

# An exploration into the world of conifers on the west coast of America

Harry Baldwin



## Table of Contents

Acknowledgements .....	1
Preface .....	2
Aims and Objectives.....	3
Introduction.....	4
Itinerary .....	5-7
Places visited .....	8
Olympic Park .....	9-10
Hoyt Arboretum .....	11-12
Columbia Gorge .....	13-14
Bureau Land Management – Valley of the Giants .....	15-17
Crater Lake.....	18-19
Siskiyou Mountains .....	20-27
Jug Handle Nature Reserve .....	28-31
Quarryhill Botanic Garden .....	32-33
San Francisco Botanic Garden .....	34
Sequoia National Park.....	35-37
Conclusion, Appraisal and References .....	38
Costing's.....	39

## Acknowledgements

I would like to thank the following people for their help with the development of this proposal:

RHS Coke Trust.

Merlin Trust

Great Dixter Trust

Bentham and Moxon Trust

Hardy Plant Society

Tony Kirkham – Head of the Arboretum RBG, Kew

Richard Wilford – Head of Travel Scholarships at Kew.

Aljos Farjon – Conifer Specialist, RBG, Kew

Michael Kauffmann – Conifer Specialist, Humboldt State University

Stephen Fitzgerald – Silverculture Specialist – Peavy Arboretum

Paul Tigan – Head of Bureau Land Management

Matthew Stephens – Curator San Francisco Botanic Garden

Lisa Blackburn - President of Oregon Native Plant Society

Martin Nicholson – Curator Hoyt Arboretum

David Olszyk – President of the Western Conifer Society

Sara Malone - President of California Native Plant Society

Bentham Moxon Trust

## Preface

Conifers have a huge diversity, spreading to all corners of the world where man has utilised them for thousands of years. To this day, they are used for a huge variety of reasons, whether its for timber, paper or furniture, but to many of us they are best known as the 'leylandii' hedge. It sadly seems that that the general public take a dislike to conifers as they have seen poor specimens in badly designed landscapes, with often no associated planting and interpretation. They have the ability to grow extremely well in the British Isles, and if cultivated and presented correctly, can prove to be garden worthy.

The applicant has had a keen interest in conifers for many years, his passion began when working with the National Collection of *Pinus* at the Sir Harold Hillier Gardens, Hampshire. It was there where he realised that conifers on the whole are not particularly popular and are perceived with little merit. From much research, the applicant has found countless specimens that lack proper cultivation, design implications, companion planting and interpretation; all of which are vital for the trees growth and representation.

Travelling to Washington, Oregon and California to see conifers in their native habitat will be invaluable for increasing the applicant's knowledge of the cultivation of conifers. This opportunity to study them in their natural environment as well as comparing them within *insitu* environments will benefit his understanding hugely, as up to now he has only been able to work with them under cultivation within a garden setting. Wishing to pursue a career within arboreta, he felt that this would be a fantastic opportunity for him to see a huge diversity of conifers first hand whilst understanding properly what they require within a garden setting.

## Aims and Objectives

### Aims

- To identify a range of conifer species from Seattle to Los Angeles
- To identify the various understory plants that grow in association with conifer habitats
- To understand what factors have an important role in maintaining that habitat whether it be human induced or climatic.
- To gain an insight into how forest parks and national parks are managed: sustainable timber felling, encouraging wildlife and habitats as well as sustaining a healthy park for the next generation.

### Objectives

- To meet Michael Nicholson, curator of Hoyt Arboretum, for a tour and an outing to visit native Oregon conifer forest within the vicinity.
- To meet Michael Kauffmann, author and conifer expert to answer the applicants questions and take a hike within a conifer coastal environment in Northern California
- Meet Matthew Stephens, Curator of San Francisco Botanic Garden for a tour of the California native beds as well as studying the mimicked redwood forest.

## Introduction

The applicant travelled in May 2017 to Western North America to understand conifer ecology, forest management practices and associated planting; in order to gain a better knowledge of conifers in general as well as transfer ideas and improve the representation of conifers within gardens for education, cultivation and ornamental horticulture.

The applicant specifically chose coniferous biodiverse hotspots within Washington, Oregon and Northern California all of which provide a huge array of geographic, climatic and topographic environments. The applicant visited a vast number of habitats including; Olympic Park, Redwood National Park, Siskiyou Mountains and Sequoia National Park and among many others. The applicant managed to meet many experts on his journey, both in the field as well as arboreta and botanic gardens. Visiting a wide variety of conifer habitats at varying altitudes from coastal, lowland, temperate rain forest and montane forest, allowed the applicant to understand how plant and conifer communities adapted with varying elevation. The applicant wanted to understand how these important sites were managed; by meeting up with various specialists who allowed the applicant to understand how parks are managed in relation to timber felling, forest regeneration, controlling invasive species as well as ensuring their longevity for the future.

With the valuable knowledge gained from the field, the applicant was able to see how native conifer communities were represented and cultivated within gardens. The arranged meetings with Hoyt Arboretum, Bureau Land Management and San Francisco Botanic Garden gave the applicant the chance to ask questions and relate his knowledge gained from the field and put into practice.

The applicant has endeavoured to include as many of the main visits within the text as possible and he hopes that this trip will inspire others to travel too. If anyone has any questions, the applicant would be more than happy to help.

## Itinerary Saturday 29<sup>th</sup> April - Sunday 21<sup>st</sup> May 2017

**Day 1** Fly from London Gatwick 13:10 and arrive in Seattle Airport 17:45PM. Pick up Hertz car and drive 1.7 miles to Hampton Inn accommodation.

Accommodation: Hampton Inn accommodation 2 nights

**Day 2** Rest.

**Day 3** Rest.

**Day 4** World Forest Museum.

**Day 5** Drove to Hurricane Ridge, driving from sea-level to 1500m+ to view *Abies lasiocarpa* but large amounts of snow was present at 1500m, instead took notes of elevation change to that point.

Accommodation: Red Lion Hotel Port Angeles for 1 night.

**Day 6** Drove 39 miles (57 mins) to Hoh Rainforest where the applicant surveyed and identified various layers of undergrowth planting whilst noting the main occurring species. Saw *Picea sitchensis*, *Tsuga heterophylla* with *Acer macrophyllum* with an understory of many *Polystichum* spp as well as many unique mosses and lichens. Drive 69 miles (1 hour 27min) to Quinault River Inn.

Accommodation Quinault River Inn for 2 nights.

**Day 7** Undertook rainforest drive (30 miles all day) loop around Lake Quinault. Undertaking various short loops within the rainforest observing the surrounding flora. Spent a good day discovering Pony Bridge trail. Found the worlds largest *Pseudostuga menziesii* and *Thuja plicata*.

