Factors influencing northern spruce engraver colonization of white spruce slash in Interior Alaska

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Ips perturbatus (Curculionidae: Scolytinae)

- Distribution generally coincides with that of its primary host, white spruce. Other hosts include Engelmann, Lutz, and in rare cases, black spruce.
- Recorded from Alaska, Idaho, Maine, Michigan, Minnesota, Montana, and Washington, and from nearly all of the Canadian provinces.

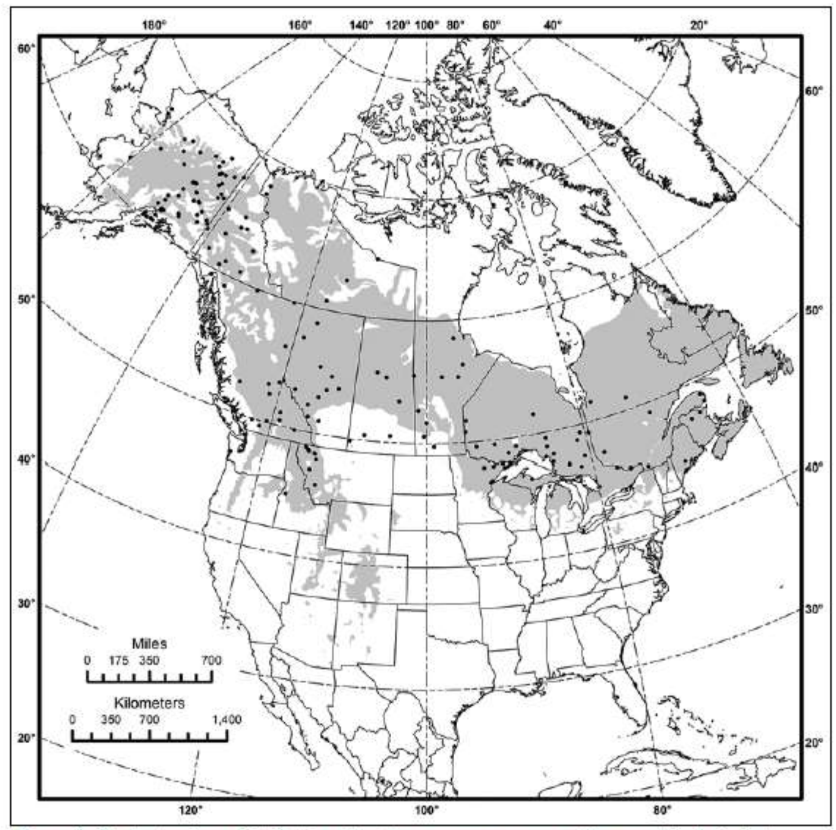

Figure 2. North American distribution of northern spruce engraver (shown as black circles) assembled from historical collection records (Bright 1976, Wood 1982) and pest surveys across the range of its major hosts, white spruce and Engelmann spruce (shown in gray).

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- Univoltine. Adults primarily overwinter in forest litter beneath brood trees, and disperse short distances in late spring.

- Males produce an aggregation pheromone (ipsenol, ipsdienol and *cis*-verbenol) (Holsten et al. 2000). Galleries are initiated in the phloem by males, which are later joined by and mate with up to 4 females in a central nuptial chamber (A).

- Larvae hatch in ~7-10 d and feed on phloem developing into pupae in ~4-5 weeks. The pupal stage lasts ~10 d.

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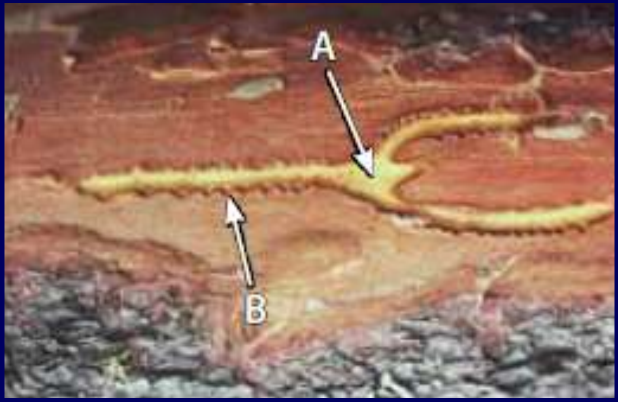

