# Did the Polar Vortex freeze the NJ bark beetle epidemic? 11 January 2014

The Polar Vortex made a rare visit to the NJ Pinelands last weekend. Did the cold extinguish the southern pine beetle epidemic that has been plaguing the Pinelands for the last decade? Good question, as reported on this week by Lisa Foderaro in the New York Times, The NOAA weather station at Millville Airport in the southern Pinelands reported a low of -9 °F early Sunday morning. Our studies predict about 95% mortality in southern pine beetles from this temperature (Figure 1), which would be enough to produce an important decline in the abundance of this pest. However, the cold was right on the edge of beetle-killing temperatures and of course the news emphasized reports of exceptional cold. The other NOAA stations in and around the Pinelands only reported lows of 3 to -3 °F (Figure 2), yielding expected mortality of only 35-70%. With a pest that has 3 generations per year and can increase by at least 4-fold per generation, this is helpful but not enough to squash the epidemic. The cold seemed dramatic, and in fact was the first subzero report from the Atlantic City NOAA station since the winter of 1995-96. However, colder temperatures were common during the 1960s to 1980s. Weather records from the National Climate Data Center for stations in Atlantic City and Hightstown, show ten or more colder events from 1960 to 1996 (Figure 3).

It is logical to hope that a cold bout such as last weekend could help with pest insects in NJ and elsewhere. The recent epidemic of southern pine beetles in NJ has been permitted by the recent absence of cold winter nights. Unfortunately in this respect, the warming trend remains strong and seems unlikely to abate. Even with the Polar Vortex excursion of 2014, there is still a bumpy but statistically clear warming trend of about 7 to 8 °F in the coldest night of the winter since 1960 (Figure 2). This dwarfs the warming trend at these same two stations in average annual temperature over the same time period (only 1-2 °F). Furthermore, minimum annual temperature is probably of more consequence than average temperature for biological systems because the coldest winter night limits the distribution of many plants and animals. If, as scientists believe, warming is a product of rising greenhouse gases we should expect that cold bouts will continue to become less frequent in the Pinelands. This means that homeowners can expect more success with azaleas and cherry trees (USDA plant zones), but we should also expect growing interactions with pests that were previously rare or absent in the Pinelands.

The Polar Vortex did not extinguish the Pinelands beetle epidemic but it was an ally to forest managers. The cold, in combination with suppression by NJ Forest Service during 2013, means there will be less beetles than otherwise in 2014. This creates a management opportunity because beetle abundance is bipolar with a tipping point between epidemics and relatively stable low populations. 2014 might be our best opportunity yet for suppression efforts to drive the epidemic back to less costly and more manageable low abundance. Interested readers can find more details below about our understanding of beetle mortality as a function of winter cold.

