Old Growth: What is old growth and why do some trees in the Pacific coastal region of North America reach such great age and size?

by David L. Cook

How and why do some conifer species in the Pacific coastal temperate forests reach such a great age, bulk and height? Up to about 15 million years ago in the middle Miocene, deciduous hardwoods dominated the region extending from northern California and around the northern Pacific Rim to Japan. Conifers had been confined to high elevations and were small in size because the warm, moist climatic conditions put them at a competitive disadvantage. About 10 million years ago the Coast and Cascade Mountains began to rise, influencing the climate. As the mountains rose they trapped more and more moisture. Rainfall patterns shifted, summers became warm and relatively dry and winters mild and wet. This was advantageous to conifers that retained their leaves year round, enabling them to acquire more than a third of their annual photosynthesis from October to May (Waring et al. 2002). Because of the mild winter temperatures, soils do not freeze, which allows for water transport and nutrient uptake when deciduous trees lack leaves. Even when snow covers the ground it forms a protective blanket to the underlying soil, preventing it from freezing. Without their leaves during October to April, hardwoods are unable to photosynthesize or to take up nutrients; they are completely dependent on stored reserves during that period.

Large conifers have much greater reserves of water in their sapwood and nutrients in their leaves than hardwoods. These water reserves can be called upon during the dry summer months. A giant conifer holds enough water to last a 10 day period. A hardwood tree holds less than one day's reserve.

Conifers have other advantages over hardwoods. The shape of the conifer needle is an advantage in draining water and allowing quick drying, thus facilitating gaseous exchange. The downward bending branches of conifers allow shedding of snow. The conical shape of the trees and the large number of needles maximize capture of sunlight, particularly when the sun is low on the horizon (Waring and Franklin 1979).

The great age of the trees in our coastal temperate forests can be attributed to long natural intervals between catastrophic or stand-replacing disturbance by wind or fire. These forests have experienced stand replacement due to major fire every 200–1,000 years (Wimberly 2002, Daniels and Gray 2006). Lertzman (1989) has said that the Cypress

Provincial Park old growth stands that he referred to as "snow forests" had not had major disturbance for 1,500–2,000 years and possibly not for over 4,000 years. The reason for this long fire return period is primarily because the coarse woody debris in this part of BC remains wet throughout the summer and fall, unlike the coastal forests of Oregon and Washington.

For North America, big tree hunter Robert Van Pelt (2001) lists three principal biomes that contain the largest and oldest trees. They are the Pacific Northwest, Northern Rocky Mountains and the Sierra Nevada biomes. Within those three biomes he lists six forest types, the Pacific Coast Rainforests, Redwood Forests, Coastal Montane Forests, Interior Montane Forests, Siskiyou Montane Forests, and Sierran Conifer Forests (Figure 1). The old growth in our area belongs to Van Pelt's Pacific Coast Rain Forest and Coastal Montane forests which lie within his Pacific Northwest biome.

