Bark beetle activity associated with tornado-damaged ponderosa pine in northern Arizona

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Introduction

The US National Oceanic and Atmospheric Administration (NOAA) confirmed that at least six tornados occurred during the early morning of October 6, 2010 in northern Arizona (Fig. 1). Analysis of satellite imagery found approximately 2,400 ha of moderately high to severe damage across >80 km of tornado paths, plus many additional areas of low to moderate damage. There was an array of tree damage including windthrown trees with roots still attached to soil and trees snapped off at various heights (Fig. 2). Certain species of bark beetles, mainly engraver beetles (*Ips* species), are known to infest storm-damaged trees (Fig. 2) and potentially cause tree mortality in nearby areas. We began monitoring bark beetle activity associated with tornado-damaged ponderosa pine during the spring of 2011.

Objectives

- Quantify bark beetle activity associated with tornado-caused damage to ponderosa pine forests in northern Arizona.
- Document the diversity, abundance and chronology of insects associated with this disturbance event.

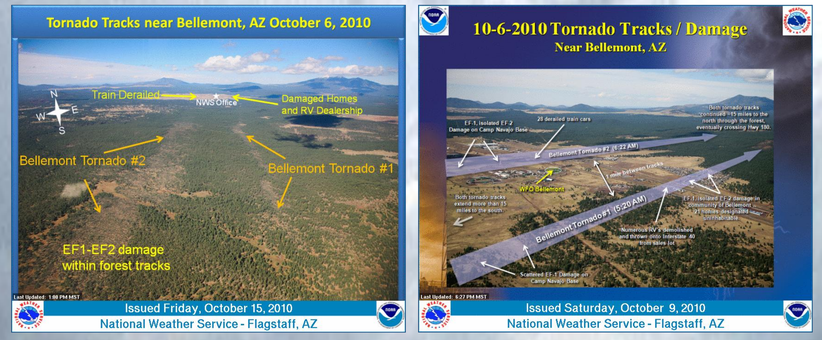

Figure 1. *A series of tornados occurred approximately 15 km west of Flagstaff, Arizona. Additional severe tornados occurred north and south of Flagstaff.*

Figure 2. *Tornado-caused windthrown ponderosa pine (a), broken tops and stobs (b). Ips calligraphus attacks indicated by large piles of boring dust (c) and nuptial chamber & egg galleries (d) in windthrown ponderosa pine.*

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Methods

- Three traps baited with either *I. pini*, *D. brevicomis* or a 4 component wood borer lure were placed at each of 13 sites
- At 10 sites bark beetle activity was evaluated in windthrown trees, broken tops, stobs & undamaged trees in both open (high damage severity) and closed canopy (low damage severity) conditions (Fig. 3a)
- *Ips pini* attack densities (nuptial chambers & egg galleries) were quantified on 5 windthrown trees at each of 2 sites by removing 200 cm^2 bark samples at varying log diameters (Fig 3b,c)
- Emergence of bark beetles & associates were recorded on a weekly basis from 4 infested bolts (18 cm diameter x 46 cm length) collected from broken tops and windthrown trees in both open and closed canopy conditions at each of 5 sites (Fig 3d).

Preliminary Results

1. Numerous bark beetles (6 *Ips* & 5 *Dendroctonus* species plus species from 5 other genera), predators (4+ species), wood borers and associates were collected from baited traps and down material in tornado impacted areas. Based on trap catches, *Ips* species (only *I. pini* shown) populations increased throughout the summer of 2011, while primary *Dendroctonus* species (only *D. brevicomis* shown) apparently did not have as large of response (Fig. 4).
2. In general, *Ips* activity was greater in smaller sized material (Fig. 5a) and broken tops (Fig 5b) that were shaded. *Ips*, *D. valens* (red turpentine beetle: RTB) and wood borers were more common in open canopy stobs than closed canopy stobs; however, the opposite pattern was observed for windthrow and broken tops. Other *Dendroctonus* were most common in closed canopy areas (Fig. 6).
3. An inverse relationship was detected between number of *I. pini* nuptial chambers and log diameter (Fig. 7) and also *I. pini* egg galleries and log diameter (Fig. 7).
4. *Ips pini* attacks (Fig. 8a) and emergence (Fig. 8b) per infested bolt were greater in closed canopy conditions compared to open canopy. Similar attack densities were found in broken tops and windthrown trees (Fig. 8a), although there was slightly lower emergence from windthrown trees (Fig. 8b)