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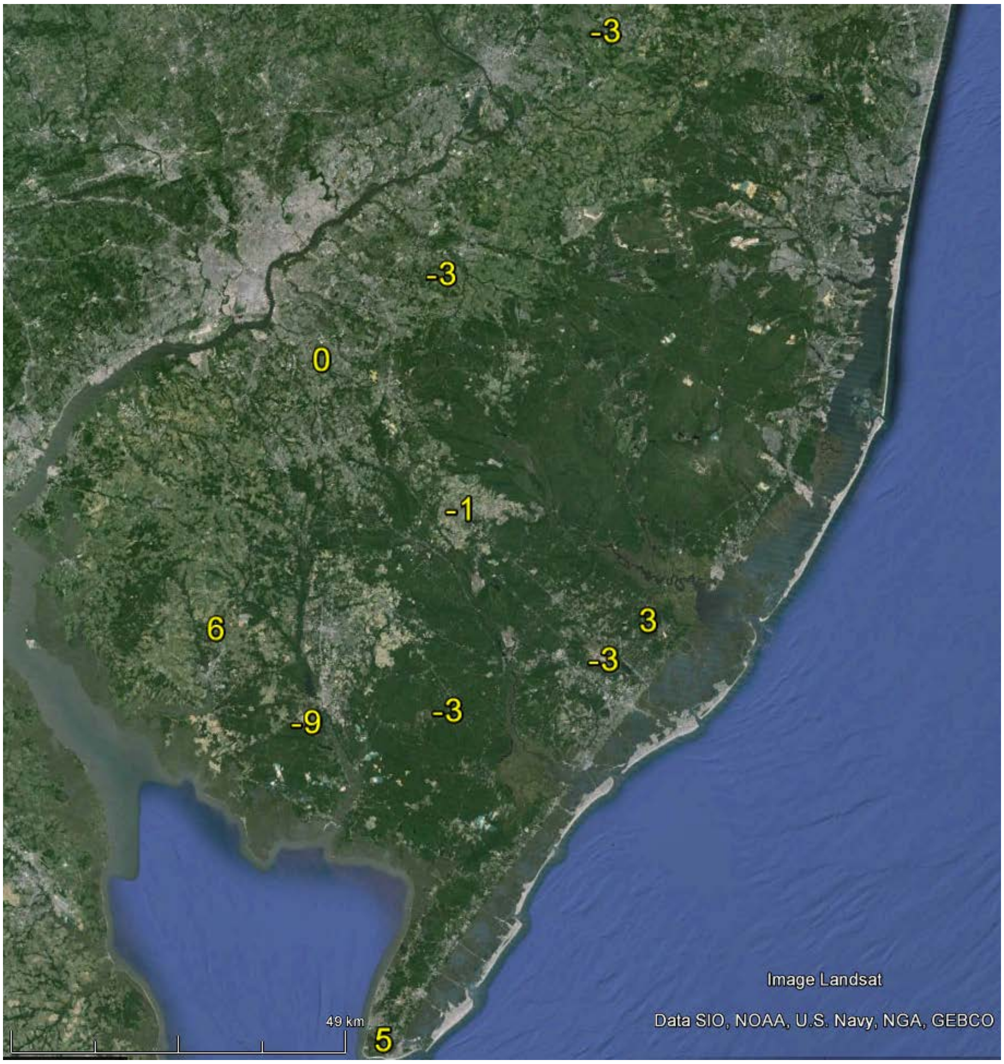
National Institute of Food and Agriculture
Southern Research Station




| Location | NOAA NCDC Station Name | Tmin (°F) | Estimated SPB mortality |
|---|---|---|---|
| N40.265 E74.5641 | HIGHTSTOWN 2 W NJ US | -2.9 | 0.70 |
| N39.9492 E74.8417 | MOUNT HOLLY SOUTH JERSEY REGIONAL AIRPORT | -2.7 | 0.69 |
| N39.8372 E75.0442 | SOMERDALE 4 SW NJ US | 0.0 | 0.53 |
| N39.6442 E74.8072 | HAMMONTON 1 NE NJ US | -1.0 | 0.59 |
| N39.500 E74.500 | EB FORSYTHE NEW JERSEY NJ US | 3.0 | 0.38 |
| N39.4871 E75.2201 | SEABROOK FARMS NJ US | 6.1 | 0.28 |
| N39.4494 E74.5672 | ATLANTIC CITY INTERNATIONAL AIRPORT NJ US | -2.7 | 0.69 |
| N39.383 E74.8288 | ESTELL MANOR NJ US | -2.9 | 0.70 |
| N39.3667 E75.0667 | MILLVILLE MUNICIPAL AIRPORT NJ US | -8.9 | 0.95 |

**Figure 1.** Minimum temperatures (°F) reported by NOAA's National Climate Data Center for stations in and around the Pinelands for night of 4-5 Jan 2014. Right column of table shows expected mortality for southern pine beetles from the corresponding temperature based on model shown in Figure 2. Satellite image from Google Earth.