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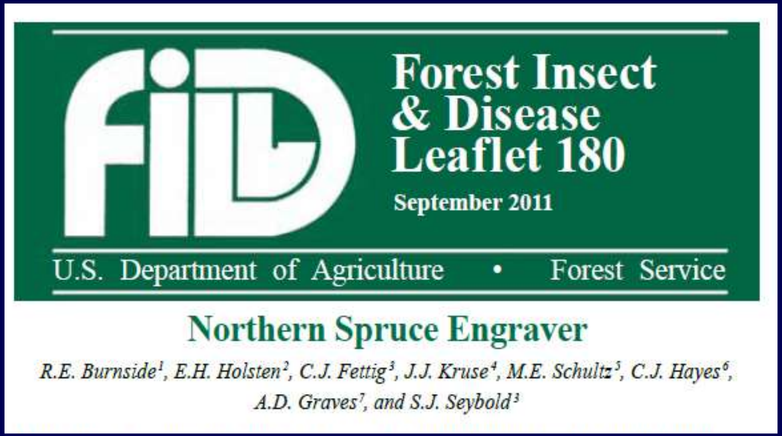
Figure 3. White spruce attacked and killed by northern spruce engraver. (A: Quartz Creek campground, AK; B: thinned white spruce plantation, MN).

- Feeding kills the phloem, which may result in tree mortality. When favorable climatic conditions coincide with large quantities of suitable host material, populations may erupt and result in mortality of apparently-healthy trees over extensive areas.

- *Pest status is increasing due to drought-induced stress of the primary host associated with climate change (Wolken et al. 2011).*

Management

- Primary preventive method is thinning followed by proper slash management aimed at maintaining healthy stands with moderate growth rates.
- During outbreaks, insecticides may be used to protect individual trees, and a behavioral interruptant has recently been discovered (Graves et al. 2008).



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Northern Spruce Engraver

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Study 1

- 20 decks consisting of 15 1.4-m logs with end diameters of 8.9–21.6 cm were cut from recently-felled white spruce in May 2009.
- Treatments: (1) untreated control and (2) *trans*-conophthorin and (–)-verbenone. *trans*-Conophthorin was attached to an end of the top log of each deck, and (–)-verbenone was stapled to the center of the top log.
- Experimental design was completely randomized (10 reps/trt).

Study 1

- Attack and emergence holes were recorded in July and August 2009, respectively, on the bark surface of each log (300) in 3 15.2-cm wide sampling (entire circumference) windows located at the center of each log and 20.3 cm from the ends of each log.

- Following sampling, logs were returned to their original positions with minimal disturbance.

