

Chapter 3

Bark beetle communities at Itasca State Park

3.1 INTRODUCTION

In 1994-96, the old growth pine forests in Itasca State Park sustained a sequence of heavy blowdowns from windstorms. Pine trees blowdowns provide a high quality food resource (fresh, undefended phloem) for *Ips* bark beetles and can permit rapid growth of bark beetle populations. With suitable food resources, *Ips* populations can increase by up to 10-fold per generation or 1000-fold per summer with 3 generations, and a single large pine tree might produce 80,000 beetles (Chapter 1). High populations of *Ips* following blowdowns or other disturbances that increase food resources might promote subsequent attacks in otherwise undamaged trees and lead to significant additional mortality of pine trees as a secondary effect of the blowdowns. It is not known which of the three *Ips* species that inhabit Itasca State Park are most likely to respond to blowdowns with population increases. Nor is it known how long such population increases are likely to persist or whether the population responses tend to be local or regional. These questions are of obvious importance in assessing the spatial scale and temporal duration of risks from windstorms to old growth pine trees at Itasca State Park. In this component of the research, we conducted replicated quantitative sampling of the bark beetle community within and outside of the blowdown area to address these questions.

As part of this research, we also assessed the spatial and temporal responses of bark beetle predators to the resource pulses that result from windstorms. Natural enemies can be potent forces in limiting the abundance of forest insects to levels below that of significant economic or ecological damage. Similarly, competitors can also function to limit the abundance of particular species. This would have special relevance if different species of bark beetles are more or less likely to attack live trees. For example, if *Ips grandicollis* and *Ips perroti* are less likely to attack live trees than *Ips pini*, then increases in the former, less aggressive, species can be viewed as a natural control on the abundance of the more dangerous *I. pini*. Management strategies that incorporate these natural control agents can be cost-effective as well as environmentally friendly. However, this approach

requires an understanding of the structure and function of bark beetle communities in Itasca State Park. Consequently, our sampling was also designed to address the following questions. Under baseline conditions (in the absence of blowdowns), what is the relative abundance of *Ips* bark beetles and their natural enemies? What is the relative abundance of the three *Ips* species that occur in the park (*I. pini*, *I. grandicollis*, and *I. perroti*)? What is the seasonal timing of their flight activity and reproduction? How does the abundance and species composition of the bark beetle community change in the presence of blowdowns? Which of the bark beetle species is the most likely to cause tree mortality and which of the natural enemies exerts the strongest control over that species of *Ips*? An additional objective was to assess the efficacy of different pheromones in sampling the various members of the bark beetle community at Itasca State Park.

3.2 METHODS

We used funnel traps and pheromone lures to sample the bark beetle community in 26 pine stands within and around Itasca State Park (Fig. 3.1: 11 sites within undisturbed old growth red pine forest, 5 sites within red pine blowdowns from the storms of 1996, 5 sites in old growth forest near the blowdowns (200 - 300 m distant), and 4 sites in red pine plantations just outside the park (30 - 60 years of age, 1 - 15 km from the park). Each site was sampled with an array of 3 traps separated by 15 m (usually configured as an equilateral triangle); within a site, each trap was baited with either ipsdienol + lanierone (produced and preferred by *I. pini*), ipsenol (produced and preferred by *I. grandicollis*), or ispdienol + ipsenol (produced and preferred by *I. perroti*). Ipsdienol and ipsenol lures had an elution rate of 0.2 mg / d. Traps were implemented by 1 July 1997 and emptied every two weeks through the remainder of the flight season during 1997 (late September). During 1998, trapping was conducted with the same protocol at the same sites from the beginning of flight (early May) until the end of beetle flight (mid-September). Pheromone lures were rotated each time the traps were checked to control against spurious effects of trap position. We counted and identified all *Ips* and *Ips* predators that were captured.