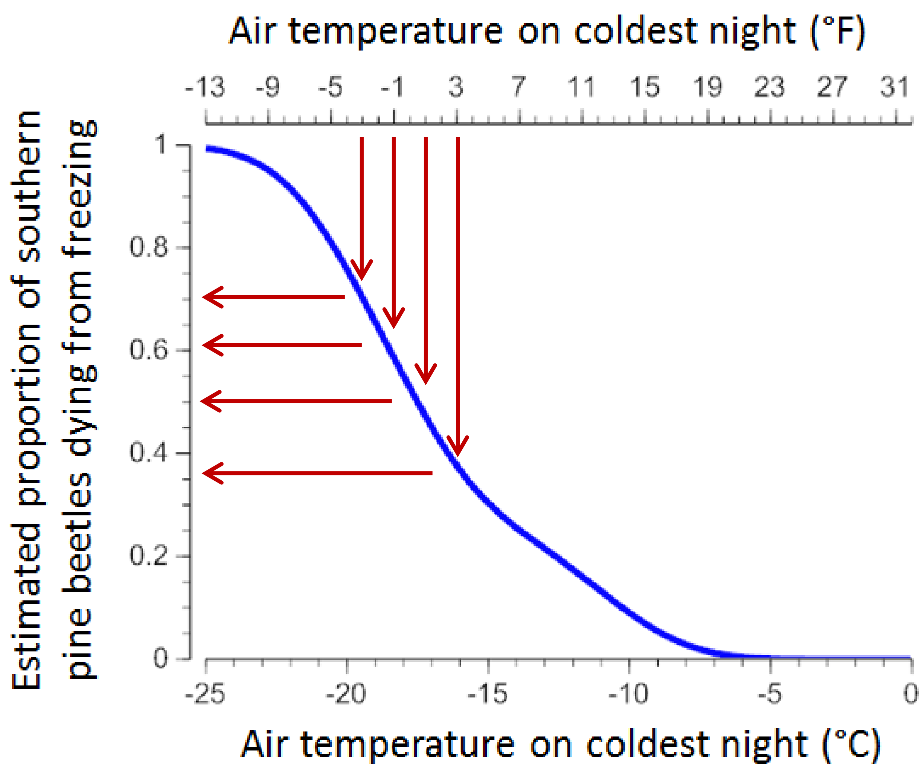



**Figure 2.** Expected mortality of southern pine beetles from the corresponding air temperature. Simplified from Equation 5 and Figure 7 in [Tran et al. (2007).]