**Day 8** Drove 183 miles (3 hours) to Hoyt Arboretum, to met Martin Nicholson (Curator of Hoyt Arboretum) for a tour and questions. Visited Forest Park and many of his colleagues who kindly gave the applicant many ideas regarding the trip. Undertook the 2 mile native conifer trail, took notes of cultivation and presentation practices.

Accommodation At Martin Nicholson's house for 1 night

**Day 9** Rest morning. Drove 75 miles (1 hour 20 mins) to Columbia Gorge to see *Quercus garryana* and *Pinus ponderosa* forests. Luckily the applicant arrived at the height of prairie fields flowering as an understory. Accommodation: Best Western for 2 nights.

**Day 10** Met Paul Tigan (Manager at Bureau Land Management) and Scott Taylor (Wildlife Biologist) took the applicant to visit The Valley of the Giants. A pristine 600 year old forest of *Pseudostuga menziesii* forest. Both Paul and Scott spoke extensively regarding good timber management practices as well as managing for maximum diversity.

**Day 11** Drove 150 miles to Crater Lake to observe the windblown and high altitude conifers. Brilliant examples of *Tsuga mertensiana* which were covered in wolf lichen.

Accommodation: Klamath River Resort 1 night.

**Day 12** Drove to the Siskiyou Mountains and visited Jeffrey Pine Nature reserve where the applicant noted many understory species within this interesting community. The applicant additionally visited a *Darlingtonia californica* fen which consisted of a very interesting plant community.

Accommodation: Americas Best Value Inn, Crescent City. 2 nights.

**Day 13** Drove deep into the Siskiyou's to find the endemic *Kalmiopsis leachiana*.

**Day 14** Drive 76.5 miles (1 hour 27 min) to Humboldt State University. Rest Day.

Accommodation: Motel 6 for 3 nights.

**Day 15** Met Michael Kauffmann at Lanaspere Dunes, Arcata and joined him on a hike within a dune coniferous habitat.

Drove to Jug Handle Reserve to visit dwarf conifer forest.

**Day 16** Drove 40 miles (45 mins) to Redwood State National Park. Undertook 4 mile loop which took the applicant through extensive old-growth coastal redwood forest. The applicant then drove to Quarryhill Botanic Garden where he was greeted by Bill Macnamara for a tour of the largest collection of Asian plants in the world.

**Day 17** Drove 222 miles (4 hours 56 min) to San Francisco Botanic Garden.

Accommodation at Twin Peaks hotel for 3 nights

**Day 18** Met Matthew Stephens (Curator of San Francisco Botanic Garden) for tour of the conifer collection and discussed how conifers can be better represented in Botanic Gardens.

**Day 19** Rest Day

**Day 20** Drove 265 miles (4 hours) to Sequoia National Park.

Accommodation: Wuksachi Lodge for 4 nights

**Day 21** Hiked within Sequoia National Park, understanding the importance of the redwood as a key stone species within its habitat. Noting many understory species as well as appreciating the role of fire.

6

**Day 22** Attempted to hike Alta Peak (elevation: 11,000 feet) to observe elevation change in conifers and plant communities, sadly the applicant had to turn back due to snow. The applicant then decided to visit an old growth *Sequoia* forest.

**Day 23** Visit the Giant Forest of *Sequoia* whilst also visiting the Giant Forest Museum. Taking notes, photos and identifying companioning flora.

**Day 24** Drove 187 miles (3 hours) to Los Angeles International airport and drop off car and catch 12:50PM flight back to London.



## Places Visited



- Rhododendron Species Bota...
- Mount Rainier National Park
- Okanapocosh Visitor Center
- Hurricane Ridge Road
- Hoh Rain Forest Visitor Center
- Lake Quinalt
- Hoyt Arboretum Visitor Center
- Peavy Arboretum

- Valley Of The Giants
- Happy Camp
- Jedediah Smith Visitor Center
- Humboldt State University
- Arcata Community Forest
- Redwood National and State...
- San Francisco Botanical Gar...
- Sequoia National Park

## Olympic National Park

Olympic National Park occupies 922,651 acres of the Olympic Peninsula, that huge fin of land marking the Lower 48's northwestern extremity. The Peninsula is edged by saltwater on three sides: Puget Sound to the east, the Strait of Juan de Fuca to the north, and the open North Pacific to the west. The Olympic Mountains are a mess of seafloor that have been glommed onto the margin of North America due to the oceanic plate subducting beneath it. The range's rocks derive from eruptions of basaltic lava as well as sediments washed off the continent. Smashed, squeezed, and folded into the crook made by Vancouver Island and the North Cascades. This allows spruce rainforest to manzanita thickets, from orcas and sea otters, to pumas and Roosevelt elk, Olympic National Park is a place of spectacular ecological diversity.

The applicant visited two areas of Olympic National Park; Hoh Rain Forest and Lake Quinault. Other main key sites within the area is Queets and Bogachiel, which the applicant decided not to visit as much of what he wanted to see was found within the areas visited. However, Hoh Rain Forest is the only one that has been awarded the distinction of being a World Heritage Site and a Biosphere Reserve by UNESCO. Its unique ecosystem has remained unchanged for thousands of years and it is now the most carefully preserved rain forest in the northern hemisphere. These hotspots cradle what many consider to be the best of remaining examples of the Northwest's rain forest, a superb ecosystem found nowhere else in the world. This forest reaches its fullest potential on the west side of the peninsula. However on the east side over the mountains of Olympic National Park, the climate is a lot drier of about 45 inches a year as apposed to 170. The drier side features a lot of *Pinus ponderosa* and *Pseudotsuga menziesii* which inhabits drier conditions.



Pony Bridge – Lake Quinault. Harry Baldwin.

The dominant species in the rainforest were *Picea sitchensis* and *Tsuga heterophylla*; some grow to tremendous size, reaching 95 meters (312 ft) in height and 7 m (23 ft) in diameter. *Pseudotsuga menziesii*, *Thuja plicata*, *Acer macrophyllum*, *Alnus rubra*, *Acer circinatum* and *Populus trichocarpa* are also found throughout the forest but more often at the forest edge. A less occasional tree seen was *Taxus brevifolia*, the species was often seen as individual rather than as a clump which is likely due to how the seeds are dispersed by birds. Despite being a small tree compared to the tall douglas firs above, they happily grew in the darkest of conditions.