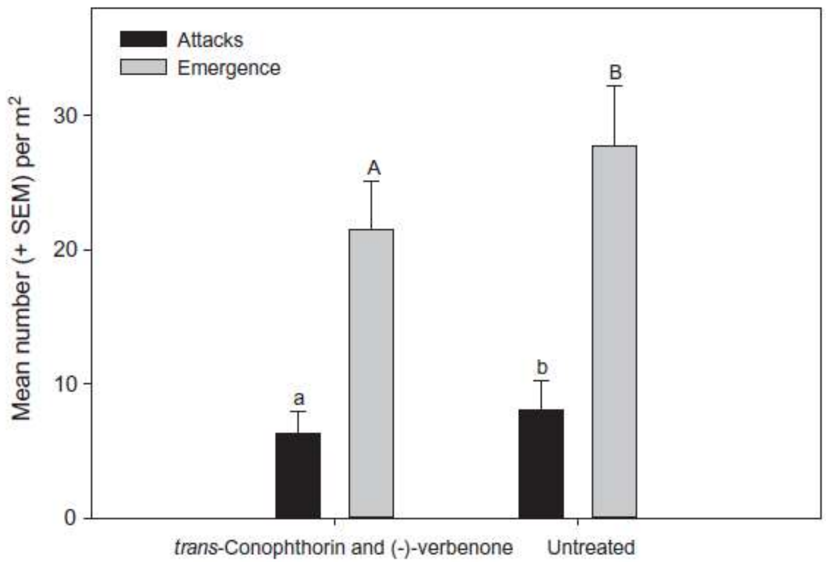

Fig. 10. Comparisons of *Ips perturbatus* attack and emergence hole densities on *Picea glauca* logs between treated and untreated decks, Tok, Alaska, USA, 2009. Means (+SEM) followed by the same letter within columns of the same color are not significantly different (t-test, $P > 0.05$). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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- Higher levels of attack and emergence occurred on the untreated control.
- Expands on earlier work (Graves et al. 2008) and provides evidence that *trans*-conophthorin and (–)-verbenone is effective for reducing colonization of slash.
- *May have utility as a semiochemical-based tool when other options (e.g., use of insecticides) are not feasible.*

Do Not Disturb These Log Piles!!!

Research in Progress

These piles may look like good firewood, but the logs are part of an important research project, conducted by the Alaska Division of Forestry and the US Forest Service, to determine the effects of different treatments to woody debris on the northern spruce engraver beetle population. The results of this research project will improve the techniques used to manage woody debris and beetle populations following a disturbance and is also part of a wood energy project testing treatments to reduce beetle infestations in stored white spruce logs.

Do not disturb! Experiment in progress.

Northern spruce engraver beetle (*Ips perturbatus*) adult. Photo by Edward H. Holsten, USDA Forest Service

For more information about this important research project, please contact Division of Forestry staff Jeff Hermanns at 883-5134 or Roger Burnside at 269-8460

Growing larvae eat live tissue under the bark and leave a distinct pattern called a gallery. Photo by Edward H. Holsten, USDA Forest Service

Small Beetle, Large Impacts

The northern spruce engraver beetle attacks white spruce, black spruce and Lutz spruce and is an important mortality agent (tree killer) of white spruce in recently disturbed areas such as those that have been recently burned by wildfire, large areas of blown down trees, recent timber harvests and land that has been cleared for construction homes, roads or fuel breaks. If favorable climatic conditions (warm, dry weather) coincide with large quantities of dead spruce, the beetle population can increase dramatically and may result in the death of healthy trees over large areas. If engraver beetle outbreaks become more common in Alaska, the effects on vegetation can increase the risk of wildfire, reduce the scenic quality of the landscape and potentially alter wildlife habitat.

ALASKA DIVISION OF FORESTRY

Study 2

- Randomized complete block with 3 blocks (locations), 9 treatments, and 2 reps/trt/block. 18 0.1-ha square plots were established in each block in May (Tok and Fairbanks) and July (Delta Junction) 2009.

- Treatments: (1) spring, decked, scored, (2) spring, decked, unscored, (3) spring, dispersed, scored, (4) spring, dispersed, unscored, (5) fall, decked, scored, (6) fall, decked, unscored, (7) fall, dispersed, scored, (8) fall, dispersed, unscored, and (9) an untreated control.

- 60 1.4-m logs with end diameters of 8.9–21.6 cm were cut (requiring 10-14 trees).

Study 2

- Attack and emergence holes were recorded on each log (960 logs X 3 blocks) in a 25.4-cm wide sampling (entire circumference) window at center (i.e., a preliminary analysis determined there was no difference in attack densities between samples obtained from the center and ends of logs).
- Data were recorded for top and bottom aspects separately. Following sampling, logs were returned to their original positions with minimal disturbance.
- A 100% cruise was conducted on each experimental plot to locate trees attacked and killed by *I. perturbatus*.

Study 2

- Few logs were attacked. Only 1 tree (29.2 cm dbh) was found to be attacked and killed by *I. perturbatus*, which is not surprising given the low attack densities observed overall.
- Treatment (decked vs. dispersed) and seasonality (spring vs. fall) had no effect on levels of attack and emergence.
- Higher attack densities occurred on scored logs compared to unscored logs, but scoring had no effect on emergence. Given the relatively low attack densities and presumably intraspecific competition, this suggests scoring increased attraction but had a negative impact on brood production.

