2020 Re-Measurement of Larch at Viles Arboretum

By David Maass[1], Kenneth Laustsen[2] and Lloyd Irland[3]

Alfred's Half Acre in the Viles Arboretum, Augusta, Maine, was planted to exotic and native larch in 1991. The September 2020 re-measurement provides more information on the growth of both native and exotic larch species in this demonstration planting.

This report is classified at LVES Note #11. LVES is the acronym for Larch Virtual Experiment Station, which has a web site of www.larchresearch.com. There are several other reports and literature regarding exotic larch on the website.

The planted species include European Larch (*Larix decidua*), Japanese Larch (*L. kaempferi*), native Tamarack *(L. larcinia*) and hybrid larch (*L.* X *marschelensi*). Seed and seedlings were provided by Scott Paper Co. The planted hybrid is known as "Dunkeld larch", for the Dunkeld estates in Scotland, where the hybrid was widely identified. The hybrid seed for this trial is also identified as "von Lochow", after the name of the commercial seed source in Europe. (See original report *Larch plantings at Viles Arboretum, Augusta, ME* (Maass 2015) for more detail and methodology.) The soils on which the plantation exists are mostly Hollis fine sandy loams which are deep and somewhat excessively well-drained.

The original plantation was designed as six rows of 11 trees each planted on spacing of 12 feet between the rows and 10 feet within the rows. Some seedlings were replaced in 1992. Because the tamarack suffered the greatest early mortality, European and Japanese larch were fill planted as needed to maintain the integrity of the plantation.

The plantation was measured in 2015 midway through the growing season for larch (July 2015). This was called 24th growing season. This current re-measurement was made on September 3, 2020, representing nearly the end of 30th growing season. In this re-measurement, diameter and height of all trees were measured. Diameters were measured using a diameter tape to the nearest 0.1 inches. Heights were measured using the percentage scale on a Suunto Clinometer to the nearest 2%. (These were converted to heights by adding the percent to the bottom of the tree to the percent of the top of the tree multiplied by the distance to the tree in feet.) Survival is based on the original planned 66 trees.

Total and merchantable volumes were calculated using Kozak taper equations (Li et al. 2012) with parameters for each of the species. Merchantable volume is calculated above a .15 m (6.1") stump to a 9 cm (3.5") top diameter. Cubic foot volumes were converted to cords at 85 cubic feet per cord. The results are provided in Table 2.

We list in Table 1 the revised data from 2015. Volume measurements were recalculated to compare 2015 and 2020 data sets using the same methodology. The recalculation of merchantable volume is larger than reported earlier. However, it didn't alter our conclusions regarding the relative growth of the

---

[1] Consulting Forester, Maine and South Carolina
[2] Retired Maine Forest Service Biometrician, Oakland, ME
[3] President, The Irland Group, Wayne, ME

several species. Also note that the 2015 heights were estimated based on regression of height to diameter from five measured trees for all but the tamarack. No heights of tamarack were measured in 2015.

Quadratic Mean Diameter (QMD) is the tree of average basal area and is considered to better represent the stand conditions than the mathematical average of tree diameter at breast height (dbh).

Table 1. Revised 2015 Data from Larch Demonstration Planting at Viles Arboretum

	% Sur	QMD (in)	Mean Ht (feet)	Trees per acre	Basal area/ac (ft^2/ac)	Mech vol (ft^3/ac)	MAI (Cds/ac/yr)
Tam.	32%	6.8		116	30	651	0.32
J. Larch	36%	14.3	74	132	147	3826	1.88
E. Larch	76%	11.0	66	183	183	4446	2.19
H. Larch	82%	10.5	66	172	178	4444	2.18

Table 2. 2020 Results of Re-measurement of Larch at Viles Arboretum

	% Sur	QMD (in)	Mean Ht (feet)	Trees per acre	Basal area/ac (ft^2/ac)	Mech vol (ft^3/ac)	MAI (Cds/ac/yr)
Tam.	26%	8.7	50	94	38	866	0.34
J. Larch	36%	15.4	74	132	171	5597	2.09
E. Larch	65%	11.8	69	237	180	5942	2.22
H. Larch	79%	11.3	73	286	201	7260	2.72