Main understory consisted of *Ribes lacustre*, *Oemleria cerasiformis*, *Sambucus racemosa*, *Lysichiton americanum*, *Petasites frigidus*, *viola sempervirens*, *Trillium ovatum*, *Maianthemum dilatatum* and *Disporum hookeri*. Yet perhaps one of the most abundant was *Rubus spectabilis*. The applicant managed to catch it in flower, and there would quite often be a sea of pink washed across the understory of the conifers. The applicant



*Trillium ovatum* a common understory at low elevation in

managed to catch a hummingbird pollinating a bramble, which was a real sight. Any woody flora was cloaked by moss and lichen; from the tops of the canopy right to the base of the trunk and often moss covering much of the soil below. Many ferns covered the floor such as *Blechnum spicant*, *Maianthemum dilatatum*, and *Polystichum munitum*.



Olympic Park. Trees covered with mostly *Isoetes stoloniferum*. Harry Baldwin

Interestingly many of the logs (known as nurse logs) harboured a great microclimate for new emerging seedlings to gather, such as; *Pseudotsuga menziesii*, *Picea sitchensis*, *Tsuga heterophylla*. All would compete for light and moisture but two main factors inhibit their growth; the first being the break down of organic matter of the nurse log itself and the second is competition for light and waiting for a gap in the canopy. Often many of the seedlings were decades old but patiently waiting for the obtuse moment. Hundreds of years old trees would quite often be in a vague line or some large trees would have huge buttressing which suggests they began life on a nurse log themselves.

The applicant visited a beach just outside of the Hoh Rain forest National Park known as Ruby Beach. The beach itself was wide with a huge expanse reaching almost as far as the eye could see. The beach needed this space to accommodate all the logs being washed at the mouth of the rivers onto the beach. It was like millions of telegraph poles had been dumped on the shoreline of the beach. At high tide these pieces of timber would be taken out to sea.



Ruby Beach. Harry Baldwin

## Hoyt Arboretum, Oregon

The applicant was kindly invited to meet Martin Nicholson who is the curator of Hoyt Arboretum in Oregon, who offered to show the applicant around and point out some of the native and non native conifers growing within the grounds. The Hoyt Arboretum, former site of a "poor farm", displays a variety of coniferous and deciduous trees, including most native varieties from the Pacific Northwest as well as other North American species and a variety of exotics. Since the Arboretum has been going since 1928, many of the trees are mature specimens and represent over 1,000 species. 237 species of conifers find their home at Hoyt Arboretum with many endangered species; *Torreya taxifolia*, *Cupressus dupressiana* and *Picea breweriana* are among the rare species to be found. Many other treasures of the conifer world are to be found in one of the most naturalistic settings encountered in American arboreta. The conifer collection continues to grow with new spruce and fir species being added from around the globe, along with additional North American conifer species.

Martin Nicholson noted that many of the native conifers that are grown within the grounds grow fairly well owing to the cool moist climate, yet during the summer it can be particularly hot and can stress certain native species. Hoyt Arboretum receives 20 inches of rain a year in comparison to 150 – 200 inches just over the border in Washington, Olympic Park. Certain species such as *Pinus jeffreyi* that can tolerate the drier climates were often used especially as a wind barrier and as specimen trees. Native conifers that thrive further south in drier areas in (ie. California) such as *Pinus coulteri* and *P. sabiniana* proved to be fairly resilient considering they do not receive too much winter wet and placed in a position with free draining soil. Some higher elevational species like *Tsuga mertensiana* that grows at 9000 feet and above proved to struggle. This interestingly was also shown with *Notholithocarpus densiflorus* which is a common understory between 1000-3000 feet which also shows signs of stress. Both of these trees



Redwood forest at Hoyt Arboretum. Harry Baldwin

experience a short growing season due to the snow and they are simply not adapted to the longer growing season and require cooler temperatures all year round. Martin Nicholson pointed out that *Pinus longaeva* also prove to struggle in cultivation. He suggests that it could be a magnesium deficiency which could be alleviated by potentially watering a high magnesium solution to reinvigorate the specimens. He also added that many of the high altitude conifers require high UV light which they do not receive at low elevation. It seems many factors can play in the struggle for high elevational conifers in cultivation.

Hoyt Arboretum is another large arboretum which of course encompasses a vast range of land and trees. The applicant has visited many arboreta in the UK all of which present understory beds in a fairly similar fashion; that is; clearing any spontaneous trees and shrub saplings taking hold under the specimen trees. Quite often mulching and or glyphosate is used at Kew to present a 'cleaner' or more park land effect. Hoyt very differently allowed any naturally growing tree saplings, or native perennials to grow amongst the specimen trees and would thin out accordingly. They did not have the time or expense to keep fighting the up hill battle of cleaning the undergrowth, so they instead gardened and worked with it. From the applicants point of view it worked particularly well. One perennial they would constantly try and rid of, is the invasive English ivy. This is

proving a large problem throughout the Pacific Northwest but most notably within town and city areas where there are gardens.

The applicant gained a good knowledge of what conifers grow well in a garden setting and the best cultivation techniques to consider. Martin kindly answered many of the applicants questions and offered a very good tour of the arboretum.

## Columbia Gorge, Oregon.



The Columbia River Gorge is a spectacular river canyon cutting 80 miles long and up to 4,000 feet deep, with the north canyon walls in Washington and the south canyon walls in Oregon. Because of its unique geology and dramatic range in elevation, temperature, and precipitation, the Columbia Gorge has diverse plant life. The gorge's dazzling array of approximately 800 flowering plants draws many visitors each spring and summer. It is home to several endemic plants and invertebrates. For example, 14 wildflowers occur in the gorge and nowhere else. Because of their limited range, endemic

species are particularly vulnerable to habitat alteration and other changes.

The reason for the Columbia River Gorge's incredible diversity is the number of ecological niches created by its extremes. Annual precipitation in the Gorge jumps from 75-100" on the upper slopes of the west Cascades to down to 10-15" near The Dalles. Elevation rockets from around sea level on the Columbia to just under 5000' at the peak of Mt. Defiance. Plant life transforms from the dark, damp forests of hemlock, Douglas-fir, cedar, and devil's club in the west to bright, airy savannas of oak, ponderosa pine, bluebunch wheatgrass, and sagebrush in the east.

The applicant visited a slightly more unusual site which consisted of mostly oak woodland with a few individual ponderosa pine. The soil consisted of a very stony, sandy soil which clearly held very little water. Beneath the scattered *Quercus garryana* and *Pinus ponderosa* laid a beautiful oakland prairie which the applicant caught just at the right season to see the height of flower. Other than the flower, it was obvious that the ecosystem very much relied on the key stone species: *Quercus garryana*. According to some interpretation found, it provides a rich array of benefits for many of the flora, fauna and invertebrates such as; jays, squirrels, insects and truffles.