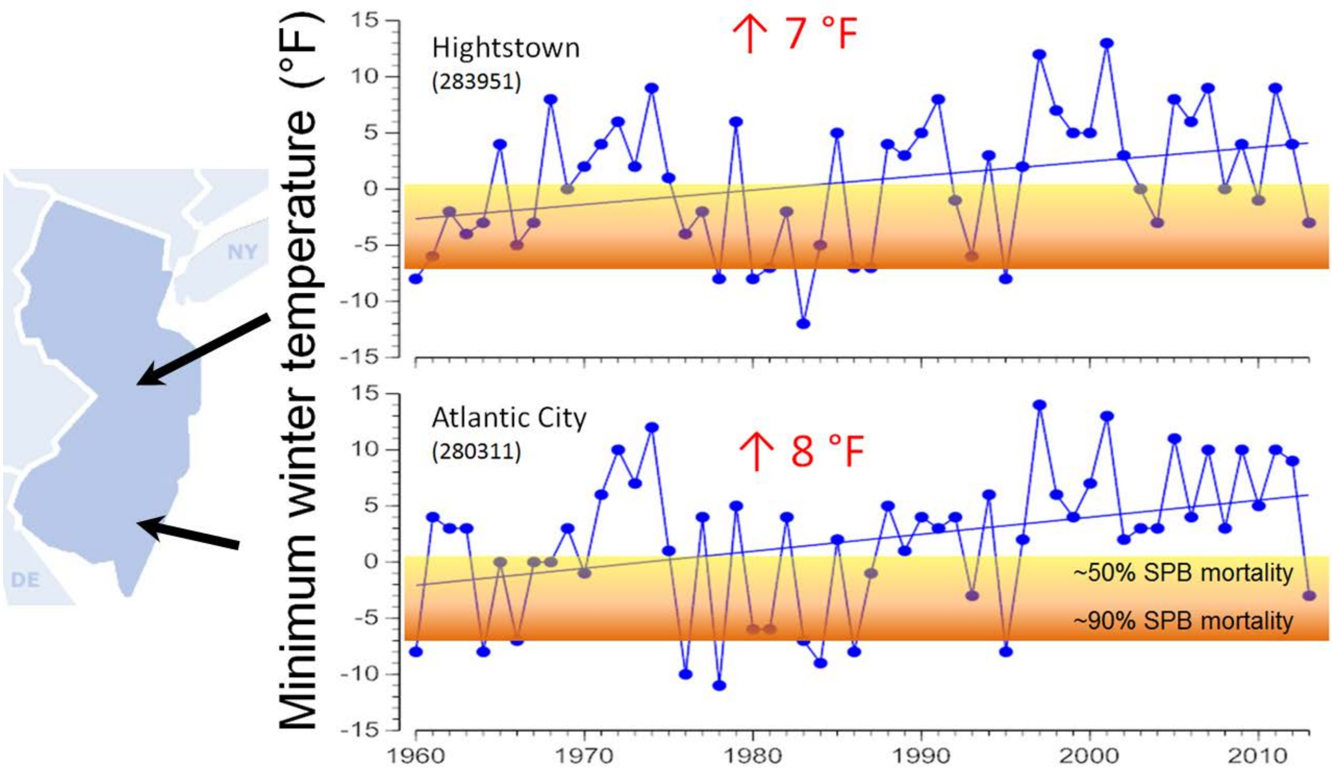



**Figure 3.** Temperatures on the coldest night of the winter from 1960 through Jan 2014 at the warm and cold margins of the New Jersey Pinelands. Data from NOAA's National Climate Data Center. Updated from Figure 7 in Weed et al. (2013).

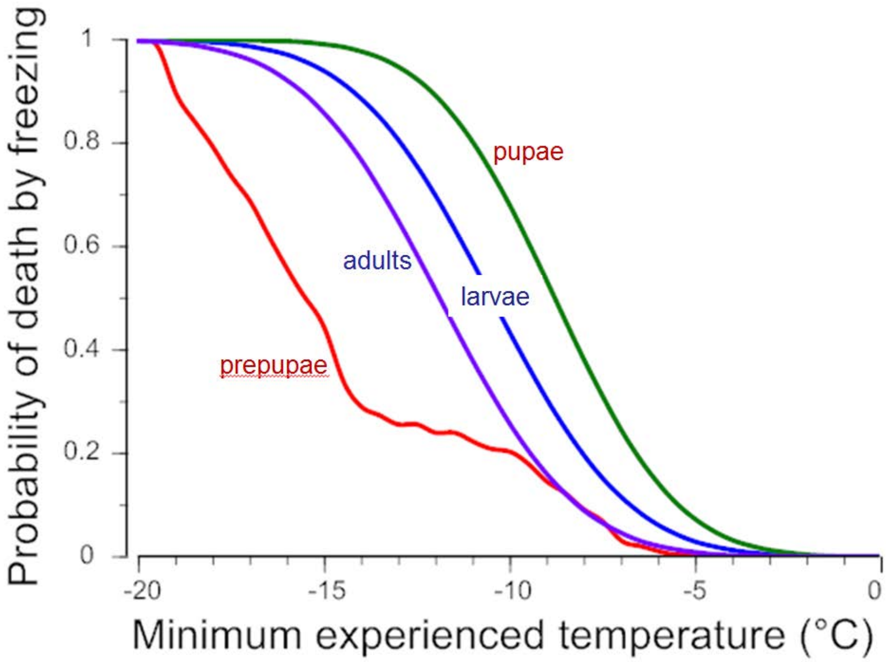



**Figure 4.** Probability of death by freezing for different lifestages of southern pine beetle. The model in Figure 2 assumes that most of the population is in the prepupal stage on the coldest night of the winter (following observations of [Tran et al. 2007]). More cold tolerance measurements in [Lombardero et al. (2000)].