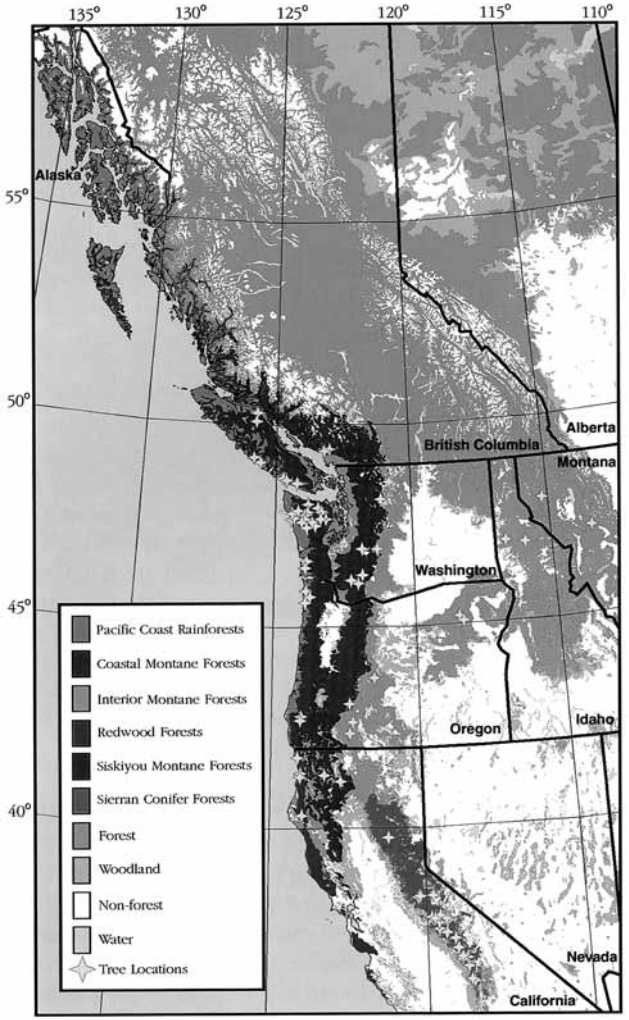

Figure 1: Six forest types are productive for giant, old trees (From Van Pelt 2001). The asterisks denote "Champion" or largest trees described in his book.

For BC, a forest classification system known as the Biogeoclimatic Ecosystem Classification (BEC) system, developed by Dr. V.J. Krajina of the University of BC in the 1960s, has been adopted

and expanded by the BC Ministry of Forests as a framework for managing ecosystems. The BEC in BC consists of 16 biogeoclimatic zones.

A biogeoclimatic zone is a geographical area with a relatively uniform macroclimate, characterized by a mosaic of vegetation, soils and, to a lesser extent, animal life reflecting that climate. Zones are usually named for the potential climax tree or self-perpetuating vegetation established on mesic (average moisture) sites and zonal (climatically determined) soils. A zone may contain smaller subzones that reflect differences in regional climate, soil properties and types of environmental disturbance.

All the biogeoclimatic zones of the BEC system contain or did contain old growth forests. However for BC, it is those zones that lie within the Coastal Western Hemlock (CWH), Mountain Hemlock (MH), Coastal Douglas-fir (CDF) and Interior Cedar Hemlock (ICH) biogeoclimatic zones that contain the largest and oldest trees.

Old growth means different things to different interest groups. To naturalists, environmentalists and recreational users it represents an irreplaceable natural treasure which should be preserved indefinitely. Foresters refer to big "overmature" trees. Ecologists look to old growth as a functioning ecosystem and discuss intricate food webs, biodiversity and distinct soil patterns. The biochemist sees old growth as a reservoir of new and useful compounds. To the logging industry, old growth means a very valuable resource. To the big tree hunter, old growth means record sized trees to be recorded and protected.

Douglas-fir in the Valley of the Giants, Lighthouse Park. Photo by Jeremy McCall.

Then there is the spiritual aspect of an old growth tree or forest enjoyed by many but not always consciously. Pristine and ancient nature can call forth the archetypal experiences that traditional religious images evoke. While this spirituality is embedded in the collective

subconscious of all of us, there are the lucky few who have brought it forward to their conscious mind and are able to knowingly enjoy the experience of interacting with something that is truly wild. It is thought that old growth spirituality grows out of a sense of loss that echoes our ancestors' departure from pre-anthropoid forests. Sacred groves have played a part in many cultures both ancient and modern. An example is the experience of solitude in nature termed the "soul mood" sought by the ancient Celts in their sacred groves. To the First Nations people of the Pacific Northwest, cedar groves are places of spiritual renewal and contemplation. I was privileged to see the sacred grove of hoop pines (*Araucaria cunninghamii*) in the village of Telefolip, the ancestral village of the Telefomin people of West Sepik Province, Papua New Guinea.