The species modern range extends from Vancouver, British Columbia to near Los Angeles and on the eastern slopes of the Washington and Oregon Cascades. It was apparent from the huge amount of driving undertaken, that this species varied immensely in habit and size. It seemed to thrive in cool, coastal areas and near the edges of streams and wetlands where it tolerates seasonal flooding. It also flourishes in droughty inland sites where it grows both individually and in groves on low hills surrounded by grassland. When it grows on gravelly sites like seen at Columbia Gorge, it takes on a shrub-like or scrubby like habit. Along the blustery Columbia River Gorge, where it grows with little rainfall and atop hundreds of feet of layered basalt, harshly battered trees grow gnarled and hang on thanks to an extensive and strong root system.





*Lupinus polyphyllus* growing amongst the oak scrub prairie. Harry Baldwin.



*Balsamorhiza careyana* a common plant amongst the prairie. Harry Baldwin.



*Castilleja miniata* a parasite on grasses, with *Balsamorhiza careyana*. Harry Baldwin.

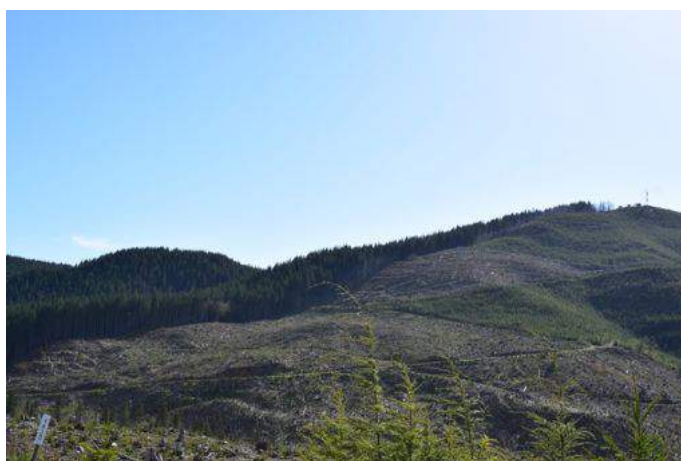
## Land Bureau Management – Valley of the Giants



Map of areas managed by the BLM, except green colour. Harry Baldwin.

The applicant was greeted by Paul Tigan (Field Manager) and Scott Taylor (Wildlife Biologist) of the government organisation; Oregon Bureau Land Management. The Bureau Land Management is the largest landowner within the US owning over 250 million acres of forested land. These forests provide food and habitat for wildlife, trails for hiking and biking, clean abundant water for communities and a variety of different wood products including timber, firewood and even teepee poles. The BLM manages forests and woodlands in accordance with the multiple-use, sustained yield mandate of the Federal Land Policy and Management Act of 1976 which means everything that forests provide today will also be provided in the future. In other words, the BLM manages forests to meet the present and future needs of communities, wildlife and all those who benefit from the services forests provide. They intend to manage the land for timber purposes in an ecological manner whilst allowing the local communities to benefit from the profits made. The mission of the BLM is "to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

*Pseudotsuga menziesii* is a common species that is grown for timber which is logged on an 80 year rotation. This species has proved to be a valuable tree for the Pacific Northwest as it is able to grow relatively fast, produce good strong timber, support a range of flora and fauna as well as being able to withstand the wet climate that is received. Part of BLM's mission is to sustain diversity whilst being productive; one way this is carried out is by selecting certain trees to be cut rather than clear felling the whole site. This way they are able to maintain a level of biodiversity within the forests as well as receiving remuneration for the government and for the local communities.



BLM land (forested area) against private land. Harry Baldwin.

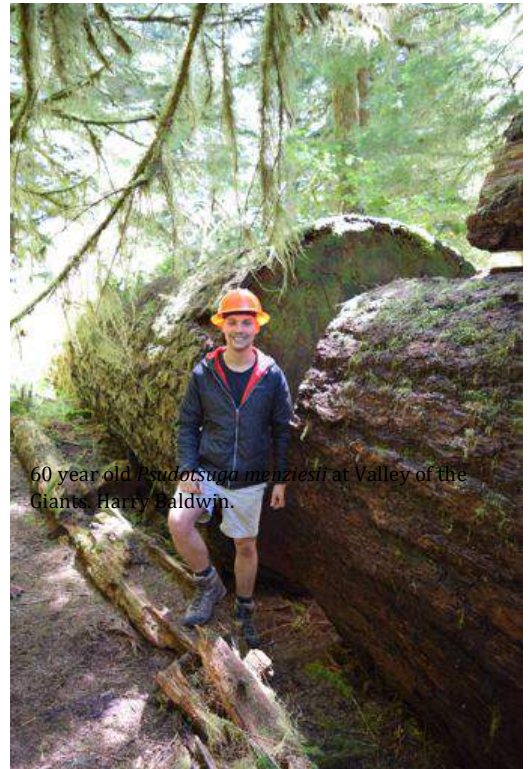
The BLM intend to set a good example for productive but sustainable timber management, yet this is not always easy. Being a federal body they have the right to enforce regulations such as the Forest Practices Act. Private landowners also have to abide by this law which includes laws such as leaving a tree depth margin along perennial river beds and leaving 3 trees per hectare if clear felling. Interestingly it was noticeable that many private landowners were exploiting the loop holes of the law and leaving only a few year old trees per hectare as the law does



not state a certain age only “3 trees per hectare that can set seed”. Private landowners receive various government subsidies if they single fell rather than clear felling and planting at a certain times of the year etc.

Paul and Scott both expressed the difficulties in terms of running on a low budget as the government regularly cuts funds which in turn creates many problems for the BLM. For example many of the timber roads that are used are shared between BLM and private landowners. These roads are constantly used and when 1000's of lorries are weighing 100s tonnes, the roads disintegrate very fast. In Oregon alone, there are 140,000 miles of road which needs repairing and maintaining almost every year. Paul added, that it costs £1,000,000 to repair 800 miles of road; despite having the cost divided between both parties, this is a substantial sum.

Some older plantations that are reaching eighty to one hundred years old are surprising not as diverse in terms of wildlife as one may think. Many of the trees are planted particularly close together so there is minimal side branching preventing bird species from nesting and its too dark for many plants to grow as an understory; therefore, thinning actually improves the diversity. One particularly rare bird known as the northern spotted owl needs an old cohort of trees to allow the owl to fly amongst the branches. Without the space beneath the canopy, the owl is unable to nest. This solidifies the importance of conserving old growth forests and sustainable timber management for the future and diversity of the forests.



