The Eurasian Larch Project

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Abstract

From 1996 to 2001 a team of forest geneticists, headed by Dr. Owe Martinsson of Mid-Sweden University, traversed the Russian Federation and collected seed and wood quality data from 1,005 individual larch trees representing four different larch species (*Larix cajanderi, Larix gmelinii, Larix sibirica* and *Larix sukaczewii*) in 49 stands from 17 regions. Ranging from 49º 08' to 66° 51' north latitude and 38º 15' to 152º 30' east longitude this is the largest organized collection of Eurasian larch seed ever and represents an unprecedented opportunity to assess the growth potential of these species around the world and northern Minnesota in particular. To date trials have been established in Alaska, Canada (Saskatchewan) Finland, Iceland, Norway, Russia, and Sweden. Additional trials will be established shortly in Japan, northern Minnesota, and Quebec, Canada. Analyses will be preformed by site as well as across sites to determine superior regions, stands, and families as well as growth patterns associated with latitude, longitude and elevation. As a cooperative effort access to growth data from other trials is assured and this presentation represents a summary of data presented at the recently convened Eurasian larch conference in Arvidsjaur, Sweden (www.siblarch.net).

International Eurasian Larch Project

The International Eurasian Larch Project grew out of conversations that commenced at the 1992 International Larix Symposium in Whitefish, Montana, USA. From 1996 to 2001 at least two different collection forays into Eurasia were made to collect open pollinated seed, wood cores and site characteristics for four different larch speices and their hybrids. By 2002 the first seed was being disseminated to cooperators and participants around the world after having been tested for germination and catalogued. In 2003 the first genetic trials were established and August 2006 the first international Eurasian larch meeting was convened in Arvidsjaur, Sweden.

The International Eurasian Larch Project has three main goals or foci. First, is to investigate the timber properties of Eurasian larch, especially as it relates to the modulus of rupture and the modulus of elasticity. Second, is to discern the genetic variability and adaptive potential of the four larch species. Third is to foster the establishment of native larch stands in Eurasia through active management that mimics natural processes.

Seed and wood cores were collected from more than 1,000 trees in 16 collection areas or regions with three to five stands in each region (Figure 1.) The four larch species that were sampled include *L. sukaczwii*, *L. sibirica*, *L. cajanderii,* and *L. gmelinii*.

As of late summer 2006 a total of 13 different genetic trials had been planted, three in Russia, three in Sweden, two in Finland, two in the US (Alaska), and one each in Norway, Iceland, and Saskatchewan, Canada. Four additional plantings are planned for the near future in Japan; the US (Minnesota); Quebec, Canada; and northeast China. Due to the limited availability of seed and the latitude of each site not all sites received all seedlots.