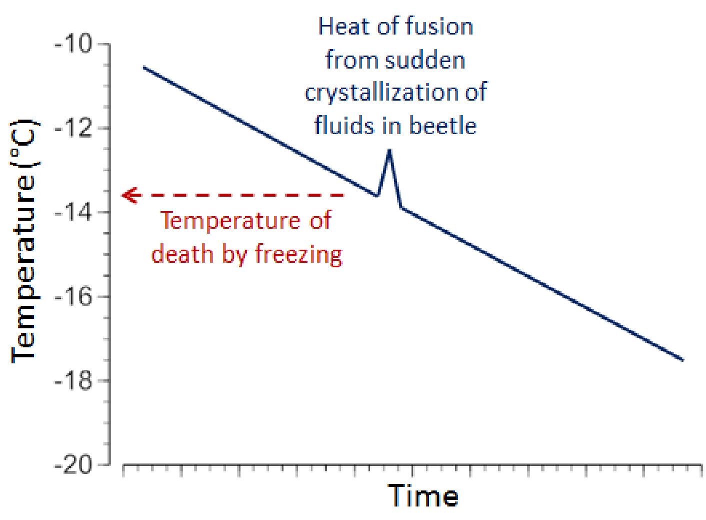



**Figure 5.** Measurement of lower lethal temperatures in bark beetles is done by slowly cooling an individual animal while precisely measuring its temperature with a tiny thermocouple. Beetles resist freezing to a point, but when they do freeze they die instantly and the moment of death is apparent from the heat spike produced by the crystallization. In the example above, the beetle died at -13.5 °C. It only takes a moment of exposure to die by freezing. Conversely, beetles exposed to temperatures not quite that cold, even if it is prolonged exposure, typically survive without harm. We have measured thousands of individual beetles with this technique under many different conditions to yield the data in Figure 4 above (e.g., [Lombardero et al. 2000]).

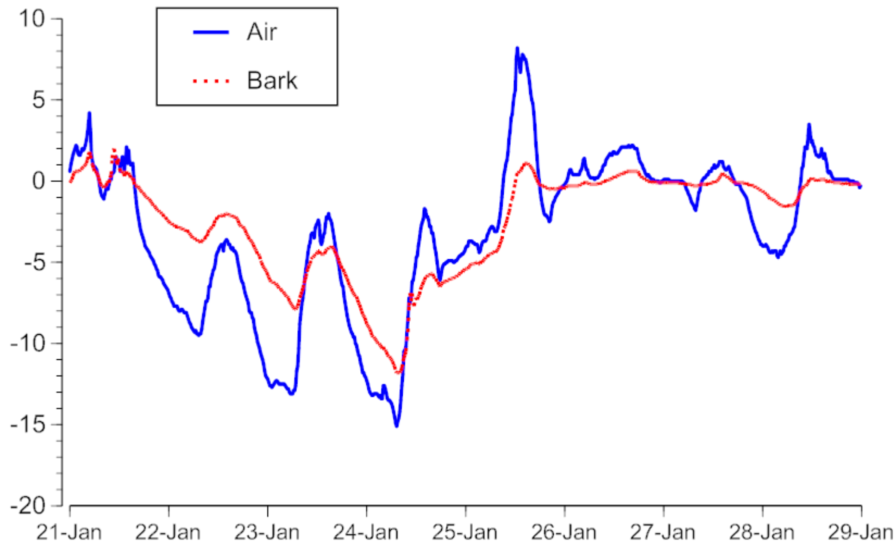



**Figure 6.** Southern pine beetles live in the inner bark of pine trees. The temperatures they experience are buffered relative to air temperatures recorded by weather stations (e.g, in Figures 1 and 3). Thus estimating the effects of a cold night on beetle survival depends upon the relationship between the air and the inner bark. We have studied this and incorporated the results into the model shown in Fig. 2. Above figure shows temperatures in the inner bark of a pitch pine relative to air temperatures during a cold bout in 2011. Note that on the night of coldest air temperature, the bark was warmer by about 3 °C. This is typical of trees about the size most frequently infested by southern pine beetles (8-15 inches diameter). The buffering can be greater in larger trees and tends to be greater if the air temperature decline is very rapid. More details in Tran et al. 2007). The cold night of January 5th 2014 was preceded by relatively cold temperatures during the previous 48 hours so bark temperatures were probably buffered by about the amount seen above, which is about that estimated in the model in Figure 2.

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*A story about a beetle*. Outstanding related video by Milo Johnson (Dartmouth '13) about the biology and management of the southern pine beetle, with special reference to NJ Pinelands. Features interviews with Ron Billings, Texas Forest Service; Amy Karpati, Pinelands Preservation Alliance; and Kier Klepzig and John Nowak, Southern Research Station, USDA Forest Service.

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