60 year old *Pseudotsuga menziesii* at Valley of the Giants Harry Baldwin.



Slender Salamander found under bark. Harry Baldwin

The applicant was taken by both Paul and Scott to an area which is miles from the main road to a locked off area known as Valley of the Giants. Valley of the Giants is a 51-acre (21 ha) forest preserve owned and managed by the BLM, and is located in a remote portion of the Oregon coast range of Northwest Oregon in the United States. Receiving greater than 180 inches (4,600 mm) of rain annually, the preserve is home to many large specimens of *Pseudotsuga menziesii* and *Tsuga heterophylla*. A famous specimen is "Big Guy" which at one time was the second largest Douglas-fir known standing in Oregon.

Before "Big Guy" was blown down by a wind storm in 1981, it was estimated to be over 600 years old, stood approximately 230 feet (70 m) above the forest floor, and had an estimated 36.5-foot (11.1 m) girth. In 1976, the BLM designated the site as an Outstanding Natural Area.

Many of the *Pseudotsuga menziesii* trees were between 200 and 300 feet tall with some reaching 12 feet in diameter. The main understory identified was *Olopanax horridus* named after its spiny stem. Other plant species included *Rubus spectabilis*, *Campanula rotundifolia*, *Maianthemum stellatum* and *Pteridium*

*aquilinum*. We also found a very rare slender salamander hiding away amongst the broken bark on the floor. We also found many different species of Caddis fly which were hiding away in the small pools off the river. Scott mentioned that there are many species present which all collect small rocky fragments to build a shell to allow them to pupate in. One species the applicant noticed had built a shell out of douglas fir needles, it apparently relies on only the needles for its shell to protect it from predators.

Overall it was a great day out and the applicant gleamed a great insight into timber management alongside conservation.

## Crater Lake



Snow 15 feet at Crater Lake. Harry Baldwin

Crater Lake National Park is Oregon's only National Park, a known collapsed stratovolcano (similar to Yellowstone) which eventually filled with water to form one of America's most iconic, natural volcanic monuments. Crater Lake National Park was established in 1902, before commercial logging reached the High Cascades. Because of this, Crater Lake National Park's forests are almost entirely old growth forest ecosystems. However, the short growing season and low-nutrient volcanic soils do not

sustain extremely large trees. Few trees get over 150 feet (46 meters) in height, and most have diameters

under 4 feet (1.2 meters).

Park forests are composed mostly of conifers, although a few hardwood species can be found. There are four major forest zones at Crater Lake National Park, each named after its dominant tree species. Starting in the park's lower elevations (about 4,500 feet or 1,370 meters), *Pinus ponderosa* forest is the first zone seen by visitors who enter on Highway 62 from the south or west entrances. The ponderosa zone gives way to *Pinus contorta* forest at about 5,000 feet (1,520 meters). Sometimes referred to as "dog's hair forest" because of the dense, scraggly stands of thin lodgepoles, this zone covers vast areas. *Tsuga mertensiana* (Mountain hemlocks) become dominant at about 6,000 feet (1,830 meters). This zone has the final tall trees in the park and has limited underbrush. The next zone is almost purely *Pinus albicaulis* and extends from about 7,500 feet (2,290 meters) to the top of Mt. Scott, the highest point in the park (8,929 feet or 2,721 meters). The *Pinus albicaulis* pine zone is more an open woodland than a forest.



Windblown *Tsuga mertensiana* at Crater Lake. Harry Baldwin.

During May when the applicant visited, snow was very much still present with over 15 feet in some places. The South Rim of Crater Lake was dominant with *Tsuga mertensiana*, *Abies lasiocarpa* and occasionally *Pinus albicaulis*; the former being particularly contorted and knarled from the harsh weather received during the year. One of the striking features on the shady side of the bark was the luminous green wolf lichen (*Letharia vulpina*). According to Kallio (1971) *L. vulpina* occurs throughout the Pacific Northwest and is often abundant on exposed branches that

During May when the applicant visited, snow was



have lost their bark. In the Rocky Mountains, *Letharia* species are found in ponderosa forests at the prairie-forest boundary at relatively low elevations though medium and high elevation *Pseudotsuga menziesii* and *Pinus contorta* forests. A study undertaken by Kallio (1971) stated that *L. vulpina* is highly tolerant of freezing and low temperatures. In one set of experiments, the lichen was able to reactivate its metabolism after 15 hours of cold storage and resume photosynthesis within 12 minutes of thawing. It was also able to start photosynthesis while rewarming, still at below-zero temperatures (°C), suggesting that it may remain active during winter.

Any of the plant life living at Crater Lake has obviously adapted to extremely cold temperatures, winds and also the very short growing season. The snow often recedes by May (sometimes even later) and returns by autumn; only allowing 5 months of active growth. This suggests why many of the conifers observed at the lake were so small, yet likely to be hundreds of years old. The applicant saw *T. mertensiana* at Hoyt Arboretum (Oregon) and was growing very poorly. This suggests that it needs the cold and altitude to thrive which is why it proves hard to cultivate.



*Tsuga mertensiana* with bright green wolf lichen. Harry Baldwin.

*Tsuga mertensiana* was easily distinguishable as it grows in high altitude environments which was a fairly stunted tree with a heavy body whose crown reaches nearly the ground. At lower elevations where it was not exposed to the elements it produces a clean, straight trunk, and narrow, sharp pointed crown. The mature cones are about 2 inches long, and their smooth scales open in late fall, liberating the seeds. The colour of the foliage is blue-green, and the reddish-brown bark is always feebly furrowed and roughened. Habeck (1967) suggested that the species affinity for areas with persistent winter snowpacks is because it cannot tolerate frozen soils. (?) also mentioned that the wood of *T. mertensiana* is somewhat inferior to that of *T. heterophylla* as timber and

as pulp, a fact that has prevented this species from being logged. In this capacity it differs from many alpine conifers in its tolerance of relatively warm, damp environments.

## Siskiyou Mountains

### Montane Mixed Conifer Forest

Driving from Crater Lake through the Klamath-Siskiyou region allowed the applicant to appreciate the montane mixed conifer forests and their importance. They are essentially the glue that binds together the many different serpentine plant communities within the Klamath-Siskiyou Mountains. The serpentine barrens, meadows, Jeffrey pine savanna, rock outcrops and other various distinct communities found on serpentine soils are within or at the margins of montane conifer forest matrix. The mixed conifer forest forms the most continuous cloth over the landscape here. Under the trees, the understory may be dense or lacking; the shrub layer may give way to grass or rocky openings.

