

INTRODUCTION

Larch sawfly (LSF) (*Pristiphora erichsonii*) is an invasive defoliator in Alaska. Based on aerial survey data, this insect has impacted an estimated 600,000 to 700,000 acres of eastern larch (*Larix laricina*) stands in Alaska during a 6-year period between 1999 and 2004. Mortality of larch within the sawfly-defoliated area was 80 percent or more (aerial survey data) in the majority of affected larch stands. Consecutive years of larch defoliation on the poorest sites resulted in 100 percent mortality.

A majority of interior Alaska's larch stands are only accessible by float plane, an expensive mode of transport, so very little historical larch stand information has been collected across the species' Alaskan range. Forest health specialists in Alaska used historical National Insect and Disease Detection Survey data, archived geospatial datasets for slope and elevation across interior Alaska, and data from a previous "healthy larch" Forest Health Monitoring Evaluation Monitoring (EM) project (FHM project #WC-EM-05-02) of the Forest Health Monitoring (FHM) Program of the Forest Service, U.S. Department of Agriculture, to identify the most likely areas with moderate to high densities of larch for ground sampling. Project goals included evaluation of regeneration potential in the post-outbreak stands and evaluation of the biotic and abiotic factors of past and present larch mortality.

This project also addressed the following EM project selection criteria: the project was initially identified from FHM Aerial Detection

Surveys (ADS); the proposed project is significant in geographic scale because it addresses the statewide distribution of larch in Alaska; and the project assessed the biological impacts of the recent extensive larch sawfly outbreak (1999–2004) and effects of the catastrophic 2004 and 2005 fire season in interior Alaska over the entire statewide distribution of larch utilizing previously acquired geospatial data in a geographic information system (GIS) from several sources. Due to limited access to the remote eastern larch distribution in Alaska's interior, GIS greatly aided site selection and cost efficiencies for small plane charter and travel time to complete this EM project.

At the time of this investigation, the regeneration potential of most stands with healthy larch remained unknown because the surviving residual trees may have been too small (young) to produce cones. Based on previous ADS estimates, larch mortality appeared to be concentrated in the largest diameter trees. It is believed that heavy sawfly infestation was a factor in significant mortality over extensive areas, with or without evidence of eastern larch beetle (LB) (*Dendroctonus simplex*) activity in the same stands, based primarily on aerial survey estimates and observations (Seybold and others 2002). We wanted to assess, on the ground, any evidence of LB as a primary mortality agent. Also, larch is a shade-intolerant, early-succession species that requires a significant component of mature, cone bearing trees for recolonizing a site after significant stand disturbances. Many stands sustained close to 100 percent mortality 3 to 4 years after this outbreak was first documented

CHAPTER 14. Assessing Mortality and Regeneration of Larch¹ (*Larix laricina*) after a 1999-2004 Landscape Level Outbreak of the Larch Sawfly (*Pristiphora erichsonii*) in Alaska (Project WC-EM-08-03)

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¹Other names: Alaska larch, eastern larch, hackmatack, tamarack, *Larix alaskensis* W. F. Wight, *L. laricina* var. *alaskensis* (W. F. Wight) Raup; reference: Viereck, L.A.; Little, E.L., Jr., 2007. Alaska trees and shrubs, 2^d ed., University of AK Press. 273 p.

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and aerially mapped. Without a cost-effective way to conduct ground checks of aerial survey observations within most of the areas, e.g., slack water swampy areas associated with black spruce, insect mortality causal agents are difficult to assess or distinguish from other potential mortality causes, e.g., disease, abiotic agents, and the like.

OBJECTIVES

Fourteen stands were evaluated in 2008 and 2009 to:

1. Determine the primary source of mortality in larch stands between 1999 and 2004.
2. Determine the extent of larch mortality since 2004 that could be attributed to bark beetles (e.g., LB).
3. Collect base forest health information and stand level detail to better assess larch stand establishment and regeneration success in interior Alaska.
4. Pin-point risk factors associated with repeated LSF defoliation and mortality impacts from that defoliation.