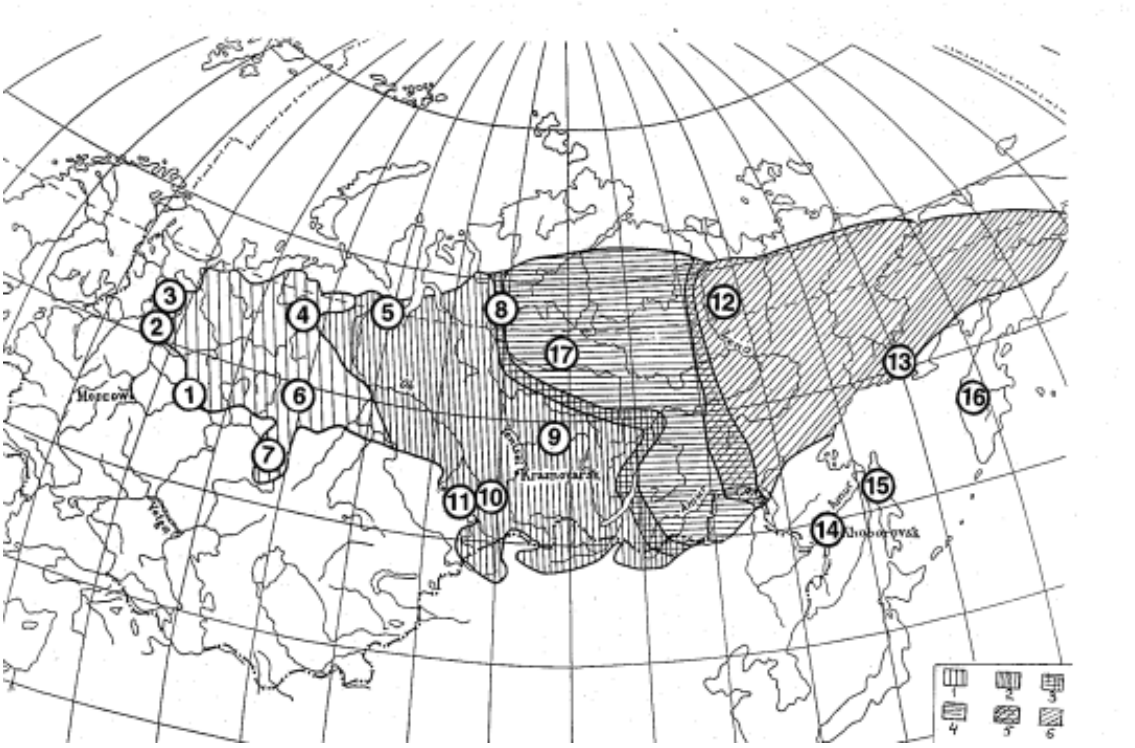

Figure 1. Sixteen collection regions of the International Eurasian Larch Project. Shaded areas represent the range distribution of the four native *Larix* species and their hybrids. From west to east they are *L. sukaczwii*, *L. sibirica*, *L. cajanderii,* and *L. gmelinii*.

The history of the Minnesota planting dates back to 1996 when Gary Wyckoff, the Director of the Aspen/Larch Genetics Cooperative, convinced the cooperators to contribute $10,000 USD to the Eurasian larch collection effort. In March 2003 the ALGC received a sample of seed and by August 2004 the first greenhouse measurements were made. Originally intended for use by cooperators in western Alberta and northern Minnesota the Minnesota planting was dealt a blow when the western Alberta cooperators withdrew from the Cooperative and another in June 2005 when Boise Cascade LLC lands in Minnesota were sold to Forest Capital Partners, Inc. (FCP). As FCP did not have an interest in the productive potential of Eurasian larch the original planting site was lost, an alternative site needed to be found and the 1-0 container seedlings were planted into the nursery. Seedling measurements were taken in September 2005 after two years of growth, one in the greenhouse and one in the nursery.

A search for a second site was conducted through the winter of 2005-2006. Ideally, it would be in northern Minnesota to take advantage of the higher latitude the colder winters and the moister summers that the area affords. By spring 2006 the search had focused on four sites in northern St. Louis County that were all operational forestry sites. In the final analysis none of these sites were acceptable, each for a different reason, and the seedlings were again put into the nursery for a third year of growth, with survival, growth and bud break measurements taken in August 2006. In the meantime site preparation for the genetics trial began on a parcel of land recently acquired by the University of Minnesota in southeastern Koochiching County for a scheduled spring 2007 planting of the 1-2 seedlings.

The interest in Eurasian larch springs primarily from the successes that the ALGC has seen with European larch. European larch is the fastest growing conifer in terms of kg dry weight/ha/year in the upper Great Lakes region and has obvious applications in biomass and biofuels as a feedstock and for enhancing the carbon sequestering capabilities of our northern forests. In the Nordic countries of Sweden, Norway and Finland the Eurasian larch are being considered as a natural substitute for treated Scots pine in an effort to decrease overall chemical usage in construction but also in recreational furniture and children's play equipment. In addition to being used for feedstock in biomass and biofuel situations larch are being used as a substitute for conifers in pulping studies where it pulps similarly to jack pine. It also is being used as a fiber for OSB which is one of the most common construction panels in the industry. From established ALGC trial at Haskell Lake in Itasca County we know that European larch outcompetes red pine in growth when planted on a former red pine cabin log site. Similar results were found in an ALGC trial on a former northern hardwood site with a high water table near Brookston, Minnesota, where European larch was superior in both height and diameter growth to white spruce.

On both of these sites browsing was very common either by deer (Haskell Lake) or by a combination of deer and moose (Brookston). On the Haskell Lake site deer browse was so sever that many of the red pine controls were killed. At Brookston some of the white spruce seedlings were browsed which indicates a high level of ungulate pressure. Larch is relatively tolerant of browse because it has a different architecture from most conifers. As opposed to most conifers where the branches are attached at whorls or nodes along the main stem larch is subopposite which means that the branches do not originate from opposing positions along the stem. Because browsing removes the leader in larch the next highest branch becomes the terminal leader and upward growth can begin immediately.