These forests are found over a wide range of elevations and topographic positions. The most important influences the applicant noted were:

- Elevation
- Precipitation
- Soil Depth
- Soil toxicity (ie. Serpentine)

The driest sites, whether from shallow rocky soil, southern exposure, or less precipitation, are dominated by *Pinus jeffreyi* and *Calocedrus decurrens* with lesser numbers of *Pseudotsuga menziesii*, *Pinus lambertiana*, *Abies concolor* and *Pinus monticola*. The understory can be scant. However at more mesic sites, near the coast or higher in elevation prove to have a stronger component of *A. concolor* along with a more even mix of *P. jeffreyi*, *P. lambertiana*, *P. monticola*, *P. contorta*, *Pseudotsuga menziesii* and *C. decurrens*, with an understory of *Lithocarpus densiflorus*, *Quercus vaccinifolia* and *Arctostaphylos nevadensis*. The Klamath-Siskiyou endemic *Picea breweriana* is supposed to be found within this community; yet the applicant was unable to reach the Brewer Spruce Botanical Area on Page Mountain as 5 feet of snow was still present.

## T.J Howell Botanical Excursion (Siskiyou Mountains)

Named for Thomas Jefferson Howell, an early botanical explorer of Oregon, this drive takes you through some of the great wonders within the Siskiyou Mountains. Approximately the 7 mile drive along Eight Dollar Road allows people to get out and undertake small hikes within the area. The drive itself passes through the Josephine Ophiolite, a large chunk of upper mantle and oceanic crust that has been shoved up above sea level, exposing ultramafic serpentine and its parent rock, peridotite. Part of the Klamath-Siskiyou Mountains, this location is one of the largest serpentine areas in North America.

Only plant species that can tolerate extreme conditions grow here. Thin soils, heavy metals (magnesium, nickel, chromium, iron), and nutrient stress (low amounts of calcium and nitrogen) make these serpentine soils inhospitable to most plants. Many unusual, rare or endemic species have evolved under these conditions, while other plants have special adaptations for survival, or exist in a stunted form.

### **Jeffery Pine Loop**

The major conifer in abundance was *Pinus jeffreyi*. Looking fairly similar in appearance to *P. ponderosa*, but the bark is darker and the cones are up to twice the size and the tips are recurved allowing it not to be prickly when holding. Occasionally in the wetter and more shaded sites, *Calocedrus decurrens* and *Chamaecyparis lawsoniana* were present in small numbers and proved to be fairly small trees. *Pinus jeffreyi* appear gnarled and stunted from the fairly harsh heat, soils and winter cold they receive. The canopy covers vary from less than 5% to upwards of 20%. Although stunted, these open stands of *P. jeffreyi* can support trees upwards of 400 years in age. The understory community appears as a pebble and rock garden but with an incredible diversity.



Jeffery Pine Loop, most trees in this photo are *Pinus jeffreyi* Harry Baldwin

Understory Communities Within Jeffrey Pine Forest

<u>Abundant</u>	<u>Occasionally Common</u>	<u>Uncommon</u>	<u>Comment</u>
<i>Festuca idahoensis</i>			Main grass species encountered
	<i>Arctostaphyllum nevadensis</i>		Growing in open sunny ground as well as dappled shade.
	<i>Rhododendron occidentale</i>		Growing on north slopes in more moist conditions near steams
<i>Iris chrysophylla and bracteata</i>			Very common amongst the grass communities and would grow in full sun or full shade. Would also vary in colour and shape.
	<i>Castilleja</i> sp.		Found amongst the grass communities where it parasitises the roots.
	<i>Allium platycaule</i>		Growing in full sun along with <i>Calochortus</i> , <i>Iris</i> spp. and <i>Tritelia hyacinthine</i> .
<i>Camassia quamash</i>			Found plentiful in boggy areas with a constant supply of water.
		<i>Delphinium nuttallianum</i>	Found less abundant and only growing in dark shade.
		<i>Trientalis latifolia</i>	Found in dappled shade.
		<i>Horkelia fusca</i>	Growing in full sunlight.



*Rhododendron occidentale* growing in moist, north facing grassland. Harry Baldwin.



View of loop. Bright blue water from the serpentine rock. Harry Baldwin



*Iris bracteata* growing in abundance beneath *Pinus jefferyi*.

Harry Baldwin



*Iris tenuissima* also growing in abundance. Beautiful red streaks on the sepals. Harry Baldwin



*Allium platycaule* growing in full sun along with *Calochortus*, *Iris* spp. and *Tritelia hyacinthine*. Harry Baldwin.



*Calochortus howellii* growing in large numbers in this prairie setting. Many *Calochortus* spp within the vicinity. Harry Baldwin



## Board Walk

The Bureau Land Management have recently constructed an interactive board walk which crosses through a wetland fen. Wheel chair accessible allows everyone to enjoy the various special plants growing within this unique habitat. The area changed rapidly from the shrubby dry *Pinus jeffreyi* habitat round the corner to a boggy wetland shrub community. The springs and seeps flowing down the mountainside contribute to the botanical diversity in the area. The wet habitat provides a perfect environment for a wide variety of water loving serpentine plants to thrive. Many species have adapted to fens (alkaline) such as:

- *Sanguisorba officinalis*
- *Hastingsia bracteosa* var. *atropurpurea*
- *Lillium pardalinum*
- *Narthecium californicum*
- *Darlingtonia californica*



Sliced *Darlingtonia californica* showing the interior windows and tubular column. Harry Baldwin

The real star of the show was to see *Darlingtonia californica* which is found in northern California and southwestern and coastal Oregon. It is generally associated with serpentine soil mostly due to their ability to tolerate toxic mineral whilst its competitors can not. It was noticed that there was a constant flow of water streaming through the fen which apparently is vital. Most would assume they are easy to cultivate, but from the applicant gaining experience in the carnivorous section at Kew he as realised it isn't. The trick is to maintain a cold water flow through the roots during warm weather.

*Darlingtonia californica* has the appetite for nitrogen due to the low nutrient soils it lives in. Being carnivorous allows it to get a booster shot of nitrogen from the insects. The plant lures the insect through its shaped hood, the insect works its way down the long tubular stem lined with stiff reflexed hair. Once the insect is inside, symbiotic bacteria begin extracting nitrogen from their nitrogen rich exoskeletons. As ground burning fires periodically pass through this cleanses out competing shrubs and pines, maintaining open conditions suitable for the plant and its

unique community. In the absence of fir, azaleas and pines shade out the light demanding *Darlingtonia californica* and other plants in the vicinity.

