

TITLE: Evaluation of eastern larch beetle activity in the Northern Great Lakes Region

LOCATION: MN, WI, MI

DATE: September 30, 2011

DURATION: Year 1 of 3 year project

FUNDING SOURCE: Base

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PROJECT OBJECTIVES:

1. Evaluate the extent of eastern larch beetle activity in the Great Lakes region
2. Characterize the seasonal phenology of this insect in actively-infested areas
3. Determine the association of climatic and/or forest inventory variables with occurrence of tree-killing activity

JUSTIFICATION:

- a. **Linkage:** Eastern larch beetle is a native insect present in tamarack across the Northcentral/Northeast states (MN, WI, IL, IN, MI, OH, PA, NY, VT, NJ, MA, NH, CT, RI, ME) stretching through the boreal forest of Canada into Alaska. High mortality of tamarack due to eastern larch beetle has been noted along the southwestern portions of the insect's host range sweeping through MN (>100,000 acres over the past decade). Mortality has been detected in both FIA plot data and more than a decade of off-plot aerial survey data collected by the MN DNR.
- b. **Significance** Outbreaks of eastern larch beetle typically commence on trees stressed by drought, flooding, defoliation (casebearer, budworm, sawfly), fire, or advanced age. MN, (and, directly north, MB), have had active beetle populations for over a decade, twice as long as "typical" outbreaks. Tamarack mortality is occurring or has occurred on approximately 10% of the nearly 1 million acres of tamarack covertype in MN to date. Predisposing biotic stresses (e.g., defoliation) have been unapparent. Continued outbreak activity - especially at distributional range margins – suggests a region-wide stress, possibly climatic, acting at a landscape-level scale.
- c. **Biological impact** Tamarack is an important contributor to watershed health in lowland forests. It is an early invader after burns where seed trees exist, although beetle pressure in MN frequently kill residual seed trees intentionally left following salvage harvests. Tamarack is principally used for pulpwood, although there is a growing market for chemicals extracted for pharmaceuticals.
- d. **Scientific Basis/Feasibility** This project has a high likelihood of success:
 - We have collected one year of field data on seasonal phenology. Preliminary field and lab findings indicate that higher than expected numbers of Brood II progeny are developing than current literature suggests (possibly indicative of an expanded growing season). These results, combined with putative moisture deficits over the past decade (Fig. 1, next page) provide logical avenues to explore linking insect abundance/tree mortality and climatic variables.

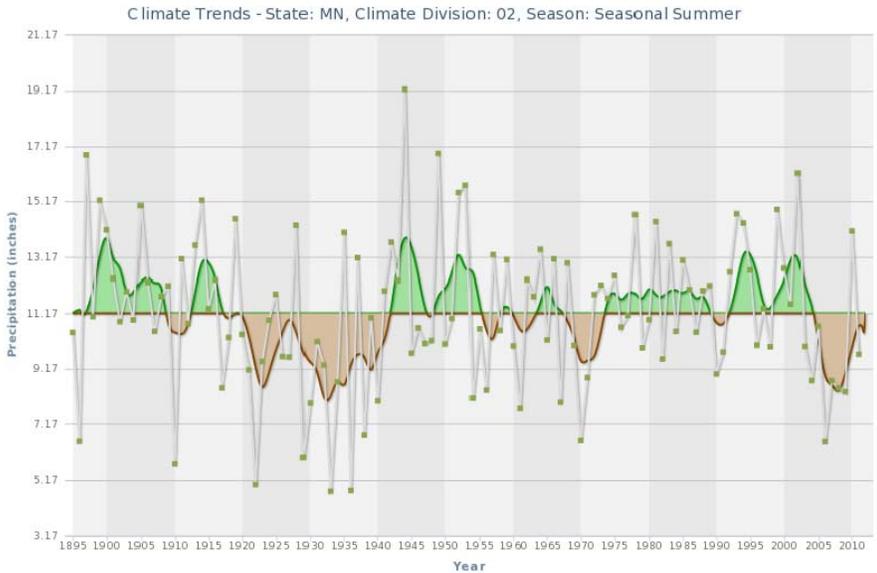


Fig. 1: Summer precipitation as deviation from seasonal norm in NC MN, one area of high ELB activity. Courtesy of Greg Spoden, MN DNR Climatologist, St. Paul, MN; additional metrics available at southernclimate.org. Note brown shading in most recent decade indicating moisture deficit (2000-)