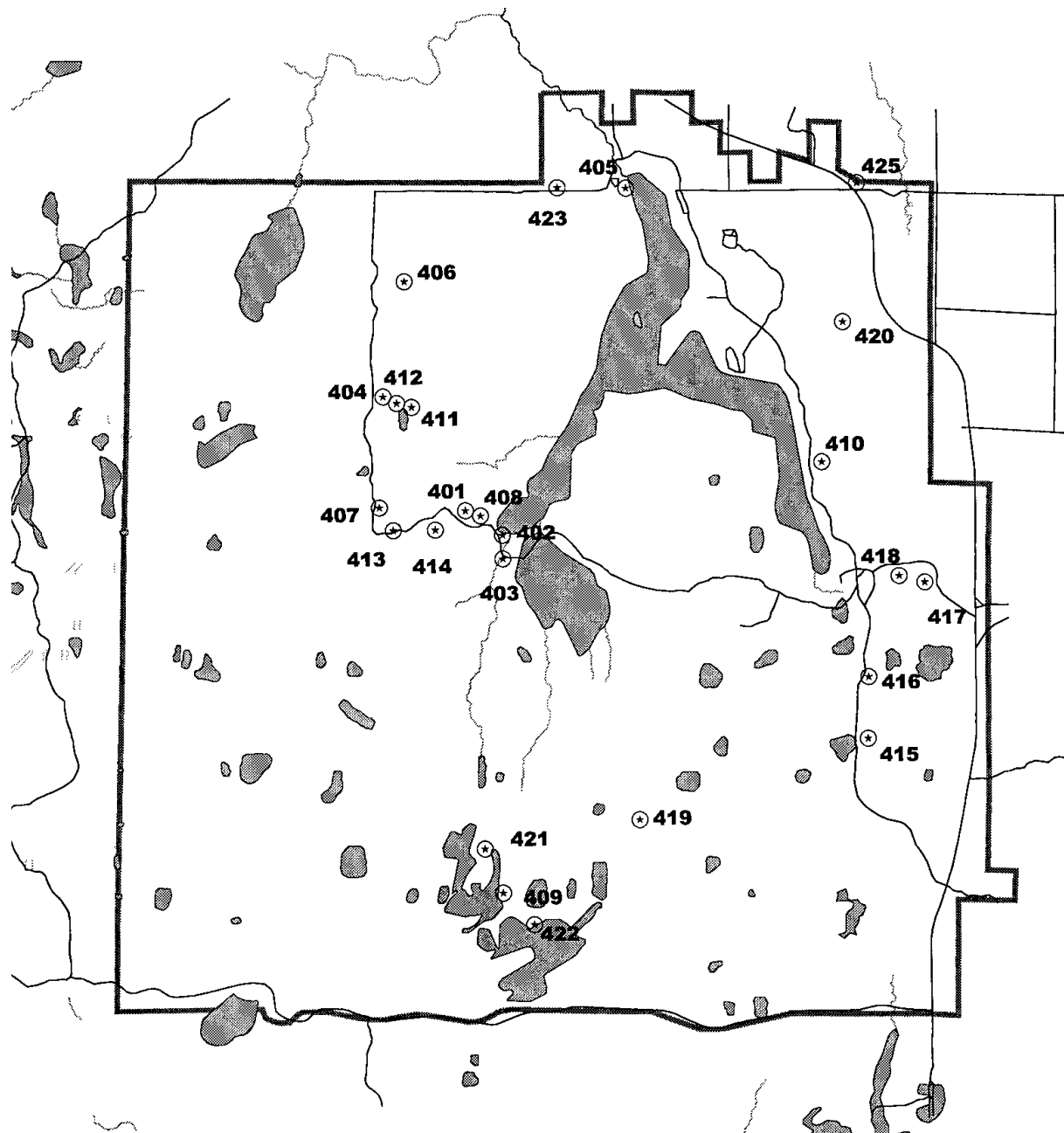


Fig. 3.1. Location of pheromone trap arrays for studies of the responses of *Ips* communities to windstorm disturbance. Appendix 4 indicates the forest type and disturbance class of each stand and provides the full record of beetle captures .