***Kalmiopsis leachiana* Hike.**

During the applicants stay at the Siskiyou Field Institute it was suggested that he could hike to see the endemic Ericaceae: *Kalmiopsis leachiana*. At the time it was unknown whether it would still be in flower as it was flowering a few weeks prior. After gaining some instructions and a map, the applicant headed off on a 7 mile hike into the Siskiyou wilderness. The instructions were slightly vague, but the applicant pushed on nonetheless. In Panther Gap where the applicant was hiking, there was strong evidence of the recent devastating Biscuit Fire which was a wildfire that took place in 2002 that burned nearly 500,000 acres within the Siskiyou National Forest. The area the applicant was hiking in had no conifers to be seen, other than tall charcoal logs littering the landscape. It was hard to identify the conifers but on the odd occasion when the applicant discovered cones on the floor it seemed to be *Pinus lambertiana*.

Many of the understory consisted of shrubbery, perennials and annuals which no junior trees establishing at that time. Plants encountered consisted of:



*Silene hookeri* found growing amongst a riverine setting. Harry Baldwin.



*Lathyrus delnorticus* a endemic legume to the Siskiyou Mountains. Harry Baldwin.



*Darlingtonia californica* flower. Harry Baldwin



*Rosa gymnocarpa* found on the rocky outcrops. Harry Baldwin



Serpentine rock. Harry Baldwin



*Pinus lambertiana* cone. Harry Baldwin

Just as the applicant began to doubt whether he had gone the correct way, he suddenly came across *k. leachiana*, Found in a small tight clump on a steep hillside colonizing a south face position. It apparently had also been burnt by the fire but has shown promising regrowth. According to the Siskiyou Field Institute, there are only a 3 small populations of this species. It obviously grows happily under *Pinus lambertiana* – perhaps a nice companion plant for a conifer garden setting.



*Kalmiopsis leachiana*. Harry Baldwin

## Jug Handle State Natural Reserve

After meeting with Michael Kauffmann, he suggested visiting Jug Handle State Nature Reserve which is located on the coast of northern California, in Mendocino County. The reserve encompasses five marine terraces along the coast which have been cut by the waves for millennia. Each terrace has been above water about 100,000 years longer than the sea level below it. Consequently, each terrace contains a different plant community, with each level showing 100,000 years of progression through the stages of ecological succession. The lowest terrace supports prairie, the second bears a redwood forest, and the third exhibits a unique pygmy forest of 5 to 10 foot tall *Cypress*, *Pinus* and *Rhododendron*, *Arctostophyllum* species. This site is particularly unique as many of the marine terraces formed along California's coast have been eroded and has rendered them indistinct except in rare places like Jug Handle State Nature Reserve.



Interpretation board representing the ecological staircase. Harry Baldwin

Undertaking a 5 mile loop allowed the applicant to identify both tree and understory species in each ecological staircase. A very rare chance to exhibit such a diversity of geology, habitats and environments in only a short area. The applicant began on the prairie terrace where grasses, wildflowers and blackberries dominated. As far as the applicant could identify, many of the grass species were invasive European grasses such as *Anthroxanum odoratum* and *Holcus lanatus*. According to the interpretation at the park, many of the invasive grasses were introduced due to past history of ploughing and grazing livestock by early settlers. Main wildflowers observed were

*Armeria maritime*, *Achillea millefolium* and *Nemophilla menziessii*.

At the edge of the prairie, stands of *Picea sitchensis*, *Pinus muricata* and *Abies Grandis* shelter a small riparian community. All three species receive harsh salt winds which is particularly evident with *Abies grandis*. The riparian community is suddenly dominated by deciduous trees and shrubs all of which do not seem to be particularly old. This is because the riparian community has adapted to the constant surge and flow of floods, distributing fertile silt along the edges of the creek; it seems flooding is a constant phenomenon within this habitat. Main broadleaves observed were *Frangula purshiana*, *Salix lasiandra* and *Alnus rubra*, all of which are suited to wet conditions.



First step of the ecological stair case. Harry Baldwin



*Sequoia sempervirens* forest type. Harry Baldwin

On the other side of the riparian habitat laid more conifers, this time not only did it include the three mentioned above with additions such as *Pseudotsuga menziesii*, *Tsuga heterophylla* but also a non native: *Pinus radiata*. *Pinus radiata* is native to Monterey peninsula, but now found even as far down as Mexico. It is a major timber tree in parts of North America but also in South America, Australia and New Zealand; in addition an ornamental tree in California. Apparently the pines were planted by earlier landowners are due to be taken

out. In addition, *Ulex europaeus* is fairly common which is also proving a problem amongst areas of California. Other understory plants found on

this staircase includes *Gaultheria shallon*, *Polystichum munitum* and *Vaccinium* sp.

Three major shrubs identified within this forest type were:

- *Arctostaphylos Columbiana*
- *Rhododendron macrophyllum*
- *Notholithocarpus densiflorus*



*Rhododendron macrophyllum* growing amongst *Sequoia sempervirens* forest type. Harry Baldwin

*Arctostaphylos columbiana* seemed to vary in habit; in some areas of the forest it would be a sprawling small shrub and in other places would grow as a small tree. I believe this to be due to light levels within certain areas as the larger more dominant specimens were amongst more *Tsuga heterophylla* which allows more light through its canopy. Apparently this species can be found growing from sea level to 2500 feet from Northern California to British Columbia.

*Rhododendron macrophyllum* again seemed to thrive better in more well lit areas of the forest but still managing to thrive well as an understory to many

of the larger conifer species. Both *Rhododendron* and *Arctostaphylos* are key understory species delivering large amounts of nectar for bees.

*Notholithocarpus densiflorus* seemed to thrive in particularly dark conditions, even more so than the two above. The time the applicant was visiting, the new flush of pink growth was emerging which was very

attractive; this species and along with various other Fagaceae on my trip are certainly underutilised in ornamental horticulture. Other than its aesthetics, the acorns are a major food source for many of the mammals and birds that live in this environment.

A mile in to the hike, there was a sudden break in the forest type. Now the applicant was away from the salt laden breeze, the forest suddenly changed and was dominated by *Sequoia sempervirens*. This site was one of the most southerly distributions of this forest type as they are concentrated along the coast between Southern Oregon and Central California where summer fog and moderate temperatures prevail. As an understory, two main species dominated; *Vaccinium parvifolium* and *Gaultheria shallon* whilst a few other species such as; *clintonia andrewsiana* and *Rhododendron macrophyllum* were less common.