CONDITIONS

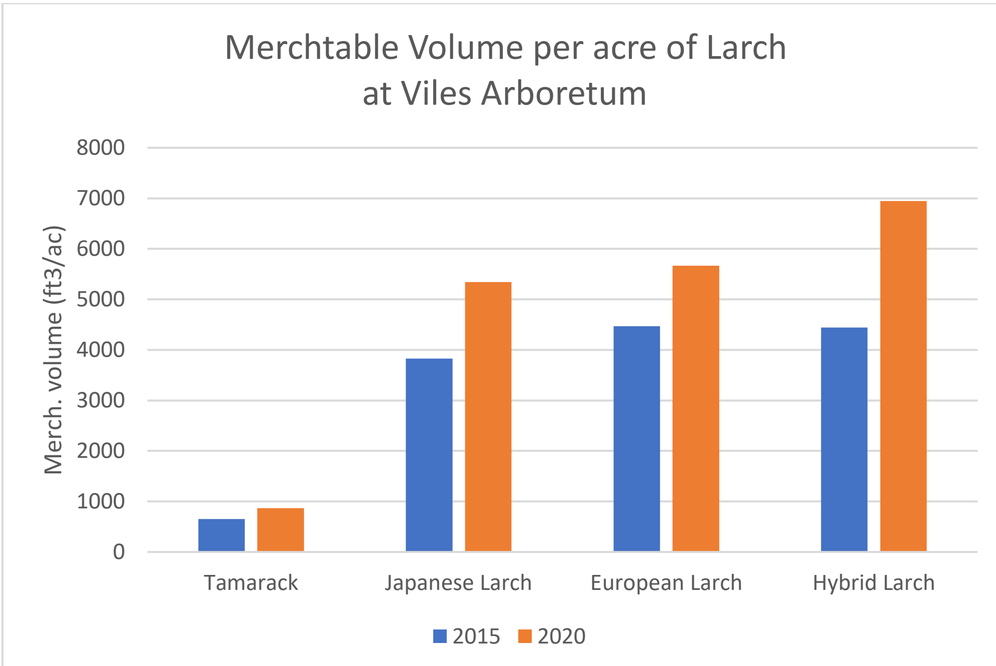
The plantation has seen some blowdown since 2015. It's apparent that the strong winds from the west across the field adjacent to the plantation have caused a few trees to uproot. We saw this in the hybrid and European larch and not in the other species. Tamarack trees had broken tops. Also, we noted some European dead trees and bark beetles are apparently active (See photo 1 below). According to the Maine Forest Service the dead European trees was likely due to drought with the bark beetle infection being a secondary cause of death.

Significant ground vegetation has grown under all of the larch plantations. (See Photo 2.) The understory is dominated by white ash (*Fraxinus americana*) and bittersweet (*Celastrus* sp.). The light shade that larch provides allows other vegetation and tree species to become established. We've seen this elsewhere as well. In this way, it may be possible to utilize the larch as a nurse crop.

DISCUSSION

The three exotic larches continue to grow well compared to the native Tamarack. (See Figure 1.) All three of the exotics has achieved a mean annual increment (MAI) of over 2 cords per acre per year, while the Tamarack remains below 1 cord/acre/year. As mentioned above the soils are somewhat excessively drained and deep to the water table. We think of the Tamarack as a species that prefers wet, even boggy, soils. The excessively dry site for this species may be the reason for low survival and growth.

Figure 1. Merchantable volume of Larch Demonstration Plantings in 2015 and 2020



The Japanese larch suffered poor initial survival, but the remaining trees have responded well. The mean diameter is nearly 15 inches, while the European and the hybrid are less than 12 inches. We suspect that the fewer stems of the Japanese larch have allowed those remaining to grow rapidly in diameter. Also, the heights on the Japanese exceed those of either of the other two exotics. This species continues to increase its mean annual increment from 1.88 cords/acre/year five years ago to the current rate of 2.09, despite the significant lower stocking.