3.3 RESULTS AND DISCUSSION

During 1997, 1-2 years after windstorms, the abundance of *I. pini* was 4-5 times higher in the windthrow areas of old growth forests at Itasca Park than it was in undisturbed old growth or near windthrow areas (Fig. 3.2). However, *I. pini* abundance declined markedly in 1998 and there was no longer any effect of disturbance history on local abundance *I. pini*. *I. grandicollis* also showed an increase in their abundance in response to windstorm disturbance, but in this case, abundance was elevated at sites both within and near the site of windstorm disturbance, and the effect persisted through at least 1998 (Fig. 3.2). (Note that the abundance of *I. grandicollis*, the predator, *Thanasimus dubius*, and to a lesser extent, *I. perroti*, was underestimated in 1997 because the sampling was not implemented until after the peak flights for these species; Fig. 3.3.) *I. perroti* did not show any obvious responses to previous windstorm disturbance in either 1997 or 1998 (Fig. 3.2).

From July - September 1997, the abundance of *Thanasimus dubius*, the most important specialist predator of *Ips*, was lower in sites near blowdowns than anywhere else, including sites within the blowdowns (Fig. 3.2). Thus, the cumulative effect of disturbance on *I. pini* and *T. dubius* was that the abundance of prey relative to predator was markedly increased within and near windthrow areas of old growth forest (Table 1.1). Consequently, the potential for predator regulation of *I. pini* was reduced both within the blowdowns (due to increases in *I. pini*) and near the blowdowns (due to decreases in *T. dubius*) (Table 1.1). Presumably, the abundance of predator was reduced in forests adjacent to blowdowns because they were drawn into the blowdown areas by strong pheromone plumes from logs being colonized by *Ips*. Thus, the indirect effect of windstorm disturbance on *I. pini* and their predators can extend >200 m into the adjacent undisturbed forest. *I. grandicollis* differed from *I. pini* in that their abundance was increased by blowdowns over a larger area and for a longer time. Presumably, the larger spatial effect is because *I. grandicollis* tends to disperse more widely than *I. pini* and the greater longevity of the effect is because most *I. grandicollis* have only a single generation per year at Itasca, compared to 2-3 generations per year for *I. pini*. These results indicate that healthy pine within at least 200-300 m of blowdowns may be at risk for at least two years as a result of local increases in the abundance of *I. pini* and *I.*

grandicollis, and correlated decreases in the abundance of predators relative to prey