As a result of these varied interests, definitions for old growth are many and varied. For the coastal temperate forests of BC, the Ministry of Forests defines old growth as a forest comprising trees more than 250 years old. In the interior of BC, where trees have a shorter life span due to greater frequency of wildfires, old growth is defined as more than 120 years of age for forests dominated by lodgepole pine or broadleaf species, and more than 140 years for all other forests such as Englemann spruce, white spruce and interior Douglas-fir.

Old growth has many aliases; ancient forests, climax forests, decadent stands, first forests, old growth stands, older growth, over-mature stands, late seral forests, primeval forests, pristine forests, virgin forests, primary forest, antique forest, frontier, heritage, indigenous, intact, natural, original, presettlement, relict, untouched forests, and ancient woodland.

There is considerable variation nationally and globally as to what constitutes an old growth forest. A literature search by Lund (2012) found 121 definitions of old growth forest and 21 definitions for ancient forest. This reflects differing views of industry, scientists, naturalists and environmentalists as well as geographical differences. With the large amount of scientific study of old growth forests in recent years, definitions have proliferated.

For simplicity an old growth forest is the climax phase in the life-cycle of a forest characterised primarily by four characteristics; some large, old living trees; dead standing trees known as snags; large fallen trees referred to as coarse woody debris; multilayered canopy reflecting uneven age of the forest. These four characteristics need some explanation.

1. Large trees

"Large trees" means great bulk, girth or height and implies great age. Height is limited by gravity and the friction between water and the vessels through which it flows to between 122 and 130 m (400' to 426') (Koch et al 2004). This is known as the cohesion-tension theory of water transport in plants.

The tallest living tree in North America is named Hyperion (a coast redwood *Sequoia sempervirens*)

which is 115.24 m (378.1'). The all-time record was the Dyerville Giant (also a coast redwood) in Humboldt Redwoods State Park, California which was 113.4 m (372') when it fell in 1991.

The largest living tree by volume in North America is believed to be a giant sequoia (*Sequoiadendron giganteum*) known as the General Sherman Tree in Sequoia National Park in Tulare County, California. Only the trunk is used in the calculation and the volume is estimated to be 1,487 m^3 (52,508 cu ft).

For BC the Big Tree Registry aims to record the 10 biggest specimens of each tree species native to BC. Those trees qualifying for registration are known as "Champion" trees. The registry is modeled after the American Forestry Association's Social Register of Big Trees. The registry was established in 1986 by the BC Forestry Association. Big trees were nominated by people who submitted information forms, photos and maps. The person who initiated the register, and who located more record trees than anyone else, was Randy Stoltmann. Randy published many of the registry records in his book *Guide to the Record Trees of British Columbia* (Stoltmann 1993). Robert Van Pelt (2001) describes many of the "Champion" trees of the Pacific Coast

The general public is encouraged to submit to the Registry nominations for big trees that they have encountered. Instructions for measuring a prospective tree and nomination forms can be found at http://bigtrees.forestry.ubc.ca.

The oldest living tree in North America with a verified age is a Great Basin bristlecone pine (*Pinus longaeva*) called Methuselah growing in the White Mountains, Inyo National Forest, California. It has been dated by drilling a core sample and counting the annual rings and was considered to be 4,844 years old in 2012. For comparison the oldest redwood so far measured is a dead snag of giant sequoia from the Sierra Nevada Mountains, California called the Muir Snag which is more than 3,500 years old.

2. Snags

Snags are dead, standing trunks of trees that have died due to disease, senescence or fire. They are usually missing all branches and their canopy tops, and are in various stages of fungal decay. In the early stages of decay they can be excavated by the larger species of woodpecker such as Common Flicker and Pileated Woodpecker for food and their own nests. Other bird species and small mammals may take advantage of the activities of the larger birds and use the cavities as nests or dens. Black bears will often hollow out the rotten base of snags for dens or excavate them for ants or beetle larvae. The burnt-out or rotted-out heartwood, particularly of cedar snags provide chimneys which serve as roosts for bats and nest sites for barred owls and swifts. Such trees are called "wildlife trees."