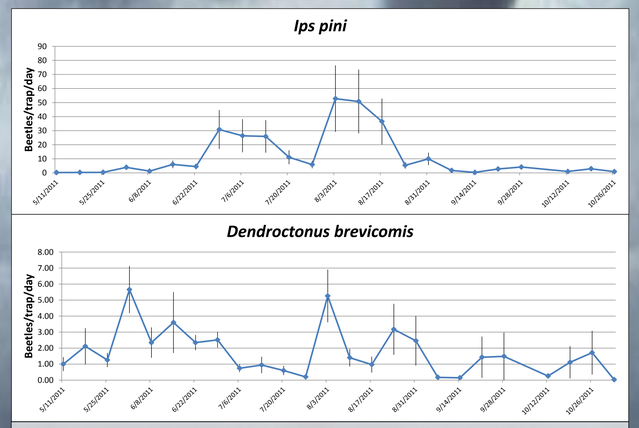


Figure 4. *Trap catches of* I. pini *and* D. brevicomis *from five tornado impacted sites on the Flagstaff Ranger District, Coconino National Forest.*

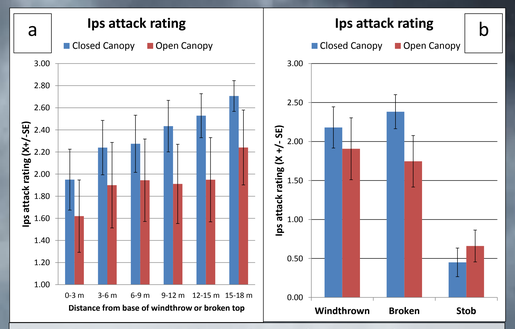
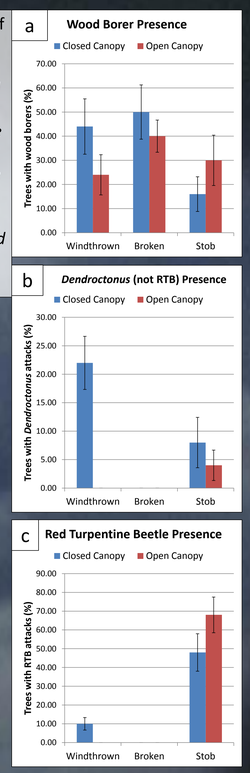


Figure 5. Ips *attack density by distance from base of down material (a) and by damage material type (b) in closed and open canopy conditions using a 0-3 rating scale. 0 = no attacks/3 m section, 1 = 1-5 attacks, 2 = 5- 10 attacks and 3 = >10 attacks .*

Figure 6. Presence of (a) *wood borers (all species combined), (b) Dendroctonus (all species combined except red turpentine beetle (RTB), and (c) red turpentine beetle in different types of tornado-caused tree damage in closed and open canopy conditions*



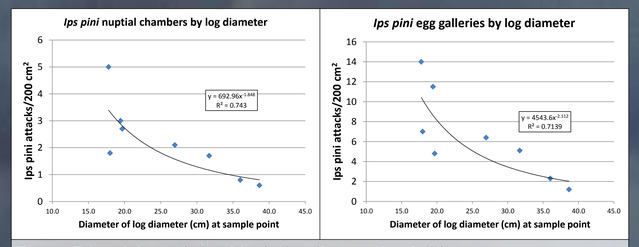


Figure 7. Ips pini *attack densities by log diameter in windthrown trees.*

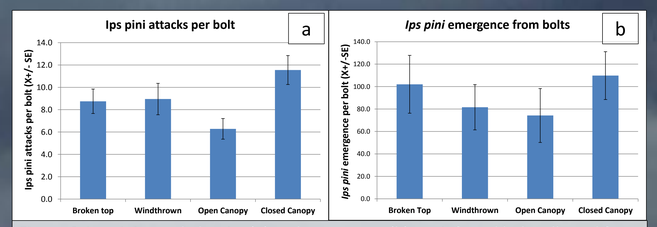


Figure 8. Ips pini *attack density (a) and emergence (b) per infested bolt collected from broken tops & windthrown trees in both open canopy and closed canopy conditions.*

Future Plans

During 2012 we will repeat trapping and monitoring activities. In particular, we will be focusing on areas adjacent to tornado swaths as we expect bark beetles to begin attacking undamaged or partially weakened trees once downed material has been completely utilized or is no longer suitable for brood production.