Conserving Minnesota's tamarack forest in the face of an unprecedented bark beetle outbreak

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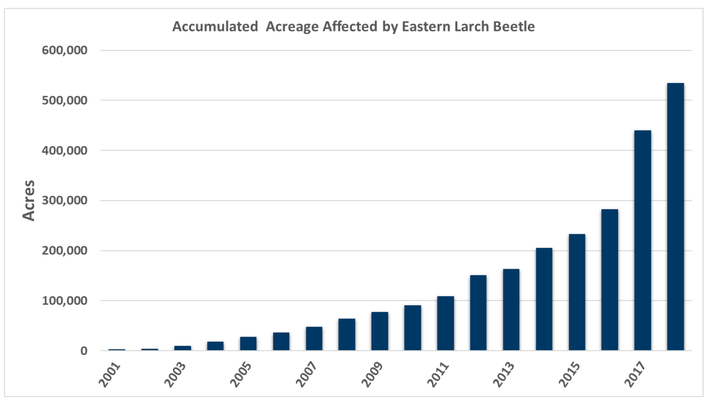
Eastern larch beetle and tamarack

Minnesota has 1,398,900 acres of tamarack (*Larix laricina*) forest, the most tamarack in any of the lower 48 states. Eastern larch beetle (*Dendroctonus simplex*) is a native bark beetle that primarily feeds on tamarack larger than 4" DBH. Historically, eastern larch beetle outbreaks in Minnesota were localized and lasted three to six years. However, an outbreak that began in 2001 has been ongoing for 17 years and has affected more than 40 percent (534,900 acres) of the tamarack forests in Minnesota (Figures 1 and 2). Of these impacted forests, a large percentage has been severely affected (>50 percent of trees killed). Outbreaks have also been reported in Michigan, Wisconsin, Manitoba, Ontario, and Alberta.

Researchers from the University of Minnesota discovered that a portion of the eastern larch beetle population is capable of completing two generations per year[1] despite normally requiring a period of cold weather to mature and reproduce. This change in reproductive capability has been linked to a longer growing season. Tamarack appear to be unable to tolerate the stress of a second attack from eastern larch beetle in mid-summer. At this time there is no indication of the outbreak's collapse in Minnesota.

Figures 1 and 2. Accumulated acreage and spatial distribution of eastern larch beetle damage in Minnesota.



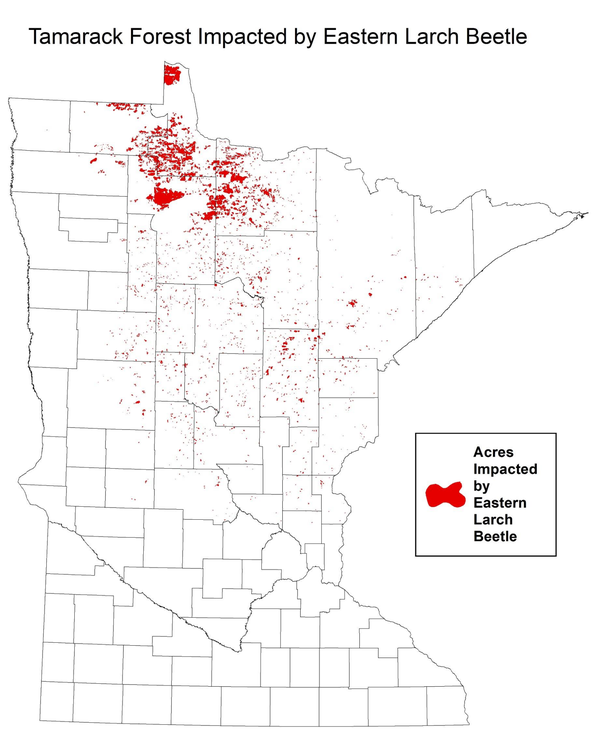
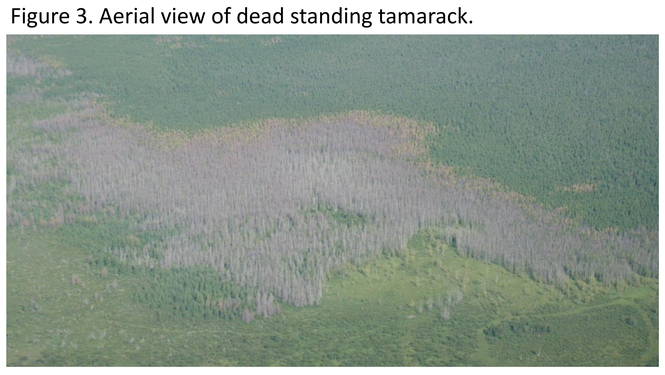


Figure 3. Aerial view of dead standing tamarack.