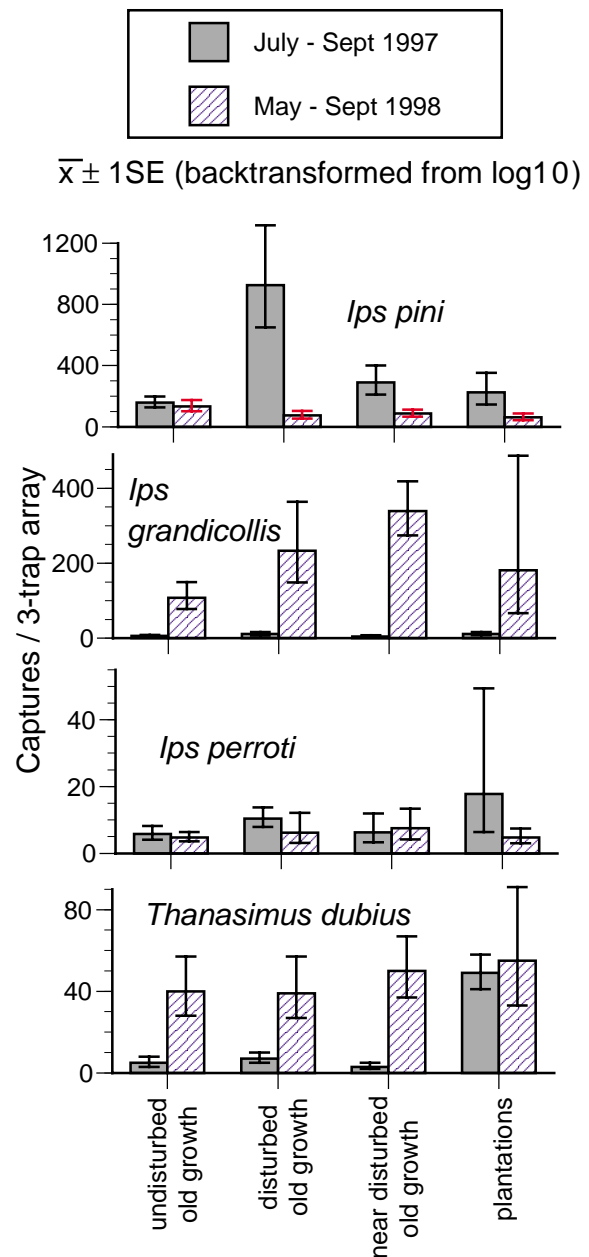


Fig 3.2. Abundance of *Ips* and their chief predator in old-growth pine stands at Itasca State Park with recent blowdowns (disturbed old growth), within 200-300 m of recent blowdowns (near disturbed old growth), and separated from the nearest blowdowns by > 500 m (undisturbed old growth). We also sampled in red pine plantations outside the park that contained younger trees (35 - 80 years old) and were 2 - 20 km from the nearest pine blowdowns.

Table 3.1: Relative abundance of predators (*T. dubius*) and prey (*Ips* spp.) in undisturbed old growth forest, old growth forest with windthrows in 1996-97, old growth forest near windthrows, and pine plantations near the park.

	Number of predators			
	Undisturbed	Disturbed	Near dist..	Plantation
Observed	163	46	18	212
Expected ^a	93	232	55	59
Prey / predator	15	129	78	7

^a based on the null hypothesis of equal predator : prey ratios

Chi-square = 628.60, df = 3, P < 0.0001

The abundance of *I. pini* peaked during late summer, mid-September, while the abundance of *I. grandicollis* peaked in early May, and that of *I. perroti* peaked in August (Fig. 3.3). These patterns are similar to what we have typically observed during about ten years of similar sampling in west central Wisconsin, where we have additional information from direct observations of development in immature beetles and sampling throughout the year of adult colonizers in logs. Our interpretation of the data from Itasca is that most *I. grandicollis* have a single generation per year, but that some individuals of *I. grandicollis* go through a second generation (indicated by the small rise in trap captures during late 1998). In contrast, *I. pini* apparently complete two - three generations per summer: captures in May represent adults that successfully overwintered (parental generation); captures in late July represent their adult progeny (F₁ generation); captures in September represent their progeny (F₂ generation). *I. pini* captured the subsequent spring will be a mix of the F₂ generation that deferred reproduction and entered diapause directly plus progeny of the F₂ generation (F₃ generation) that completed development to adults during autumn of the Wisconsin. During 1998, maximum abundance of *I. pini* was about twice that of *I. grandicollis* and about 8 times that of *I. perroti* (Fig. 3.3). Captures of both of the most abundant specialist predators, *T. dubius* (Coleoptera: Cleridae) and *Platysoma cylindrica* (Coleoptera: Histeridae) were greatest in May and then remained at low levels throughout the rest of the summer. This temporal pattern matches our observations in west central Wisconsin and indicates these predators are much more likely to prey upon *I. grandicollis* than *I.*

pini. Based on our studies in Wisconsin, we believe that *T. dubius* has but a single generation per year at Itasca, and that the captures of *T. dubius* adults in late summer represent a proportion of the population that completed development the previous year and remained in diapause as prepupae throughout the first part of the summer.