The European larch had good initial survival and good growth rates. In 2015, the mean annual increment (MAI) was 2.19 cords per acre per year. It appears that this species continues accelerate their growth, despite the loss of a number trees to windthrow and mortality. The QMD is 11.8 and height is 69 feet.

The hybrid larch has accelerated its growth during the last five years. The QMD is 11.3 inches and height averages 73 feet. Current mean annual increment is 2.72 cords per acre per year compared to 2.18 in 2015.

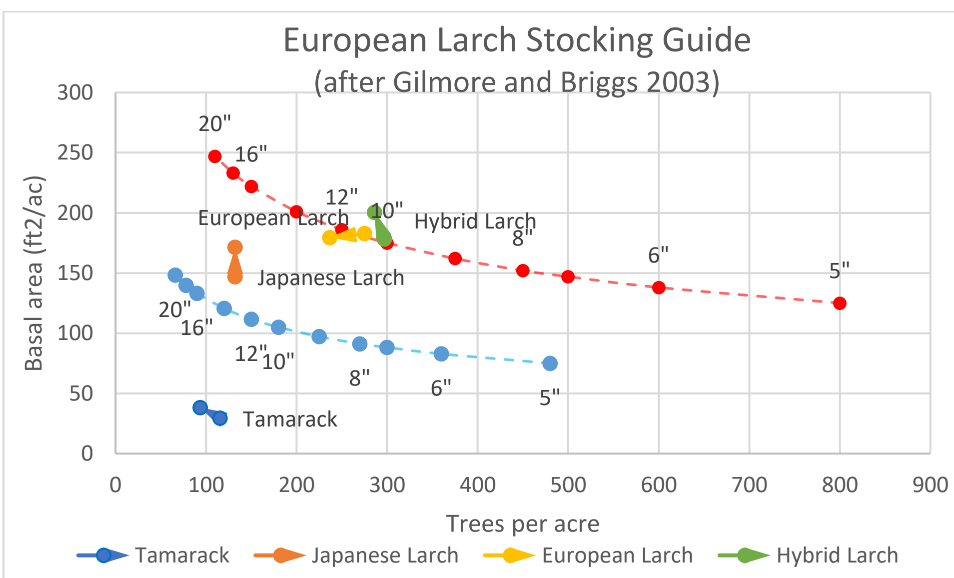
In Table 3, we compare MAI and periodic annual increment (PAI) between species. Because of difference between methodologies for obtaining heights, there is no periodic annual increment for heights. As expected, diameter growth for all species appears to be slowing down due to higher levels of stocking. However, volume PAI is larger than MAI in all species, indicating that these plantations even at age 30 are not near their biological rotation age.

Table 3. Comparison of Mean Annual Increment and Periodic Annual Increment

	Mean Annual Increment			Periodic Annual Increment	
Species	dbh (in)	ht (ft)	volume (ft^3)	dbh (in)	volume (ft3)
Tamarack	0.28	1.67	29	0.06	36
Japanese Larch	0.50	2.46	178	0.19	252
European Larch	0.38	2.31	189	0.12	201
Hybrid Larch	0.37	2.42	232	0.12	417