Study 3

- As a result of the low attack densities observed in Study 2, we reproduced several aspects of that study on a smaller spatial scale using a baited design.
- Randomized complete block with 2 blocks (forest and shaded fuelbreak), 4 treatments, and 8 reps/trt/block. 32 plots were established in both the shaded fuelbreak and adjacent forest in May 2011.
- Treatments (1) decked, scored, (2) decked, unscored, (3) dispersed, scored, and (4) dispersed, unscored. 15 1.4-m logs with end diameters of 8.9–21.6 cm were cut (requiring 2–4 trees).

Study 3

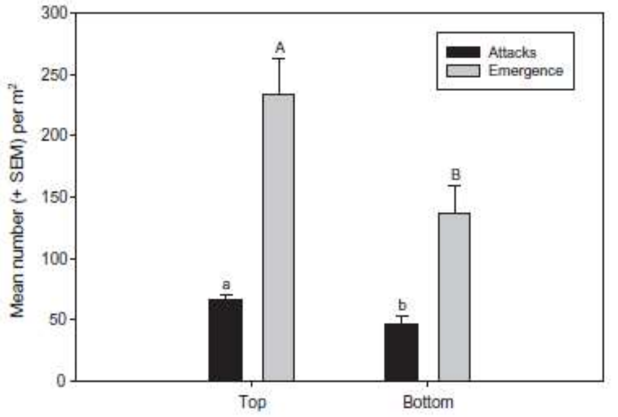

Fig. 6. Comparisons of *Ips perturbatus* attack and emergence hole densities on *Picea glauca* logs between the tops and bottoms of logs, Tok, Alaska, USA, 2011. Means (+SEM) followed by the same letter within columns of the same color are not significantly different (*t*-test, $P > 0.05$). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

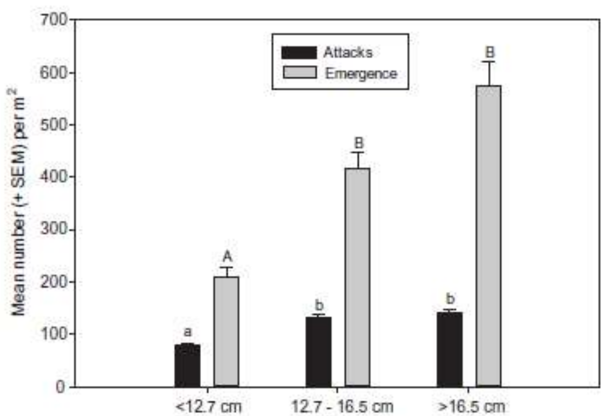

Fig. 7. Comparisons of *Ips perturbatus* attack and emergence hole densities on *Picea glauca* logs among diameter classes (measured at log center), Tok, Alaska, USA, 2011. Means (+SEM) followed by the same letter within columns of the same color are not significantly different (Tukey's HSD, $P > 0.05$). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

- Higher levels of attack and emergence occurred on the tops of logs compared to the bottoms of logs.

- Brood production (i.e., defined here as emergence/attacks on individual logs) was also greater on the tops of logs (4.5 ± 0.3 versus 3.4 ± 0.3; $P = 0.008$), suggesting the tops of logs are not only more attractive, but confer some advantage to brood development (i.e., likely differences in microclimate and levels of interspecific competition with spruce beetle).

- Lower levels of attack and emergence occurred on smaller-diameter logs.