METHODS

GIS was used to analyze previously acquired data layers (primarily insect damage and vegetation cover from archived aerial survey data) to target and select a subset of stands containing a significant component of larch for ground survey and sampling. During July–August 2008 ground sampling was completed in seven road-accessible stands along the Chena and Tanana River floodplains

in Fairbanks, north of Fairbanks (Chena Hot Springs), and within the Bonanza Creek Experimental Forest along the Tanana River west of Fairbanks, AK (fig. 14.1). During August 2009, we visited seven additional larch stands by floatplane access into lakes near the study sites (fig. 14.2). The GIS analysis helped to concentrate sampling in areas with a significant component of larch to maximize sampling time on the ground.

In each stand, tree species, including the diameter at breast height (d.b.h.) of all trees down to 1 inch was recorded within a 16.5-foot wide (1/4 chain) transect through the site. A regeneration plot was established every fifth chain for all tree species and significant shrubs, i.e., willow and alder, under 1-inch in diameter (table 14.1). Presence of cones was noted for live larch. Dead larch and spruce and LB mortality evidence was also tallied (table 14.1) (figs. 14.1 and 14.2). Dead larch killed by fire scorching, blown or fallen over, were not recorded, i.e., were assumed to predate the recent sawfly disturbance event. Other mortality causal agents, e.g., root disease, causal agents other than LB, were not recorded due to time and cost constraints. Recent evidence of fire or LSF defoliation was noted as well as general stand and site characteristics (species composition, drainage, soils, predominant ground cover, and the like). Basal stem discs from dominant or codominant spruce (healthy) and larch (dead and healthy) were taken on all sites in 2008 and 2009 to estimate stand age. For analysis, the 14 sites evaluated in this study were divided into two distinct groups (table 14.1) (fig. 14.3) based upon overstory species composition.