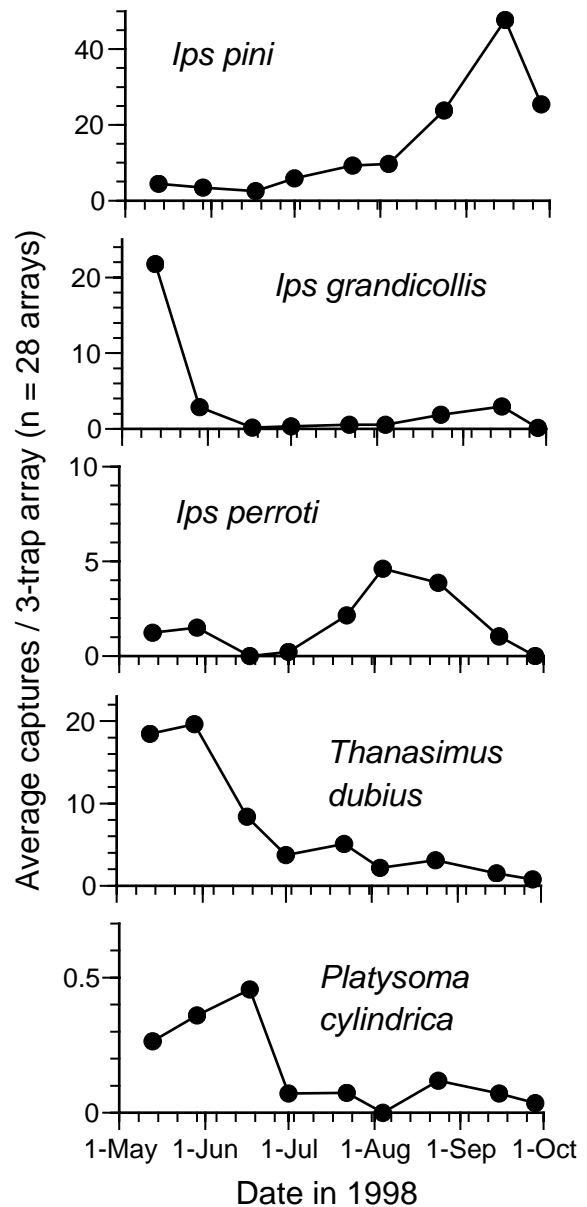


Fig. 3.3. Seasonal patterns in trap captures of *Ips* bark beetles and their chief predators at Itasca State Park

Across sites within the old growth forest, the abundance of *I. grandicollis* was positively correlated with that of *I. perroti*, but not with that of *I. pini* (Fig. 3.4), suggesting that the local abundance of the two most common bark beetles (*I. pini* and *I. grandicollis*) is determined by different factors. The local abundance of *T. dubius* was positively correlated with that of *I. grandicollis* but negatively correlated with that of *I. pini* (Fig. 3.5). Furthermore, the local abundance of both species of *Platysoma* predators were positively correlated with the abundance of *T. dubius* (Fig. 3.6) and *I. grandicollis* but not *I. pini*. It appears that the local abundance of specialist predators tends to be influenced by the abundance of *I.*