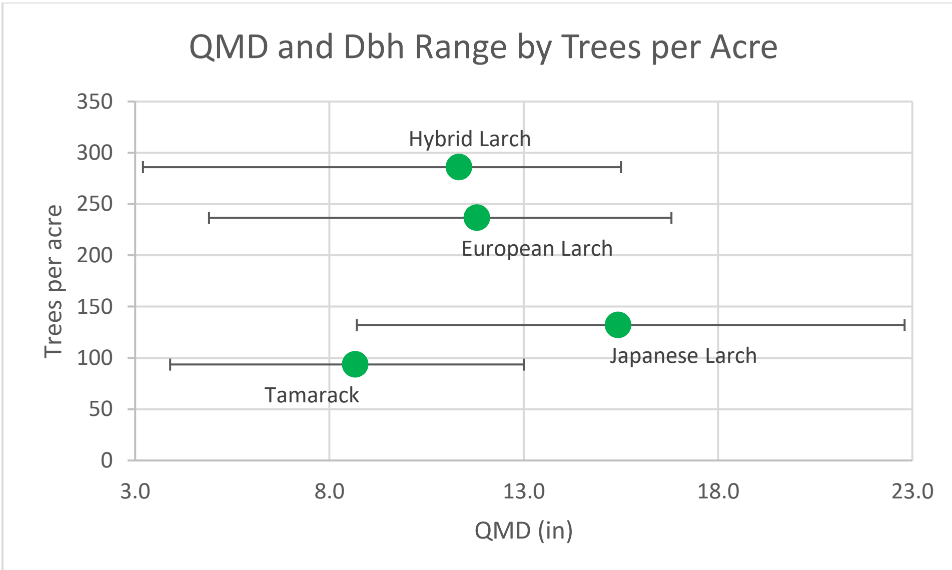
In Figure 2, we chart the changes in trees per acre and basal area on between 2015 and 2020 on a stocking guide for European larch (Gilmore and Briggs 2003). The red dotted line is an estimate of the self-thinning and line at various QMDs. The blue dotted line is 60% of the self-thinning line. The arrows point from where the stand stood in terms of basal area and trees per acre in 2015 towards the 2020 data point. All species, except European larch, gained basal area. There was no change in the trees per acre for the Japanese larch. The hybrid and European larch and the Tamarack lost stems as we noted earlier. We know that because of windthrow and other mortality, the European larch also lost basal area. We note that both the European Larch and the hybrid larch are at or above the self-thinning line. Japanese Larch is mid-way in stocking likely due to early mortality. Tamarack is well below a stocking level to maximize growth.

Figure 2. Changes in stocking levels between 2015 and 2020 Plotted on European Larch Stocking Guide



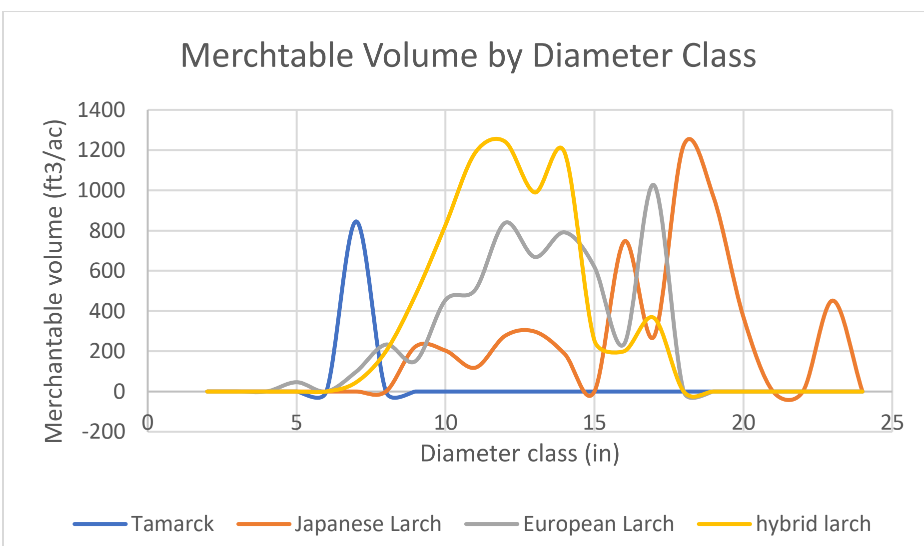
In Figure 3, we examine the distribution of trees per acre and merchantable volume by QMD. QMD is plotted for each of the four species, and the error bars represent the range in diameters at breast height. As note above the Japanese larch has the largest QMD and a maximum diameter of over 22 inches (in 30 years). The hybrid larch and European larch have similar profiles with the European larch having a larger QMD with a fewer number of trees. Tamarack has the smallest QMD.