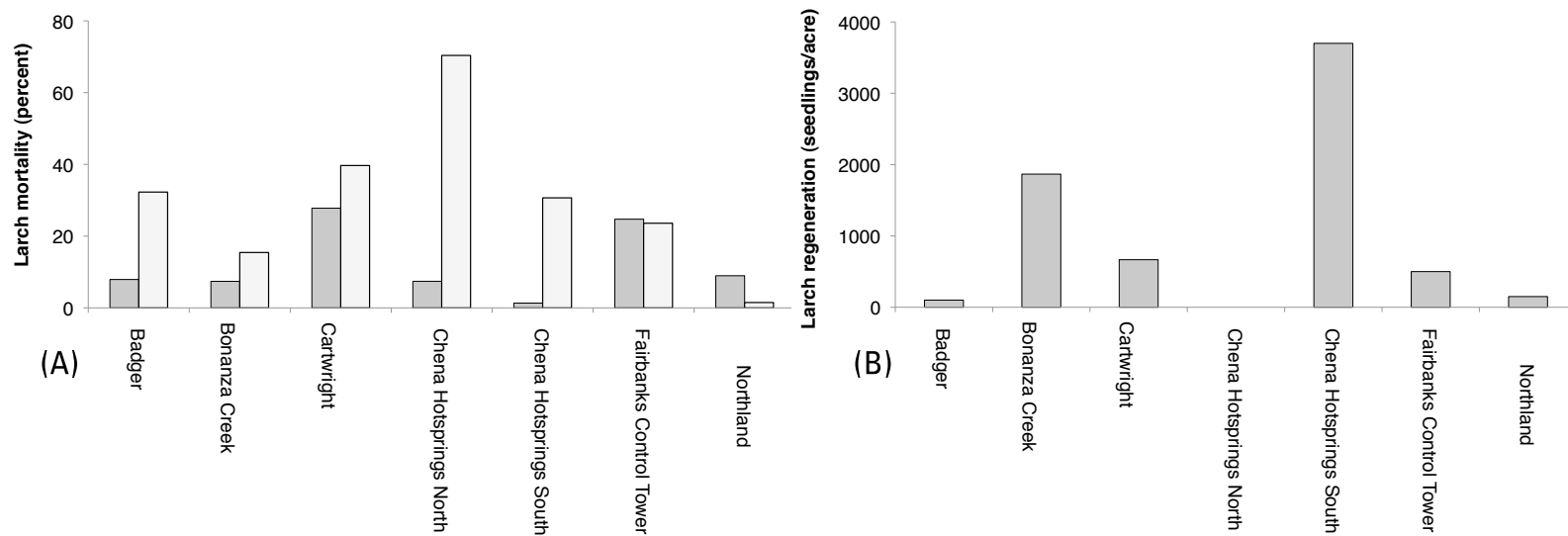


Figure 14.1—Data collected at seven road-accessible sites between Fairbanks and North Pole (interior Alaska) from July to August 2008: (A) percent mortality associated with larch beetle attacks (light gray bars) and “other” mortality which include disease, fire, etc. (dark gray bars); (B) larch regeneration estimates.