- Given 2011 brood development and expansion rates, as well as trends in increasing overwintering survival (Venette, unpublished), outbreaks are unlikely to terminate within the next 1-2 years even with a sudden onset of unseasonably cold winter temperatures.
 - Project leader has experience assembling teams to conduct field and landscape-level analyses linking tree mortality to climatic causes in other bark beetle systems (e.g., Aukema et al. 2006, 2008, 2010; Sambaraju et al. 2011), as well as expertise in statistics (e.g., Zhu et al. 2008; Zheng and Aukema 2010; Reyes et al. 2011).
 - The proposed work enjoys a strong partnership between the UMN and the DNR. The graduate student has a strong track record and enjoys a funding match from a university award to the project leader that will cover remaining tuition.
 - Project leader has been approached re expanding collaboration with Canadian Forest Service researchers in prairie, Quebec provinces given high mortality there.
- e. **Priority Issues:** This project examines the effect of abiotic stress such as **drought/flooding** (deviations from normal precipitation) on the abundance of eastern larch beetle and associated **tree mortality**. Preliminary summer data indicates strong departures in seasonal phenology from the scientific literature, possibly an indication of **climate change**. A study (unpublished) on overwintering mortality from cooperator Rob Venette suggests that a warming winter climate is contributing to higher overwintering survival. Statistical techniques/platforms developed in this and previous studies (see above) may be easily ported to future **insect and disease risk models**.

DESCRIPTION:

a. Background: Continued progression of outbreaks of eastern larch beetle in the absence of obvious predisposing agents (e.g., defoliators, localized spring flooding, etc.) over a more pronounced duration (>5 years) suggest manifestations of climatic stress in the southern portions of its range. Preliminary lab assays suggest that (1) adults **do not** require an overwintering diapause and (2) the insect **may be on verge of becoming bivoltine** in the southern portion its range. To our knowledge, successful multivoltinism stemming from Brood I adults rather than reemergent parents has not been noted previously.

b. Methods: We will augment current field plots based on FIA data and off-plot aerial survey data. To determine seasonal phenology and construct life tables, we will monitor new attacks and sample development from 10x10cm bark squares over the course of the growing season. Emergence cages on infested trees will monitor Brood I and II adults, a portion of which will be transported to the laboratory for reproductive studies.

Landscape-level models to provide inference on climatic factors associated with outbreak progression will be constructed from aerial survey data. Polygons of annual tree mortality will be overlaid on an appropriate grid (e.g., township levels) in a GIS. Climatic covariates (e.g., deviations from precipitation normal) will be defined based on known biology of the insect and discussions with cooperators. The influence of these variables on the abundance of tamarack killed by ELB will be examined in spatiotemporal regressions. Suitable spatial and temporal terms will be included to reduce coefficient estimate bias (i.e., improve inference). Model selection will utilize standard statistical practices such as evaluation of information criteria.

c. Products: This project will provide (1) new information on the biology of *D. simplex* (2) understanding of climatic factors (temperature, precipitation) that affect its success (3) peer reviewed publication(s) as part of the dissertation work of Fraser McKee (4) presentations at FHM Working Group meetings

d. Schedule of Activities:

Date	Activity	Status
Summer 2011	Collect field data	Completed
Fall 2011 / Winter 2012	Analyze field data, gather climate data	Ongoing
Summer 2012-2014	Collect field data	
Fall/Winter 2012-14	Analyze field and climate data	
Fall 2014 / Winter 2015	Write and disseminate results	

e. Progress/Accomplishments: We have gathered data on seasonal phenology and flight patterns in plots in northern MN and have begun exploring a decade of aerial survey data to date. Progress reports will be made each year.

COSTS: (Proposed three year project)

	Item	Requested FHM EM	Other-Source ^a	Source
YEAR (1 of 3)				
Administration	Salary ^b	50,568	38,212	UMN McKnight to PI
	Overhead (22%)		12,666	
	Travel	5,000	5,000	DNR lodging, survey, time
Procurements	Contracting			
	Equipment		1,800	Computer, software license UMN
	Supplies	2,000		
Total (Year 1 of 3)		\$57,568	57,568	

Total Year I \$57,568; indexed 2.3%/year for increasing fringe (Y2: \$58,832; Y3: \$59,920)

^a Cost share includes graduate student tuition paid by College, start-up funds, & McKnight professorship to BHA in years I-III, academic year salary of PI

^b Salary includes graduate student F. McKee, summer student, partial faculty summer support

REFERENCES

Vita and references/relevant publications/projects from project leader's research program are available online at <http://www.forest-insects.umn.edu>