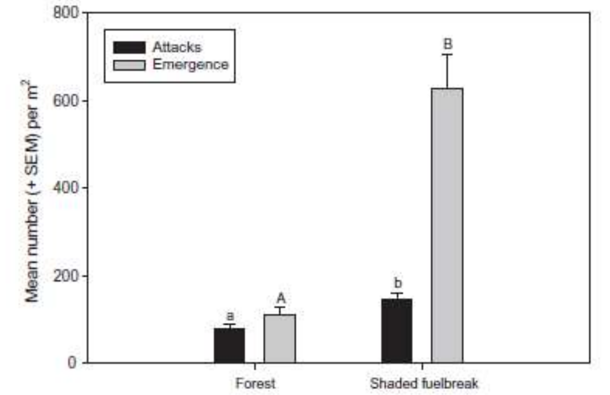

Fig. 8. Comparisons of *Ips perturbatus* attack and emergence hole densities on *Picea glauca* logs between forest and shaded fuelbreak conditions, Tok, Alaska, USA, 2011. Means (+SEM) followed by the same letter within columns of the same color are not significantly different (t-test, $P > 0.05$). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

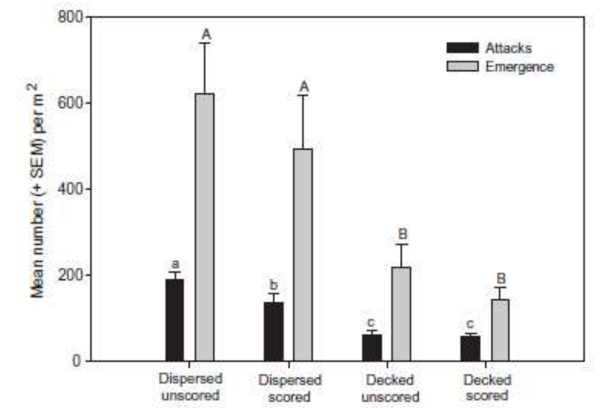

Fig. 9. Comparisons of *Ips perturbatus* attack and emergence hole densities on *Picea glauca* logs among treatments, Tok, Alaska, USA, 2011. Means (+SEM) followed by the same letter within columns of the same color are not significantly different (Tukey's HSD, $P > 0.05$). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

- Higher levels of attack and emergence were observed on logs in the shaded fuelbreak. Temps were warmer in the shaded fuelbreak (13.2 ± 0.1 vs. 12.6 ± 0.1 °C) likely affecting activity levels, flight periodicity, pheromone plumes, and survivorship.

- Treatment had a significant effect on levels of attack and emergence, which differs from Study 2 presumably due to elevated attack densities. Higher levels of attacks and emergence occurred on dispersed logs. Attack densities were highest in the dispersed, unscored treatment, and ~70% higher than observed in the decked, scored treatment.

- The scoring of dispersed logs significantly reduced attack densities by ~28%, but had no effect in decked treatments or on levels of emergence in either treatment.

Conclusions

- Most efforts that focus on providing guidelines for managing slash to minimize *Ips* brood production have been conducted with other *Ips* spp. Many have shown that fewer attacks occur on logs in more open areas or when logs are exposed to high levels of sunlight (reviewed by DeGomez et al. 2008). However, we found *I. perturbatus* colonization and brood production were higher on logs in more open conditions.

- In addition, others have reported *Ips* attacks are concentrated on the bottoms of logs particularly when exposed to high levels of sunlight (DeGomez et al. 2008), which disagrees with our results. While the impacts of drying on the suitability of slash have been well demonstrated for other spp., *I. perturbatus* seems regulated more by the apparency and accessibility of hosts.

Conclusions

- Our work reaffirms concerns about applying results obtained from studies conducted elsewhere (e.g., the western USA) to understudied areas like Interior Alaska, and highlights the need for local science to guide management activities.

- We offer the following suggestions concerning the management of slash to minimize impacts from *I. perturbatus*: (1) logs <12.7 cm in diameter are less attractive and produce less brood, and therefore represent less of a concern; (2) scoring of logs is ineffective for reducing brood production, and is likely not justified despite previous reports; (3) logs should be stored in areas of forest condition with limited sunlight, but not against residual host trees; (4) logs should be stored in a manner similar to the decked, unscored treatment; and (5) *trans*-conophthorin and (–)-verbenone may be useful for inhibiting attacks on slash, and warrants further study for larger-scale applications.

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