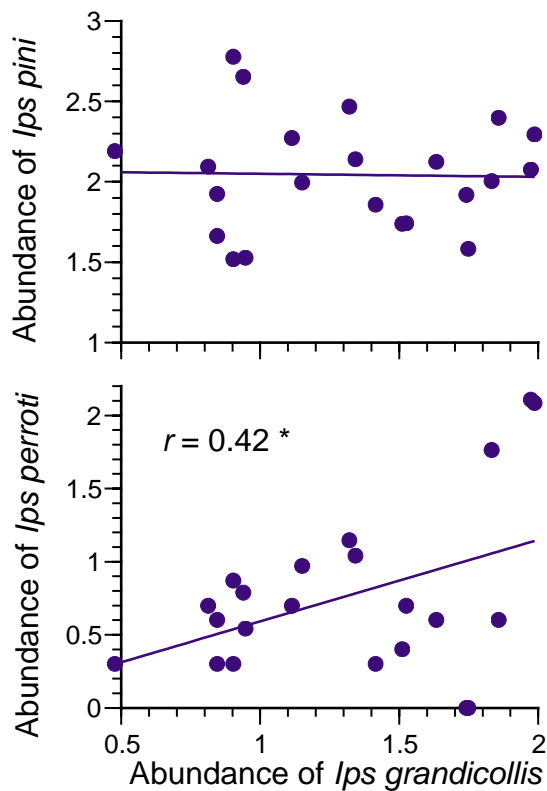


Fig 3.4. Correlation across stands of old growth forest between the abundance of different species of *Ips*

grandicollis, presumably because *I. grandicollis* are the most abundant prey when *T. dubius* adults are feeding and reproducing in May. Conversely, the negative correlation between *I. pini* and *T. dubius* (Fig. 3.5 upper) suggests that *T. dubius* predation may sometimes limit the population size of *I. pini*. It is possible for *T. dubius* populations could simultaneously respond to the abundance of one prey species (*I. grandicollis*) and control the abundance of a second prey species (*I. pini*) if they prey upon both species but exert greater per capita impacts on the second species.

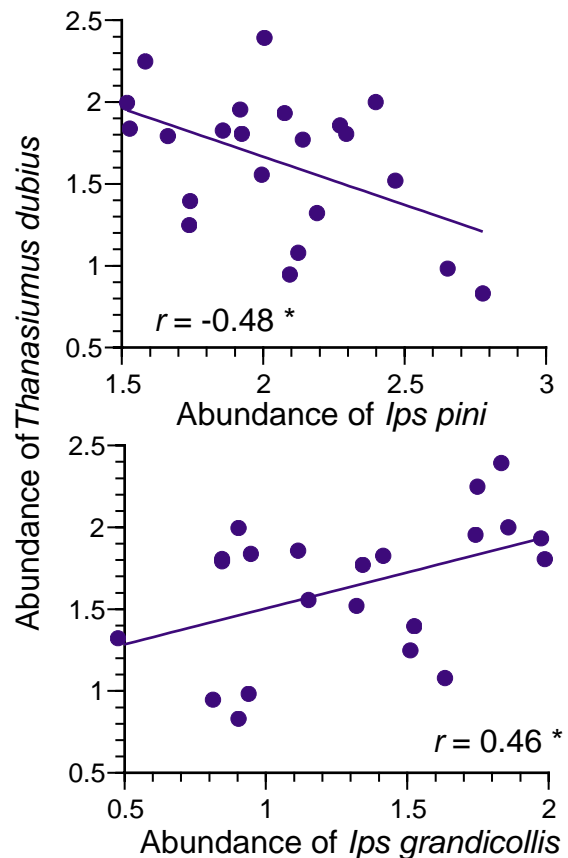


Fig 3.5. Correlation across stands of old growth forest between the abundance of *Ips* and their most common specialist predator, *Thanasius dubius*

Competition among bark beetle species apparently tends to be reduced by the spatial and temporal separation of the three species, but they nonetheless overlap extensively in their resource use, and food resources are frequently limiting. So it seems probable that increased abundance of any one of the three species would tend to lower reproductive success of the other species. It is generally thought that of these species, *I. pini* is the most likely to kill trees. However, only limited evidence supports this belief and we observed all three species attacking live trees at Itasca. To the extent that *I. pini* is the most significant forest pest, *I. grandicollis* and *I. perroti* can be thought of as natural control agents of *I. pini*. Alternatively, if *I. grandicollis* is equally likely to attack live trees, then mass-trapping of *I. pini* may allow compensating increases in the abundance of *I. grandicollis* (because of relaxed competition from *I. pini*) and provide no net benefits in reducing tree mortality.

