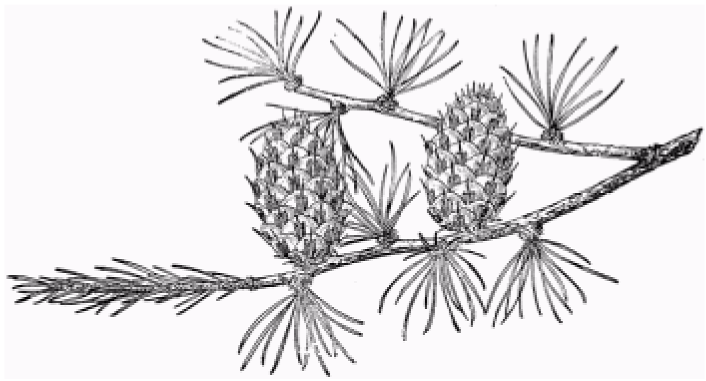
The Beauty & Biology of Larch

by Dana Visalli



There are two species of larch in the Methow, three in North America, and a total of ten species (or more, depending on who is counting) in the Northern Hemisphere. All of them seem to have the ability to cast a certain spell over the people who live in proximity to them, enchanting their human admirers with their curious deciduous nature, with their soft, sensuous green leaves in the spring, and with the brilliant shades of yellow to which they turn in the fall. Their biology is no less intriguing, as in spite of close scrutiny it is not completely clear why these deciduous conifers ever evolved to live so differently than their evergreen coniferous kin.

We tend to think of larches as somewhat rare exceptions to the fact that most conifers in the world are evergreen, keeping their leaves (also known as needles) throughout the year. But in fact taking the larch genus *Larix* as a whole, they are among the most abundant trees on the planet. This is in no small part due the fact that the boreal forest in eastern Siberia is dominated by the Dahurian larch (*Larix gmelinii*), with Siberian larch (*Larix sibirica*) filling in any available empty space. And while our two local species, western larch (*L. occidentalis*) and alpine larch (*L. lyallii*) have rather limited ranges, the third species in North America, eastern larch (*L. larcina*; another common name for it is tamarack) grows from the eastern seaboard all the way to Alaska. These northern species extend northward all the way to the Arctic treeline, surviving winter temperatures as low as -80ºF.

Being in the same genus, our two Pacific Northwest species, western larch and alpine larch, share the same evolutionary history, but have diverged in character to adapt to their particular habitats. Perhaps most notably, western larch is a fire-evolved species, and is in fact considered to be the most fire-resistant tree in our region, while alpine larch is neither fire-evolved nor fire resistant. Western larch's adaptations to fire include bark in mature trees up to 10” thick, branchless boles of mature trees for up to 50' in height, and very rapid growth of young trees in bright sunlight, allowing western larch to out-compete other species after a fire. The needles of all larches are 'forever young' (they are replaced annually), and have a higher moisture content and lower flammability that evergreen needles. Its open crown architecture allows the heat of a fire to pass through rather than ignite the foliage. Also, if damaged, larch’s deciduous needles are replaced the following season. Fire favors larch because fire will reduce the competition of other tree species and understory vegetation.

Western larch grows up to 200' tall, allowing it to dominate access to sunlight in the upper forest canopy. Whereas all conifers do best in bright light, larch can survive *only* in open sunlight. If larch is overtopped by other species its crown rapidly deteriorates, and its vigor declines severely. Western larch is the most

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An alpine larch on the rock glacier near Hoodoo Pass, going with the flow

shade-intolerant conifer in the Northern Rockies and Cascades. Fire suppression in last century has favored thickets of suppressed shade-tolerant conifers, which result in a decline in the vigor of all trees. These sites are at risk of high-intensity wildfires. Large areas in and around the western larch habitat type are now characterized by such crowded and stagnant stands.

While young western larch can grow at a rate of one foot or more a year, juvenile alpine larch grows about one inch a year. Western larch begins to produce cones and seeds at about 25 years of age, while alpine larch has to wait until nearly 100 years of age to reproduce. The thickest bark on old alpine larch is only one inch deep, and young trees actually develop lower branches with 'evergreen' leaves (these needles last for two years), which survive winter by being buried by deep snows, and give these trees a photosynthetic boost during the growing season. Alpine larch bark is thin because fires are rare in the rocky uplands in which it grows.

Alpine larch exhibits a highly discontinuous distribution (see range map on page 12), which is believed to be a remnant of a continuous range existing at a time when cooler, more extensive timberline habitat existed. It is a durable species, with may trees reaching 500 years of age, and one tree in Alberta that has been dated at 1925 years old (it is still alive; the oldest known western larch is about 1000 years old, in Montana). The tallest known alpine larch is in the Washington Cascades and is 95 feet in height.