In other conifers the whorled branch arrangement means that each branch in the whorl directly below the browse line has an equal chance at becoming the next leader. This sorting out process delays upward growth and keeps the seedling short and branch tips within reach of ungulates. The browse tolerance exhibited by larch species exacerbates their growth potential when compared to the native conifers.

The objectives of the Minnesota trial are to compare growth and survival of different seedlots to red pine, determine the seed collection regions adapted to the local climate, identify individuals that would be suitable for use in a seed orchard and share information regarding patterns of growth and adaptability with other researchers participating in the international study.

The site that was chosen for the genetic trial is a former hay field with a high clay content located in southeastern Koochiching County. At latitude 47'57" and longitude 93'05" it is approximately 35 km west of Gheen, Minnesota, located in USDA plant hardiness zone 2.

The Minnesota site that will be planted in spring 2007 will be one of the most southern trials at just under 48' latitude. Many of the most northern collections will not be well adapted to the photoperiod and climate at this location. As a result only 10 collection regions will be planted. The experimental design for the Minnesota planting is shown in Figure 2. There are three

replications, collection regions are represented in blocks to make the visual assessment of adaptation ability more obvious. Not all stands within regions and families within stands were available due to limitations in the numbers of seed. Larger numbers of families and stands will be planted from regions that are most likely to have a photoperiod and climate similar to northern Minnesota. Red pine will be planted as a control species.

Table 1. Experimental design for the Minnesota planting of the International Eurasian Larch Project. Numbers refer to collection regions (see Figure 1), red pine is a local control. Large plots (7, 11, 14, 15 and red pine) represent 100 seedlings, plots numbered 1 and 9 represent approximately 66 seedlings, while plots 2, 4, 5, 6, 12, and 13 represent approximately 33 seedlings.

Rep 1	7	2	14	15	1	11	12	9	red pine
		4					13		
		5			6		10 16	6	
Rep 2	1	14	2	11	red pine	15	9	7	12
			4						13
	6		5				6		10 16
Rep 3	12	2	14	7	9	red pine	15	11	1
	13	4							
	10 16	5			6				6

First year height measurements of the Minnesota seedlings from the greenhouse and a subsequent two years of nursery measurements (2004-2006) indicate that seedlings from three collection regions have maintained their overall height ranks. Seedlings from Chabarovsk, Novgorod and Sachalin were ranked first, second, and third in height in each of the three years of measurements (Table 2).

In the summer of 2006 bud set was measured in the nursery (Table 3). Bud set for a region was defined as a minimum of 90 percent of the seedlings having formed a terminal bud on the leader. Results indicated that the regions that expressed the greatest height growth also tended to be regions with the latest bud set dates. This is not surprising, European larch has a similar growth rhythm which allows it to grow into August when the native conifers have ceased height growth by mid-July. Although this exposes these seedlings to early fall frost events if a terminal bud is formed early September there is usually sufficient time to initiate the cold hardiness process before an extremely hard frost.

Because bud set is typically correlated with photoperiod one would expect northern collection regions to set a terminal bud first and the most southern regions last. However, bud set date did not appear to correlate well with latitude across collection regions. In fact, if there was any trend at all it was for the interior regions, i.e.: 4, 6, 9 11, and 13, to set bud first by 18 July, then the easternmost regions, 1,2 and 7 to set bud by 26 July and finally regions 14 and 15, the westernmost regions to set bud last. This trend toward a regional pattern instead of a latitudinal pattern may indicate the influence of climatic forces such as aridity, or proximity to large water bodies that override the traditional latitudinal control on bud set.

Table 2. Mean height in centimeters for Eurasian larch seedlings from different collection regions, in Grand Rapids, Minnesota after one year in the greenhouse (2004), an additional year in the nursery (2005) and two additional years in the nursery (2006).