3. Coarse woody debris

Large fallen trees and root balls which are referred to as coarse woody

debris litter the forest floor and represent trees that have fallen due to collapse of senescent, diseased or fire and wind- damaged trees. This debris provides nurse logs for competition-sensitive or water-sensitive seedlings and serves as habitat for small mammals, amphibians and birds. The Pacific Wren (*Troglodytes pacificus*) is one notable example of a bird that nests in upturned root balls of fallen trees. The logs also serve as runways for small mammals when moving through the forest and the rotting wood provides nutrients and refuge for a host of invertebrates. Ultimately this coarse woody debris decays with the aid of fungi, replenishing the soil with nutrients for the new generation of plants.

4. Uneven or mixed age trees

The fourth most commonly recognized characteristic of old growth forests is the uneven or mixed ages of trees in a forest. Uneven age reflects multiple generations of trees resulting from varied regeneration patterns related to small-scale disturbances such as windthrow, disease, low-intensity fires (in our coastal area) and old age. Such disturbances along the west coast of North America are primarily by windthrow or death of a large-canopied tree forming small-scale treeless patches in the forest. Tree saplings and understory shrubs grow into these forest gaps and form a patch of younger forest. This process, known as Gap Dynamics, is the principal process for forest renewal in our high rainfall, coastal temperate forests. Further inland, fire is the usual control for stand age variation. The uneven age of the trees results in varied height of trees creating what is known as a multi-layered or deep canopy. The oldest trees may emerge above the canopy of an old growth forest creating an uneven canopy profile. A second-growth forest, where trees are of the same age (even-aged), forms a single-layered, shallow canopy with an overall flat canopy profile without emergent trees.

Canopy depth of a forest is directly proportional to faunal species diversity. The canopy of an old growth forest is the second realm of high faunal biodiversity, particularly with regard to invertebrates and lichens. The first realm of high biodiversity is the soil of an old growth forest where micro-organism species numbers can reach incredibly high figures. For bacteria, 1 gram of temperate rain forest soil has been estimated as containing 5,000 species. Species of fungi can run into the thousands in the old growth forests of the Pacific Northwest. Two factors enhance biodiversity in the canopy; depth of the canopy, and thus varied light penetration which creates a diversity of habitat niches, and high humidity which is maintained during periods of low rainfall or drought.

While the four characteristics described above are those usually quoted for identifying old growth forests, there are many other compositional and structural features exhibited by old growth forests in the Pacific Northwest. Some of these are pit and mound topography, a well-developed soil profile, high diversity

of fungal and lichen species, old growth indicator species, and secondary canopy features

Unfortunately old growth forests are being depleted at an alarming rate. The area of "primary" forest or original forest cover, of which old-growth forests would make up a large part, is estimated to be only 24% of its pre-settled-agriculture amount (Postel and Ryan 1991).

Since European contact, old-growth forests of the Pacific Northwest have declined by 90 percent, California has lost 95 percent of its redwoods, Swedish forests have experienced more than a 90 percent decline in large tree density, and since 1970, over 600,000 square kilometers (230,000 sq mi) of Amazon rainforest have been destroyed. The Amazon Rainforest will be reduced by 40% by 2030 at the current rate. Compounding the problem is that fragmented Brazilian rainforests typically see a 50 percent die-off of big trees within 30 years of isolation.

It only takes a few minutes to cut down a tree that has taken a thousand years to grow.

Since David Cook joined Nature Vancouver in 2001 he has performed many roles in the Society. Not only has he been a director and chaired the Botany Section for several years, but he has also led many field trips, some of which have been aimed at reviving members' interest in a Geology Section. David is also well known for his field trips under the title of "Reconnecting with Nature." David is the editor of Nature Notes for this journal.

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