Male alpine larch cones hanging downward, a female cone from the previous year standing upright

Both species are monoecious, which means they produce separate male and female reproductive structures, but that they occur on the same tree. A warm spell in mid-March will induce western larch to send out its small, pollen-producing male cones, while pollen in alpine larch is not released until May. Both species are likely be still standing in deep snow at these times, but pollen release is initiated by air temperature, not ground temperature. Like all conifers pollen transport is on the wind, with millions of pollen grains released for each one that finds its way to a receptive stigma on a female cone. After releasing pollen the small male 'cones' fall to the ground.

Female cones of both species ripen in autumn, releasing seeds with a single wing attached, allowing the seed to be blown away from the parent tree as it falls to the ground. Female cones on western larch are about 1 inch long, while alpine larch cones are closer to 2 inches.

Larches are relatively well-defended against plant-eating adversaries. Bark beetles rarely attack them, and chemicals produced in the resin protect larch trees from root rot and other forms of fungal decay. They are susceptible to parasitism by mistletoe; in fact there is a species of mistletoe specially evolved to prey on larch, *Arceuthobium laricis*. Western larch has so much sugar in its sap that black bears frequently strip the bark off of saplings in the spring to get at and eat the cambium layer. The sap is sweet enough that it has on occasion been tapped by

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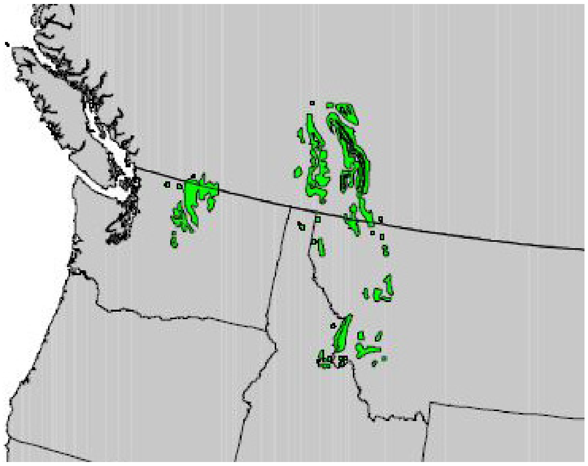
Recently the site of the Lyall Glacier, above Rainy Lake, now bare rock and gravel being quickly populated by alpine larch (all the light dots in the image)

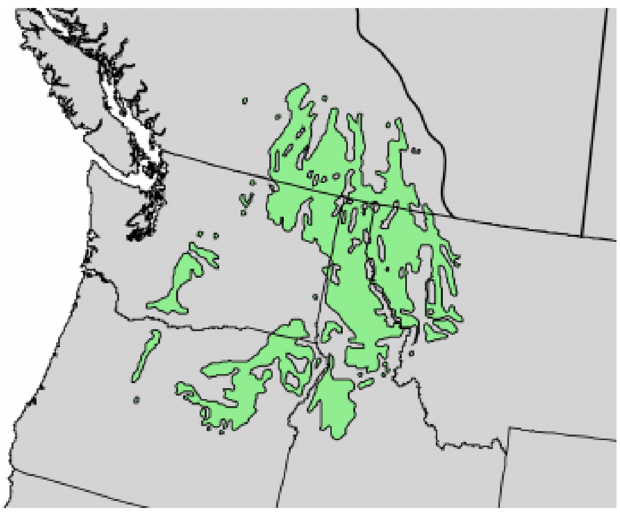
Larch, continued from page 5



The limited range of alpine larch, showing a population in north-central Washington, and scattered in western Montana and southern BC & Alberta

humans for 'larch syrup.'

There are some surprising hydrological benefits to the deciduous nature of western larch. A forest dominated by western larch intercepts much less snow with its leafless winter branches than does an evergreen coniferous forest. A considerable portion of the evergreen canopy intercepted snow evaporates, which means that western larch actually increases the amount of water reaching the soil in spring relative to evergreens. With its bare branches in spring allowing sunlight to penetrate to the ground, western larch forests would experience an earlier snowmelt than neighboring evergreen stands, and thus warmer soils and more effective spring photosynthesis once leaves have appeared.



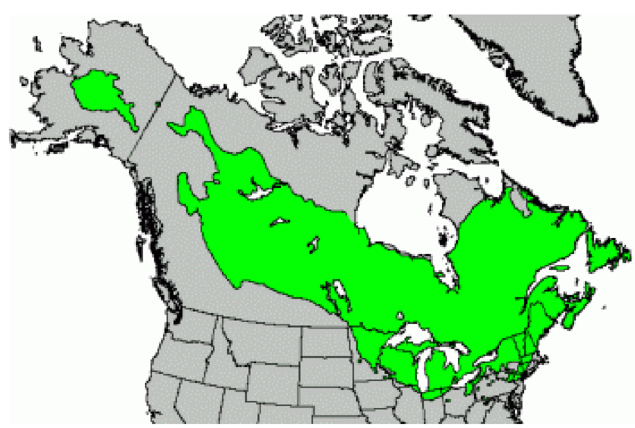
The more expansive range of western larch, growing from the northern half of Oregon and Idaho well into British Columbia

Why do larches turn yellow in the fall? Larches prove to be very efficient at recovering limiting nutrients from their leaves before shedding them. While carbon is always available from the atmosphere, nitrogen is usually in short supply in the nutrient-poor soils of the high country. Larch effectively translocates nitrogen from the foliage back into the tree tissues before dropping its needles in the fall, and it does this more efficiently than any other tree genus. For example, the needle litter of most other regional conifers has about 1 part nitrogen per 16 parts of carbon, whereas larch has only 1 part nitrogen per 50 parts carbon in its needle litter.