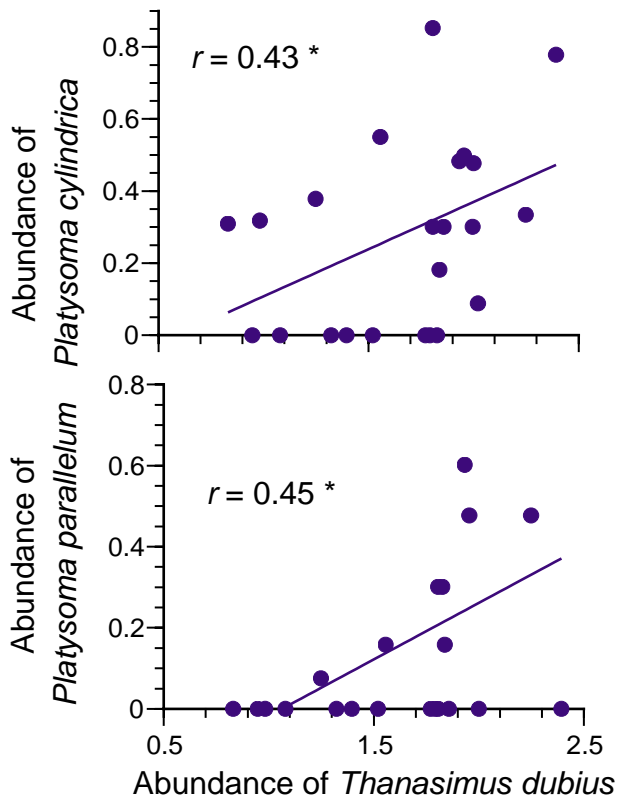


Fig 3.6. Correlation across stands of old growth forest between the abundance of the most common specialist predators of *Ips*, *Thanasimus dubius* (Cleridae) and two species of *Platysoma* (Histeridae).

These results allow some inference about the scale of beetle movements. Preliminary interpretations suggest that the effects of windthrows on *Ips* populations was restricted to within 200-300 m of the disturbance. This is also consistent with empirical studies of bark beetle movement indicating that within continuous forests, most beetles disperse less than 500 m (Turchin and Thoeny 1993). The implication is that beetle control programs or risk mitigation measures in response to blowdowns could be effective when conducted on a scale of hectares and need not be conducted across many square kilometers. One other practical implication is that forests outside the park suffer little risk of outbreaks due to beetle population fluctuations within the park.

Trapping results indicate that 3-trap arrays baited with 3 different combinations of commercially available pheromone blends provide an efficient protocol for quantifying the abundance of the most numerically important members of the bark beetle community at Itasca State Park (Fig. 3.7). A racemic blend of ipsdienol plus Lanierone captured primarily *I. pini*. Ipsenol by itself captured primarily *I. grandicollis* and ipsdienol + ipsenol captured primarily *I. perroti*. *Thanasimus dubius* and *Platysoma cylindrica* respond about equally to all three pheromone combinations, indicating that they are potential predators of all three species (although they overlap more in space and time with *I. grandicollis* than with *I. pini*). *P. parallelum* was least common of these predators, but displayed a strong preference for the combination of ipsdienol + ipsenol, suggesting that it is specialist predator of *I. perroti*.

Modest sampling with different enantiomeric blends of ipsdienol (one 3-trap array at each of 4 sites) indicated that a blend of 75%-(+): 25%(-) was most attractive to *I. pini*, followed by a racemic blend of 50%-(+): 50%(-), and a blend of 25%-(+): 75%(-). The relative attractiveness of the racemic blend was sufficiently high (and its cost sufficiently low) that this makes a good cost-effective pheromone blend for trapping *I. pini* populations at Itasca. All of these patterns in pheromone preferences match our observations in Wisconsin, indicating that the broad patterns in pheromone preferences of these species are relatively constant across the western Great Lakes region.