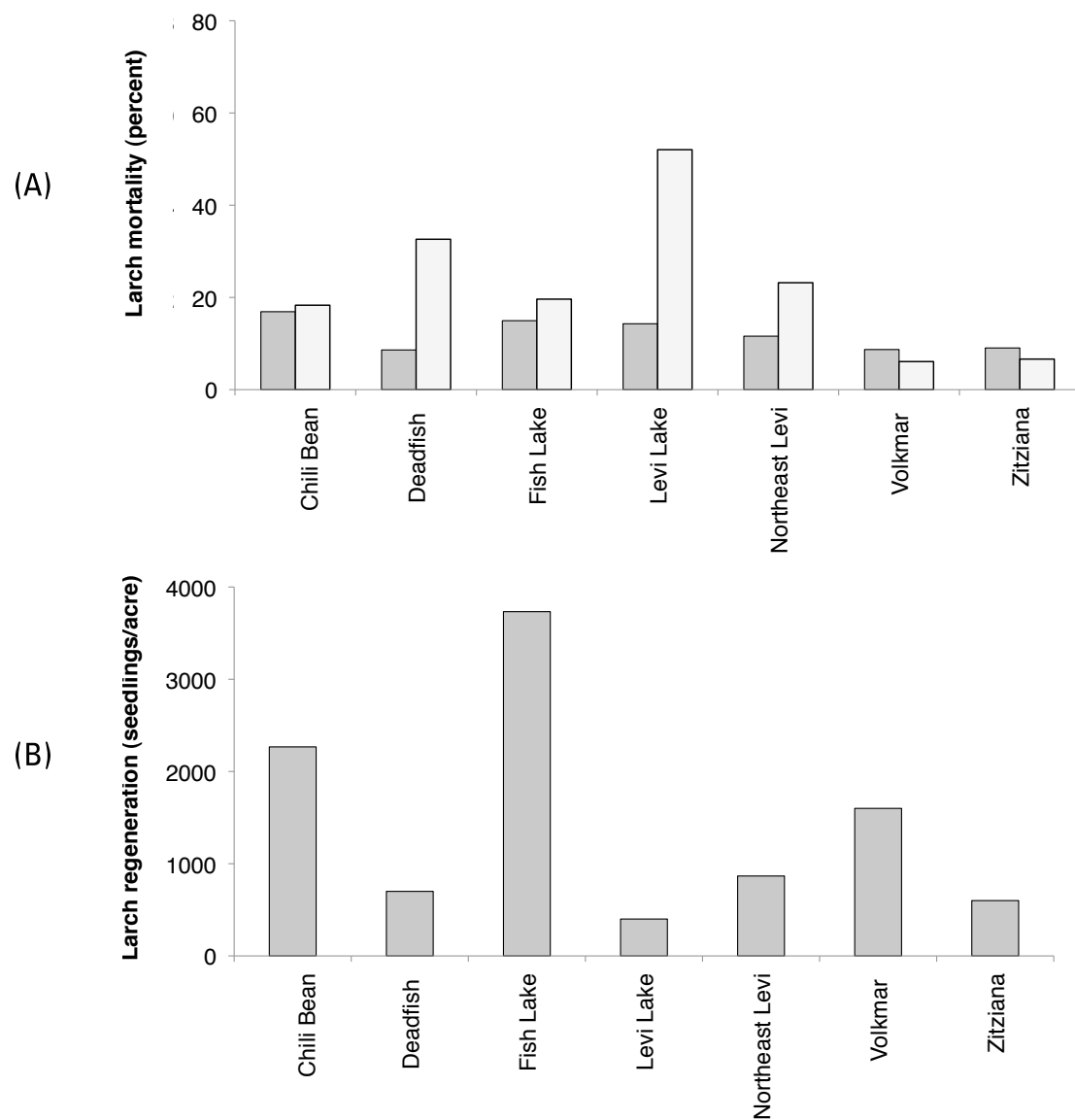


Figure 14.2—Data collected at seven remote sites in interior Alaska during August 2009: (A) mortality associated with larch beetle attacks (light gray bars) and “other” mortality which include disease, fire, etc. (dark gray bars); (B) larch regeneration estimates.

Table 14.1—Larch regeneration estimates, larch beetle mortality, and general stand characteristics averaged along site transects within each productivity class

	Average size class	Total stems/ acre	Larch stems/ acre	Spruce stems/ acre	Birch stems/ acre	Cottonwood stems/acre	Willow/ alder stems/acre	Dead larch/ acre	Larch dead from beetles/ acre	Live larch age	Larch seedlings/ acre
Group 1 hydric sites											
Chili Bean Lake	1.4	2,987	379	2,608	0	0	0	67	32	48	2,267
NE of Levi Lake	1.5	5,269	368	4,901	0	0	0	64	21	45	867
Bonanza Creek (Tanana R. floodplain)	1.8	1,973	1,659	219	11	0	85	189	61	39	1,867
Deadfish Lake	1.5	3,896	2,232	1,616	16	0	32	460	96	32	700
Fish Lake	1.4	768	571	176	21	0	0	99	43	26	3,733
Chena Hot Springs Road 2 (Fbks)	1.5	3,744	600	3,120	24	0	0	96	4	70	3,700
Northland Wood (Fbks)	1.5	3,488	918	2,122	36	0	412	14	12	35	150
Average	1.5	3,160.8	960.9	2,108.9	15.4	0	75.6	141.2	38.5	42.1	1,897.6
Group 2 mesic sites											
Badger Road (North Pole, AK)	1.5	4,688	2,528	1,144	80	48	888	508	100	66	100
Levi Lake	1.3	4,896	784	4,016	96	0	0	260	56	28	400
Airport 2 Cartwright Road (Fbks)	1.8	2,891	672	2,064	133	0	21	227	93	57	667
Zitziana River	1.8	2,128	885	1,109	133	0	0	91	40	28	600
Chena Hot Springs Road 1 (Fbks)	2.3	3,867	240	3,476	151	0	0	93	9	61	0
Volkmar Lake	1.9	848	613	59	176	0	0	45	27	79	1,600
Airport 1 (near Fbks Int'l Airport Control Tower)	2.0	2,952	712	1,920	224	48	48	172	88	25	500
Average	1.8	3,181.3	919.2	1,969.7	142.0	13.7	136.8	199.4	59.0	49.1	552.4

Note: Averages shown in bold represent differences between the two groups greater than one standard error.