Figure 3. QMD and Dbh Range by Trees per Acre



When we consider merchantable volume, we can see that the hybrid larch again has the most volume but a lower QMD than either the European or Japanese Larch. The European larch has a little less volume, but a larger QMD, while the Tamarack shows the lowest volume and a QMD of around 8.3 inches.

Figure 4. Merchantable volume by Diameter Class



From Figure 4, we see that the hybrid larch has the most volume through the range of diameters from 10 t0 15 inches. The Japanese larch has the most volume at diameters above 15inches. Tamarack peaks at around 7 inches. European larch has a modest amount of volume in the 12-to-15-inch range and again at 17 seventeen inches.

Mortality data:

Regarding mortality, the most interesting note is that we observed no mortality in the Japanese larch in either 2015 or 2020 observations.

In 2015, we recorded two dead hybrid and two dead European Larch trees. One small (5.5 in dbh) European likely died from suppression. The other died from an unknown cause, perhaps lack of soil moisture. The two dead hybrid larch trees likely were suppressed by other taller trees. Their diameters were 4.4 and 2.2 inches in 2015. The dead Hybrids and Europeans would have added only 0.7 and 4.0 square feet of BA respectively. They would have added 21.1 and 106.3 cubic feet per acre of volume for the hybrids and Europeans respectively.

We noted in the 2015 report that there was low survival of the tamarack on the apparent excessively well-drained site. Only 23 of the potential 66 trees survived including the fill planting with either Japanese or European larch.

In 2020, we found three dead hybrids, seven dead Europeans and five dead tamaracks. It appears that all the dead hybrids, four of the dead Europeans as well as three of the tamaracks died from windthrow. Tamaracks had broken tops. This plantation is on the easterly end of the large open field. The other three European trees and one of the tamaracks seemed to have died from drought. The fifth dead tamarack was likely suppressed, having a dbh of only 2.2 inches. We observed a secondary bark beetle infection in one of the European larch trees (See photo #1).

The seven dead European larches had an impact on the basal and volume. The European stocking was reduced from 183 to 180 square feet of basal area over the five-year period, while the other two exotic species increased in basal area (See Figure 2). Volume was also impacted. We note that the volume for European larch did not increase as much as the other two exotics over the interval (See Figure 3).

The impact of mortality is summarized in Table 4. In order to calculate basal area and volume, we made (what we consider reasonable) estimations to calculate dbh and/or height or both to estimate volume on the trees that were alive in 2015 and dead in 2020.

Table 4. The loss of dead and/or dying on trees, basal area and volume by assumed cause.

	Trees per acre		Basal area per acre (ft^2)		Total volume per acre (ft^3)	
	wind	drought	wind	drought	wind	drought
Tamarack	17	11	12	1	32	24
Japanese						
European	22	17	18	11	595	362
Hybrid	17		9		290	

Carbon sequestration:

In Table 5, we look at the number of green tons of carbon produced by various components of the three exotic larches (Tamarack was not included). Total above ground carbon produced was 190 green tons per acre, with most of that being in the bole of the tree. Also, the bulk of the carbon was in the sawtimber size trees (larger than 11 inches dbh). Over the 30 years, these three species produced 6.3 tons per acre on an annual basis.

