctilio*'s native range that will likely influence populations of the woodwasp.

The current population of *S. noctilio* was first detected in upper New York State in 2004, very close to Lake Ontario. In 2005, the Canadian Forest Service (CFS), the Ontario Ministry of Natural Resources (OMNR) and the Canadian Food Inspection Agency (CFIA) joined their efforts to set up a survey in Ontario along an east-west corridor from Cornwall to Wellington in close proximity to the New York infestation. As a result of that survey, the presence of *S. noctilio* was confirmed at six locations in southern Ontario. As of late 2010, the insect had been found throughout most of southern Ontario, as far north as Manitoulin Island, and in two areas in Quebec, within 100 km of Montreal. These finds, combined with the distribution in the northeastern U.S. suggest a wide-spread and well-established population of *S. noctilio* in North America. The impact this woodwasp could have in large jack and red pine plantations and natural forests of Canada is currently unknown, but initial work conducted in red and Scots pine stands suggest that damage is limited and that smaller suppressed trees are preferred habitat. It is currently unknown how *S. noctilio* will behave in more homogenous landscapes containing commercial forests of early rotation ages. Until more data is gathered, *S. noctilio* should be considered a high-risk pest for North America. If it spreads throughout Canada's native pine forests and is left unmanaged, the potential economic loss to Canada could be severe.

GREAT LAKES FORESTRY CENTRE (GLFC) RESEARCH

The team that coordinated the research and development of management options for *S. noctilio* in Canada was initially led by the late GLFC senior entomologist Peter de Groot. This research included developing an understanding of its life history in our ecosystems, designing detection and monitoring methods including traps and semiochemical lures, investigating the role played by natural enemies and competitors including insects and fungi on population levels, and determining the damage and potential impacts in natural and managed forests. Some of this research on *S. noctilio* management is being completed by another senior entomologist at GLFC, Jean Turgeon.

Biology of the insect

The development of *S. noctilio* from egg to adult can take one to two years, depending on climate. In southern Ontario and Quebec, adults can be found from early-July to late-September but most symptoms of new activity are seen between mid-July and late-August. Females lay eggs by drilling tiny round holes into the outer sapwood of the tree with the ovipositor, and in an adjacent drill hole they inject arthrospores of a symbiotic wood-decaying fungus (*Amylostereum areolatum*) along with a toxic mucus. Together, these substances weaken the tree and provide an ideal environment for the developing larvae to feed. Symptoms of attack include resin beads or drips from these oviposition sites. Infested trees may also have fading crowns or reddened needles. Trees usually die within one year of being colonized by *S. noctilio*.

Detection and monitoring

Effective tools to detect and delimit areas infested by *S. noctilio* are essential to its management. For example, international agreements regarding the cross border movement of wood and wood products require that accurate information on areas infested with most

invasive alien species be communicated to trading partners. Thus, CFS researchers, in collaboration with the CFIA and other partners, have been conducting research since 2005 on the development of an effective trapping device and the identification of the best way to deploy this device in the landscape to increase its effectiveness. Currently available trap and semiochemical combinations used to monitor for *S. noctilio* are generally viewed as ineffective and weak monitoring devices. Consequently, improvements in survey methodology would be helpful to the CFIA for their regulatory program.

Role of natural enemies and competitors

In its native range, parasitic insects and nematodes are effective in regulating populations of *S. noctilio*. These natural enemies have been used successfully as biological control agents in other countries where the woodwasp has been recently introduced by accident. The parasitic nematode *Deladenus siricidicola*, which sterilizes female wasps, has been shown to be very effective in some regions and is commercially available. This nematode has been found in *S. noctilio* in Canada, however, its effect on the woodwasp here is still being investigated. The parasitic wasp *Ibalia leucopsoides*, is native to Canada, where it attacks and kills native woodwasps. Native *Deladenus* spp. have been found in *S. noctilio* populations in North America, and *I. leucospoides* and other parasitoids have also expanded their host range to include *S. noctilio;* however, studies are ongoing to quantify and identify the entire complex of *S. noctilio* natural enemies in Canada and to assess their impact on its mortality. Collaborative field and laboratory studies with the University of Toronto to determine how the presence of competitors, including native bark beetles, woodborers and their fungal pathogens may affect woodwasp development and population dynamics are nearing completion. It has been speculated that native fungi may be competitors of *Amylostereum areolatum* and help limit *S. noctilio* populations.

The genetic variation of native and exotic species of the nematode *D. siricidicola* and the symbiotic fungus *A. areolatum* are also being studied. The importance of understanding the strains of each organism and techniques for identification cannot be understated. Fungal and nematode strains have important implications for a biological control program and matching these with the *S. noctilio* population is important to get the maximum efficacy from any program.

Damage and potential impact

Bioeconomic analyses and simulation models of the impact of *S. noctilio* on timber supply and harvesting in eastern Canada are being carried out by modelers at GLFC and their colleagues from the CFS and the United States. Based on these analyses, it appears that economic losses could vary considerably depending on the complex interactions among insect spread, tree mortality, and forest harvest schedules and approaches. Integrated approaches to modeling risks of invasion and impacts of the invasive species have already been developed. Indeed, a recent study maps the potential distribution of *S. noctilio* in North America over a 30-year time horizon, using a combination of risk scenarios (high, medium and low) and entry scenarios (entry from ports only and ports plus existing infestations).

These and other modeling approaches are useful for providing advance warning of the potential impact of *S. noctilio* and for prioritizing landscapes for management and survey activities. Models will likely be improved as data on impacts in different forest types (pine species and management scenarios) and a better understanding of the population biology of *S. noctilio* are gained from infested areas. Some work of this nature has been completed through collaborative efforts of the CFS, USDA Forest Service, and Harvard University where *S. noctilio* impacts in red and Scots pine stands were retrospectively studied in Ontario and New York. This work concluded that damage was limited, even in unmanaged stagnant stands and that small diameter trees with low live crown ratios were attacked more often than larger trees with healthier crowns. Results from this work and research conducted in the U.S. suggest that silvicultural treatments would be an effective tool for managing *S. noctilio* populations in North America.

CONCLUSION

GLFC scientists will continue to work closely with regulatory agencies and managers to identify the best strategies for detecting, controlling and mitigating losses from the alien woodwasp *S. noctilio* in natural and managed stands. By collaborating with other researchers, they hope to gain a greater understanding of the behaviour of the insect and find the most appropriate way to effectively manage its populations. Predictive models and field evaluations will be important tools in decision making, to minimize economic losses from this invasive insect.

COLLABORATORS

Other CFS research centres, Canadian Food Inspection Agency (CFIA), Agriculture and Agri-Food Canada (AAFC), Ontario Ministry of Natural Resources (OMNR), USDA Forest Service, and University of Toronto, Harvard University, University of Pretoria (South Africa).

ACKNOWLEDGEMENTS

Special thanks to Kathleen Ryan (University of Toronto) and Kevin Dodds (USDA Forest Service) for assisting Jean Turgeon in completing this note initiated by the late Peter de Groot.

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ISSN 1496-7847