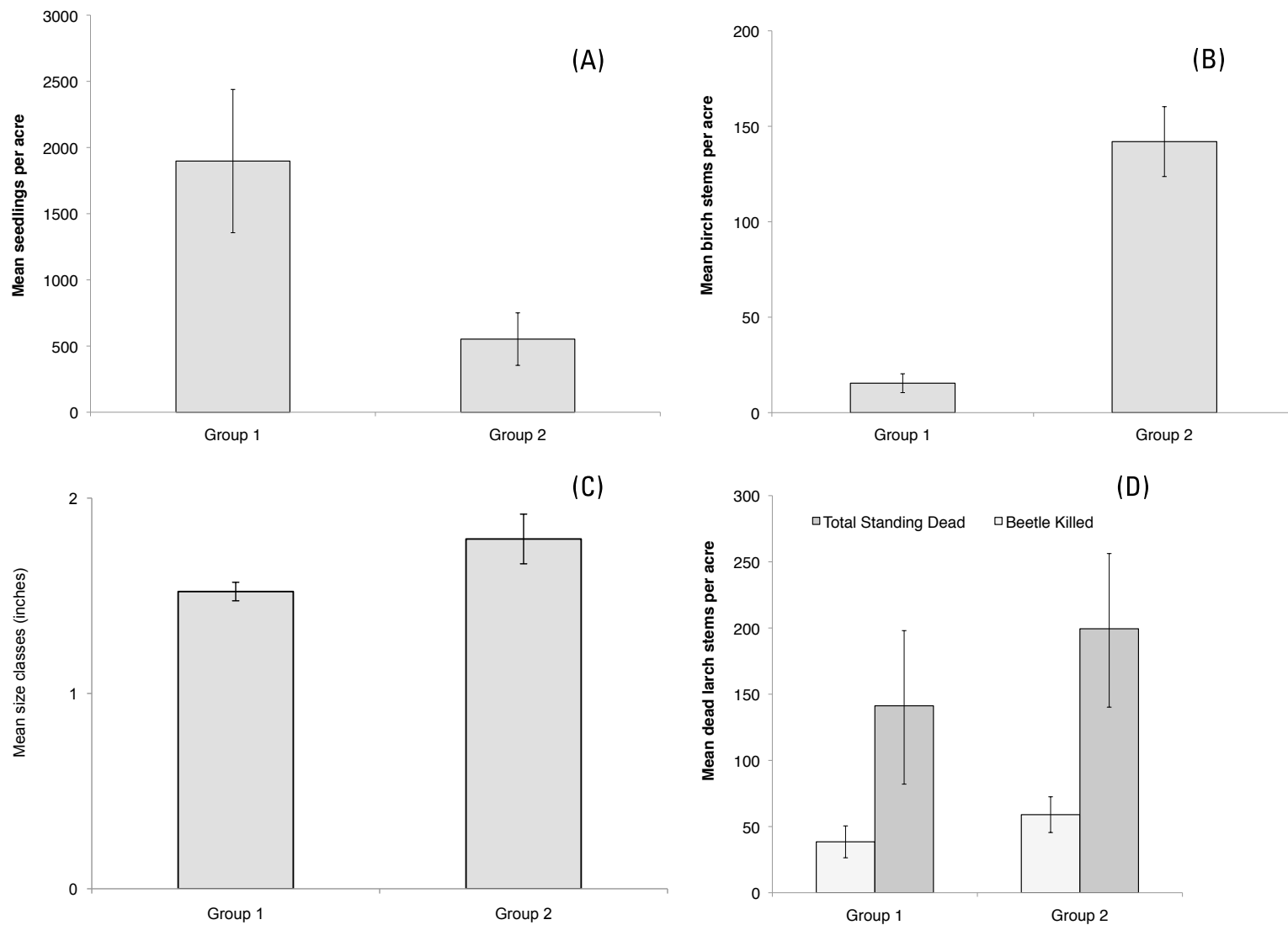


Figure 14.3—Stand characteristics of study sites grouped in table 14.1. (A) larch regeneration (B) number of birch trees (C) average size class, and (D) number of dead larch trees. Group 1 represents lower productive (i.e. more hydric) sites, while Group 2 represents the higher productive (i.e. more mesic) sites (+/- SE).