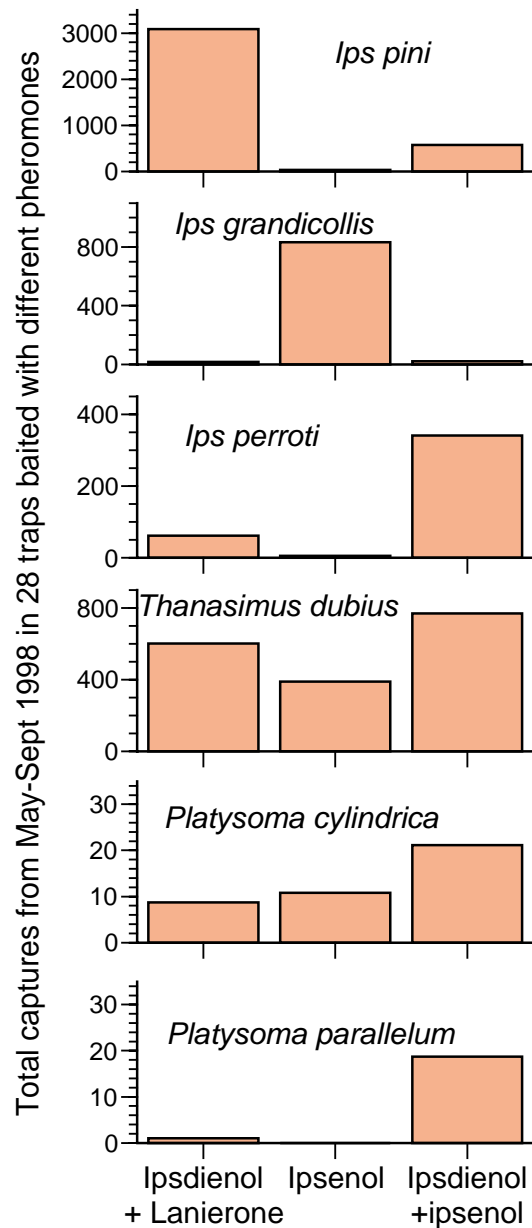


Fig 3.7. Captures of three species of *Ips* bark beetles and their most abundant specialist predators in funnel traps baited with different combinations of pheromones

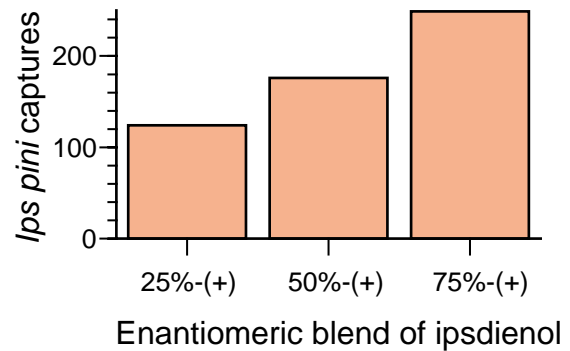


Fig 3.8. Captures of *Ips pini* in funnel traps baited with different enantiomeric blends of ipsdienol.

Conclusions. We recommend that low level sampling of bark beetle populations be continued each year at Itasca to monitor the relative regional abundance of bark beetle populations. Establishing 5-10 permanent trapping sites, with a 3-trap array at each site (each baited with either ipsdienol + lanierone, ipsenol, or ipsdienol + ipsenol) would provide a valuable tool for assessing the risks from bark beetles that are associated with blowdowns or controlled burning. Controlled burning, which appears to temporarily exacerbate the risk to trees of bark beetle infestations could then be planned to follow summers in which the regional abundance of *Ips* is low, especially when low abundance during the summer is followed by winter conditions that will further lower the abundance of bark beetles (see Chapter 4). The logistics of establishing such a monitoring program would be quite easy now because of the availability of traps and trained personnel at Itasca.