Tamarack resource issues

Historically, annual timber harvest yields 50,000 cords of tamarack for the forest products industry, representing seven percent of softwood use in the state[2]. However, in recent years, a combination of rapid stand mortality, decreased timber quality, low stumpage value, fluctuating markets, and poor frozen ground conditions have resulted in thousands of acres of unsold, unharvested, and dead standing tamarack. There is growing concern that tamarack may not be regenerating. Many mature trees are killed before they produce seed to grow the next generation of tamarack trees, resulting in large losses of forest and subsequent impact to ecosystems and wildlife habitat.

State Land management

Prior to widespread eastern larch beetle mortality, regeneration in tamarack stands has been a result of clearcut with reserves and seed tree silvicultural systems. Healthy, live trees are left randomly scattered as singles, clumps, or in strips throughout a harvest with the intent to provide adequate future seed source for natural regeneration. Dense germination occurs on moist mineral or organic soils with moderately-to-well-decomposed substrate and adequate water and nutrient availability[3] (Figure 5). In the last decade, we have seen an increase with larger clearcut-salvage harvest prescriptions in an effort to remove timber under threat or direct attack from eastern larch beetle. Without live seed trees, artificial regeneration using a helicopter to disperse seed may be necessary to regenerate tamarack and meet stocking standards. Consequently, silvicultural practices are shifting away from reliance on natural seeding while nursery seed extraction and aerial seeding investment are increasing significantly.

Case study

Recent observations suggest that poor tamarack regeneration due to eastern larch beetle infestation can occur in years of low seed and cone production. Low available seed in conjunction with unsuitable seedbed due to lack of disturbance such as logging can lead to low stocking. A field evaluation of regeneration in two previously damaged tamarack stands was initiated in 2017. The goal was to evaluate tamarack establishment under two scenarios in stands with eastern larch beetle damage. Stand #1 was unharvested and left to naturally regenerate, and Stand #2 was salvage harvested and aerially seeded in 2010. Results show levels of recruitment in Stand #1 of 511 crop tree stems per acre at year seven (Table 1), below our stocking standard of 600 tamarack seedlings per acre on 75 percent of plots. Stand #2 had over 3,000 stems per acre of crop trees at year seven, far exceeding our standards (Table 1). While we do see lower levels of natural recruitment in unsalvaged and unseeded stands, it is encouraging to see some natural regeneration of tamarack where no silvicultural intervention occurred.

Figure 4. Aerial view of an eastern larch beetle outbreak with dead and dying tamarack trees.

Figure 5. Dense tamarack seedling natural regeneration in a strip clearcut prescription.

Table 1. Comparison between unharvested, natural regeneration and salvage clearcut, artificial regeneration treatments.

Treatment	Size class*	Tamarack	Black spruce	Paper birch	Quaking aspen	Black ash	Balsam fir	Bur oak	Total
Stand #1 Damaged, Un-harvested, Natural Regen	Regenerants	116	-	-	27	-	18	-	**161**
	Seedlings	179	18	9	9	-	-	9	**224**
	Saplings	27	9	-	9	-	-	-	**45**
	Small trees	45	36	-	-	-	-	-	**81**
	Total	**367**	**63**	**9**	**45**	**0**	**18**	**9**	**511**
Stand #2 Damaged, Salvage Harvested, Artificially Seeded (2010)	Regenerants	82	130	5	-	5	-	-	**222**
	Seedlings	2,054	435	158	54	16	11	-	**2,728**
	Saplings	43	-	22	-	-	-	-	**65**
	Small trees	16	-	5	-	-	-	-	**21**
	Total	**2,195**	**565**	**190**	**54**	**21**	**11**	**0**	**3,036**

*Regenerants (<1"dbh, <1' tall); Seedlings (<1"dbh,>1' tall); Saplings (1-3"dbh); Small Trees (3-5"dbh).

Next steps

The University of Minnesota in partnership with the USDA Forest Service and Minnesota DNR has received preliminary approval for a two-year forest health monitoring grant to understand and quantify tree regeneration (if present) and recruitment in stands impacted by eastern larch beetle. In addition, the cooperating partners, along with the Natural Resources Research Institute, are submitting a larger research proposal to evaluate the level of regeneration (if present) and recruitment in stands with greater than 50 percent mortality from eastern larch beetle and how the loss of forest cover affects wildlife habitat. Collectively, if both proposals are funded, forestry researchers and practitioners will establish foundational forest inventory data to determine if and how these areas are regenerating. If necessary, future silvicultural intervention may include using aerial seeding with tamarack, black spruce, and northern white cedar to supplement future regeneration in dead and dying stands.

Sources and acknowledgements

1. McKee, F., & Aukema, B. (2015). Successful reproduction by the eastern larch beetle (Coleoptera: Curculionidae) in the absence of an overwintering period. *The Canadian Entomologist.* 147(5), 602-610.
2. Minnesota Department of Natural Resources (2017). Minnesota's Forest Resources 2016.
3. Minnesota Department of Natural Resources (2013). Tamarack Assessment Project.

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