RESULTS AND DISCUSSION

The first group of larch stands was on more hydric sites with lower productivity and few, if any, hardwoods. The second group of sites are characterized as more mesic, with higher productivity and a substantial component of birch (*Betula neoalaskana*), and to a significantly lesser degree, balsam poplar (*Populus balsamifera*) (also known as “cottonwood”). Mesic sites contained 10 times more birch per acre on average than hydric sites. Both groups had about 3,000 stems per acre, and the average stem diameter on mesic sites was 20 percent larger than on hydric sites. Data from the 14 study sites suggest a strong, inverse relationship between site productivity (i.e., relative productivity of competing hardwood species such as birch) and larch regeneration (< 1 inch d.b.h.) (table 14.1) (fig. 14.3).

The occurrence of larch mortality between the two groups, and mortality from LB on the sites and component of dead larch examined was substantially greater on the mesic sites supporting birch trees (although this difference was statistically marginal due to large natural variation observed). These more mesic sites also had significantly fewer larch seedlings on a per-acre basis than the more hydric sites. Higher productivity of competitor species could make larch, a poor competitor for light and nutrients, more susceptible to disturbance agents (LSF and LB) on better drained sites. This could be attributed to larch’s inability to compete with other species on undisturbed sites (Girardin and others 2002, Jardon and others 1994, Johnston

1990) and the increased likelihood of mortality observed in larch growing on mineral soil following insect attacks (Beckwith and Drooz 1956, Girardin and others 2002). Mortality of larch over the 14 sites (and transects sampled) attributable to the LB is also higher on mesic sites, i.e., 5 percent or more birch composition, compared to hydric sites, i.e., < 5 percent birch composition (table 14.1) (fig. 14.3).

While the number of sampling sites is likely not large enough to be able to make any definitive conclusions about the primary cause of larch mortality or regeneration success, comparisons can be made among the various sites. These results should provide forest health professionals with some initial clues on the productivity of the Alaska larch sites.

Larch regeneration, establishment, growth, and mortality are both directly and indirectly related to larch stand disturbances, including insect outbreaks. The current project was designed to conduct a point-in-time sampling of larch stocking levels, estimate general stand characteristics of larch stands, determine larch regeneration potential (existing stocking, presence/absence of cones), and collect data on its primary insect mortality agent, i.e., larch beetle, in the area of a recent landscape-level outbreak of LSF.

The recent landscape-level LSF outbreak from 1999 to 2004 (associated with equally dramatic mortality in 80 percent of LSF-impacted stands) as well as dramatic evidence of landscape-level changes in vegetation cover and diversity,

changes in continuity of permafrost layers, and other landform changes resulting from climate change, illustrate potential threats to the sustainability of the forests in interior Alaska. This has also led to concerns about the genetic conservation of native larch in Alaska. The current project successfully determined larch stocking levels, larch regeneration potential (existing stocking, presence/absence of cones), and primarily insect mortality agents, e.g., larch beetle, in the area of a recent landscape-level LSF outbreak.

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LITERATURE CITED

- Beckwith, L.C.; Drooz, A.T. 1956. Tamarack mortality in Minnesota due to larch sawfly outbreak. *Journal of Forestry*. 54: 268-269.
- Girardin, M.P.; Tardif, J.; Bergeron, Y. 2002. Dynamics of eastern larch stands and its relationships with larch sawfly outbreaks in the Northern Clay Belt of Quebec. *Canadian Journal of Forest Research*. 32: 206-216.
- Jardon, Y.; Filion, L.; Cloutier, C. 1994. Long-term impact of insect defoliation on growth and mortality of eastern larch in boreal Quebec. *Ecoscience*. 1(3): 231-238.
- Johnston, W. 1990. *Larix laricina* (Du Roi) K. Koch: Tamarack. In: Burns, R.M.; Honkala, B.H., tech. coords. *Silvics of North America: Vol. 1. Conifers*. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture: 260-280. http://www.na.fs.fed.us/spfo/pubs/silvics_manual/volume_1/silvics_vol1.pdf. [Date accessed: May 22, 2012].
- Seybold, S.J.; Albers, M.A.; Katovich, S.A. 2002. Eastern larch beetle. *Forest Insect and Disease Leaflet 175*. [Place of publication unknown]: U.S. Department of Agriculture Forest Service, State and Private Forestry, Forest Health Protection. 12 p.