The yellow and orange pigments in fall leaves are known as carotenoids. Plants contain a variety of such compounds, but the most common are β-carotene (pronounced beta-carotene, the same pigment responsible for coloring carrots orange) and lutein (a yellow compound at low concentrations, but orange-red when concentrated). These pigments are always in the leaves, but only become visible as photosynthesis shuts down in the fall and green fades as the dominant reflected light, allowing the yellow pigments to be seen.

These pigments seem to have two primary functions. One is that chlorophyll only effectively absorbs light energy in blue and red ranges of the light spectrum, and does poorly in the green range- which is why plants are green; wavelengths of light in the green portion of the spectrum are reflected rather than absorbed. Meanwhile, the carotenoids are absorbing maximally at those wavelengths where chlorophyll does poorly: green. Once that light energy is absorbed, the carotenoids pass that energy on to a neighboring chlorophyll molecule, increasing the energy capture in the leaf. As chlorophyll degrades in the fall, other pigments in the leaf--most notably the yellow carotenoids--become more visible.

Light energy striking the leaf can cause injury to the internal biochemical machinery, especially the parts responsible for withdrawing nutrients back into the leaf. The presence of the carotenoids appears to physically shield the proteins and membranes, reflecting certain wavelengths and acting as a light screen, which assists the leaf in withdrawing nutrients



Tamarack has an extensive range, extending from the eastern seaboard across Canada to Alaska

Species	Rank
western larch	1
ponderosa pine	2
Douglas-fir	3
western white pine	4
lodgepole pine	5
grand fir	6
western redcedar	7
western hemlock	8
Engelmann spruce	9

Fire-resistance of western conifers, rated from high (1) to low (9)

back into the twigs so that the tree can reuse them next season when it forms new leaves.

The enduring question about larches is, why would the deciduous habit evolve and succeed in the midst of a forest of coniferous trees that are evergreen? The major advantages of evergreen leaves are thought to be 1) a longer photosynthetic season, as evergreem leaves can photosynthesize on days above 32° in late fall and early spring, 2) evergreens have lower amortized costs of leaf construction because each leaf lasts a number of years (typically only a few years, but up to 40 years in bristlecone pines!), and 3) the tougher leaf structure of evergreens can better endure frost, drought, and/or herbivore attack.

The oldest know western larch at about 1000 years, growing at Seeley Lake in Montana

The potential advantages of deciduous trees such as larches are 1) a higher photosynthetic rate per unit leaf mass because there is less protective structural material in the leaf, 2) lower root costs during the winter season because there is no leaf transpiration and thus water loss through the leaves, and 3) less winter damage from wind and snow due to the absence of leaves.

The last point may be a major factor, as in the alpine zone at treeline, evergreen conifers such as subalpine fir and Englemann spruce are reduced to a krummholtz (shrubby) structure, growing low to the ground, while alpine larch will often march up the mountain another 200 yards as an upright tree, protected from the insults of winter by shedding its leaves in the fall.

Another factor has been suggested for the evolution of the larch genus in what had previously largely been an evergreen world. The oldest known fossils of the genus *Larix* come from Axel Heiberg Island, adjacent to Ellesmere Island, in the Canadian Arctic, and are about 50 million years old. Axel Heiberg Island is located at 80º north latitude, within 10º and 1500 miles of the North Pole, and 1600 miles north of the Arctic Circle. Trees could grow at that latitude 50 million years ago because it was much warmer in the North at that time, in fact there was no ice at the North Pole until 3 million years ago. But, the dynamics of the Earth's orbit around the Sun would have been the same, which means that at 80º North, then as now, there would be 100 days of winter with no direct sunlight whatsoever, and almost a full half year with zero or low photosynthetic capacity. Under such conditions it might well benefit a tree species to shed its leaves and avoid the continual water loss and tissue damage of near-endless night.

Our minds are naturally inquisitive and like gathering information about the world around us. At the same time we have an emotional response to the overall colors and textures and dynamics of life. Larches do not disappoint in either realm; they are scientifically fascinating and aesthetically delightful. Larch adds a measure of color and textural diversity to the world that no other conifer can match. Starting in spring with soft, delicate green foliage which becomes darker green in the summer, larch really shines in the fall, turning brilliant yellow, that in combination with neighboring dark green conifers, makes a uniquely delightful landscape.

Yellow-leaved larch glowing in evening light in the alpine zone