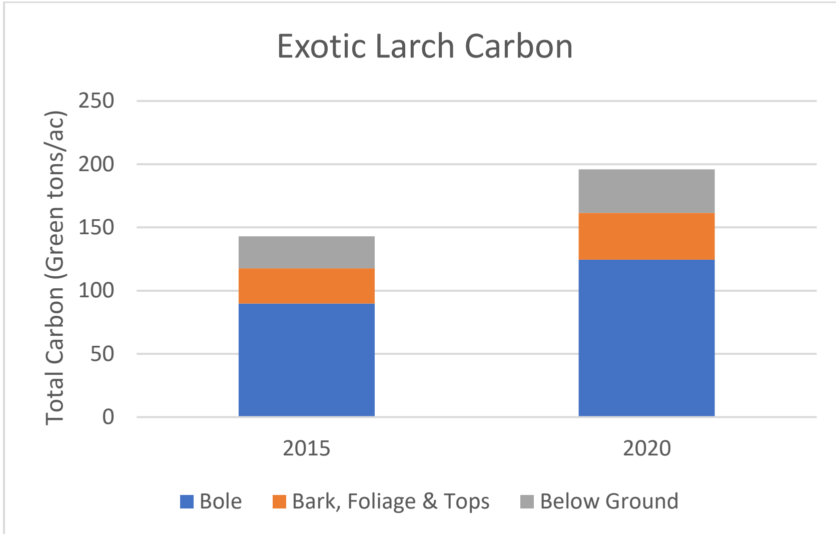
Carbon tonnage was calculated by inserting the diameter distribution for combined exotic larch species (European, Japanese and hybrid) into a cedar/larch species grouping in a spreadsheet prepared by author Ken Laustsen. The spreadsheet source information is from General Technical Report NE-319 (Jenkins et al. 2004).

Table 5. Green tons per acre of carbon produced by exotic larch in 2020

Size Range	Stem Wood	Stem Bark	Bole	Foliage	Tops & Branches	Total Aboveground	Coarse Roots	Total Above & Belowground
Saplings (<1.0 - 4.9")	0.2	0.0	0.2	0.0	0.1	0.4	0.1	0.4
Poletimber (5 – 10.9)	19.4	3.6	23.0	1.9	5.6	30.5	6.6	37.0
Sawtimber (11.0"+)	82.5	15.0	97.5	7.4	21.0	125.8	26.9	152.7
Total	102.2	18.6	120.7	9.3	26.6	156.6	33.5	190.1
Mean Annual Increment	3.4	0.6	4.0	0.3	0.9	5.2	1.1	6.3

In Figure 5, we see the change in the amount of carbon from 2015 to 2020. We note that carbon is accumulation is increasing annually. Comparing mean annual increment in 2015 and 2020 we note that it is increasing from 6.0 to 6.5 green tons per acre per year.

Figure 5. Change in Green Tons of Carbon per acre from 2015 and 2020



Conclusions

In conclusion, we expect to see continued good growth on the three exotic species of larch. The native Tamarack, either due to low initial survival or the poor-quality site for this species, or both, remains the poorest performer. No mortality was observed in the Japanese larch, but the stocking is well below the self-thinning line. Because both the European and hybrid larch are close to the self-thinning line on the stocking guide, it will be interesting to see how these two species grow in next few years. Both of these species lost trees due to wind and/or drought. A spreadsheet with the data for both data sets has been sent to the Viles Arboretum for their records.

REFERENCES

Gilmore, D. and R. D. Briggs, R. W. 2003. Stocking Guide for European Larch in Eastern North America. North. J. Appl. For. 20(1)34-38.

Jenkins, Jennifer C.; Chojnacky, David C.; Heath, Linda S.; Birdsey, Richard A. 2004. Comprehensive database of diameter-based biomass regressions for North American tree species. Gen. Tech. Rep. NE-319. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 45 p.

Li, R., A. Weiskittel, A. R. Dick, J. R. Kershaw Jr., and R. S. Seymour. 2012. Regional Stem Taper Equations for Eleven Conifer Species in the Acadian Region of North America: Development and Assessment. North J. of Applied Forestry 29(1):5-14.

Maass, D., and K. Laustsen. 2015. Larch plantings at Viles Arboretum. Larch Virtual Experiment Station (LVES) Note #1. 7p.

PHOTOGRAPHS

Photo 1. Picture of bark beetle hole in European Larch

Picture 2. Sign at Alfred's Half Acre