Region	Region Name	2004		2005		2006	
		height (cm)	n	height (cm)	n	height (cm)	n
1	Novgorod	27.7	264	33.2	264	45.0	195
2	Plezetsk	22.4	137	27.0	137	34.2	98
4	Petchora	13.2	124	14.6	124	20.3	95
5	Salechard	17.3	7	20.6	7		
6	Perm	25.0	282	30.1	282	40.4	197
7	Ufa	24.3	428	28.4	428	38.0	299
9	Boguchany	25.6	311	29.6	311	36.2	198
10	Novokutznetsk	26.5	15	31.6	15		
11	Altai	23.2	389	27.7	389	34.5	295
13	Magadan	23.2	119	26.7	119	31.8	51
14	Chabarovsk	30.5	399	37.4	399	54.4	273
15	Sachalin	26.6	439	32.2	439	44.2	298
16	Kamchatka	21.7	30	25.5	30		
		25.2	2944	30.0	2944	40.2	1999

Table 3. Effect of bud set on total height (cm) for three-year-old Eurasian larch seedlings grown at Grand Rapids, Minnesota.

Region	Region Name	Date Bud Set	2006 Height	Rank 2006 Height Growth
4	Petchora	18 July	20.3	10
6	Perm	18 July	40.4	4
9	Boguchany	18 July	36.2	6
11	Altai	18 July	34.5	7
13	Magadan	18 July	31.8	9
1	Novgorod	26 July	45.0	2
2	Plezetsk	26 July	34.2	8
7	Ufa	26 July	38.0	5
15	Sachalin	10 August	44.2	3
14	Chabarovsk	not set	54.4	1

Early International Results

The early international results presented here were compiled from presentations made at the SibLarch Conference in Arvidsjaur, Sweden, in August 2006 (Table 4). Although the collection regions are similar the stands and/or families may differ as these are reported as regional means without additional information. No attempt was made to estimate standard errors, perform a means comparison test or a combined site analysis. Moreover, the results reported here vary in the age of the seedlings and the way in which they were grown. Regardless, these reports provide the first evidence of how larch seedlings from the different collection regions are growing at different geographical sites.

Seedlings were four-years old at both the Canadian and the two Swedish sites, having been grown in the greenhouse first followed by three years of field growth. As mentioned earlier the Minnesota seedlings were three years old, one year in the greenhouse and two years in the nursery. Despite the differences in seedling age and geographic location there are similarities in height rankings. Regions 1, 14 and 15, (Novgorod, Chabarovsk, and Sachalin) were in the top three regions for total seedling height at three of the four sites. The results in Minnesota were similar to results reported in Saskatchewan, Canada, and two sites in Sweden.

Table 4. Total height for Eurasian larch seedlings from 18 different collection regions grown at four different locations. The three tallest performing regions at each site are highlighted for comparison.

		$47^0 22'$	$52^0 56'$	$57^0 47'$	$65^0 11'$
Region #	Region Name	United States	Canada	Sweden	Sweden
		Grand Rapids, MN	Birch Hills, SK	Österbymo	Järvträsk
1	Novgorod	45	100	119	46
2	Plezetsk	34	63	80	51
3	Onega			66	53
4	Petchora	20	20	31	42
5	Salechard		32	36	41
6	Perm	40	79	96	44
7	Ufa	38	95	117	46
9	Boguchany	36	75	78	50
10	Novokutznetsk		90	81	53
11	Altai	35	61	47	36
12	Yakutiya		30	0	40
13	Magadan	32	41	90	58
14	Chabarovsk	54	72	147	66
15	Sachalin	44	61	141	61
16	Kamchatka		42	76	44
18	Lassnmaa (so)			75	54

Summary

Cooperators in the International Eurasian larch project, which has its roots in the 1992 International Larix Symposium, will plant their final sites in the spring of 2007. These plantings will bring the total number of sites to 17 on three continents. Height data collected over several years on nursery grown seedlings in Grand Rapids, Minnesota shows consistent performance among provenances, with the Chabarovsk, Novgorod, and Sachalin regions the tallest. These regions are also among the latest to set bud in the Grand Rapids nursery which is likely contributing to their increased height growth. The seedling height data was fairly well correlated with height data from other plantings of the same provenances around the world; especially for sites planted at latitudes lower than 58º. This is not surprising if the provenances are genetically distinct and the species possess a broad level of adaptability. However, despite the correlations among provenances in different years at the same site or among provenances at different sites it is still too early to make recommendations about the suitability of these provenances for deployment in northern Minnesota. Thus these results can only be considered preliminary because the extremes in weather and not the means will dictate the level of adaptation to local climate.

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