At the final staircase before entering the pygmy forest, it was more noticeable that the *Sequoia sempervirens* were stunted and yellow. This is due to the low soil nutrients where the pygmy species live. Over prolonged time, major nutrients such as calcium, potassium and nitrogen have been leach from the soil with the addition of dry summer heat has nurtured an inhospitable layer known as Podzol Horizon. This soil is as acid as vinegar and is the most acidic soil on earth. This unique soil layer creates edaphic microsites, allowing only a few hardy species (some now endemic) to survive in spatial isolation on these podzolized terraces. 100 year old trees only reach the height of a few feet. The ground and trees were covered by many species of lichens due to the availability of light and the suitably moist climate and clean air. The pygmy forest is essentially a bog in that the soil never dries out beneath the surface. Plants tolerate low oxygen levels in the soil because when the soil is wet, water replaces the oxygen in the soil pore spaces. Since roots take in oxygen and give off carbon dioxide, most plants can't live in soils that are too wet. *Rhododendron*, *Vaccinium* and *Gaultheria* are common in both the Sequoia forest and Pygmy

forest. These species grow poorly in pygmy soil and in the richer soils they grow larger. *Pinus muricata* grows in more infertile soils throughout the coastal area. The pygmy cypress (*Cupressus pigmaea*), *Pinus contorta* subsp. *bollanderi* and *Arctostaphylos nummularia* ssp. *Mendocinensis* tend to be more restricted to the Pygmy Forest due to their inability to compete well with other species. While cypress and pines comprise the majority of pygmy forest biomass, ericaceous shrubs comprise the majority of the dozen or so vascular plants species present.



Stunted and malnourished Sequoia at the top of the ecological staircase.  
Harry Baldwin

*Pinus muricata* subsp *bollanderi* has a height of no more than 2m. Whereas the step below *Pinus muricata* reached over 70 feet.

The hard pan and lack of nutrients has a huge knock on affect, despite them not reaching more than 2m, they were several hundred years old. A good identification feature for *Pinus muricata* subsp. *bollanderi* is that the needles are held in 2's and cones are closed.

As seen in the picture, this is a mature *Cupressus pigmaea*, perhaps a hundred years old. It has small scale-like needles and round cones that open in heat or after a fire. It can grow close to 150 feet tall in better soils, and is generally restricted in range to the Pygmy Forest or sphagnum bogs in the Pygmy Forest.



Board walk showing the stunted plants with *Pinus contorta* subsp. *Bollanderi*. Harry Baldwin



It is possible to see the slow transition from the forest to the stunted growth. Harry Baldwin



## Quarryhill Botanic Garden

The applicant was kindly invited to visit Quarryhill Botanic Garden by Bill McNamara for a couple of days during the duration of his trip. Despite not adhering to the aims and objectives, the applicant felt it would be a great opportunity to further his knowledge and interest in woody temperate plants as well as building new contacts.



Quarryhill Botanic Garden view. Harry Baldwin

Quarryhill Botanical Garden is a research botanical garden housing one of the largest collections of temperate Asian plants in North America. Quarryhill is located near Glen Ellen, in the Sonoma Valley of California, and is open to the public.



*Rosa* sp. Harry Baldwin

The garden is devoted to plants from temperate China, Japan and the Himalayas, with more than 90% grown from wild-collected, scientifically documented seed. The collection includes rare species such as *Acer pentaphyllum*, *Cornus capitata*, *Holboellia coriacea*, *Illicium simonsii*, and *Rosa chinensis* var. *spontanea*, all native to Sichuan, as well as extensive collections of *Rhododendron*, *Quercus*, *Magnolia* and amongst many others.

The arboretum can be traced back to 1968, when Jane

Davenport Jansen purchased 61 acres for vineyards, In 1967, she started a garden on 20 acres of the property. In that year Quarryhill representatives made their first seed collecting expedition to Asia. The arboretum was her personal sanctuary as well as the joy of her life.

Upon speaking to Mr McNamara, annual expeditions have collected seeds and herbarium specimens from the following regions: China – Hubei, Sichuan, Taiwan, Tibet, Yunnan; India – Himachal Pradesh; Japan – Hokkaido, Honshu, Kyushi, Shikoku, Yakushima; and Nepal. The garden also receives wild collected seed courtest of Index Seminum publications from Japan, Taiwan and South Korea, as well as Asian seed and plants fro, North American gardens.

The applicant was kindly taken for a day tour of the arboretum and shown around extensively.

## San Francisco Botanic Garden

The applicant was kindly greeted by Jake, a member of the horticultural team. The applicant's main focus was to visit the *Sequoia sempervirens* glade, where they were essentially trying to mimic the habitat of the redwoods in northern California. As you can see in the picture below, the redwoods are fairly mature and creates an ideal situation to grow an understory. According to Jake, more than one hundred species of associated plants have been added over the past forty years, which represent a typical redwood forest community. The trail was laid out to take the visitors on a trail which introduces them to many of the plants that occur in this habitat in the wild. This trail tied in nicely as the applicant has already visited the redwood forest community a few days earlier; seeing this in a cultivation setting allowed him to make some interesting observations. Many of the plants seen previously were included such as; *Ribes sanguineum*, *Polystichum munitum*, *Lithocarpus densiflorus*, *Acer macrophyllum*, *Vaccinium ovatum*, *Rhododendron occidentale* and among many others. As San Francisco is close to the sea, it regularly receives rolls of fog which supplies a lot of the water to the redwoods and keeps them cool. This all means that the redwoods do not reach their ultimate height as the cold winds blow across the garden almost stunting them.



Redwood forest mimicked at San Francisco Botanic Garden. Harry Baldwin

## Sequoia National Park

The drive from Quarryhill Botanic Garden to Sequoia National Park allowed the applicant to experience a great array of elevational changes; from the grassland foothills to uppermontane coniferous forest. The extreme topographic differences from 1360 feet (412m) to 14,417m (4,417m) create a rich tapestry of environments, from the hot, dry lowlands along the western boundary to the stark snow-covered alpine areas. The applicant was unable to drive further than 8500 feet due to the late snowline which persisted.

The topographic diversity in turn supports over 1,200 species of vascular plants which makes up dozens of interesting communities. These not only include the renowned groves of the huge *Sequoiadendron giganteum*, but also vast tracts of montane forests, spectacular alpine habitats, and oak woodlands and chaparral. According to some interpretation found along the way; the richness of the Sierran flora mirrors that of the state as a whole of the nearly 6000 species of vascular plants known to occur in California, over 20% of them can be found within Sequoia and Kings Canyon National Parks.



View from half way up to Sequoia NP. Harry Baldwin

Within the foothills it is apparent that the grassland is primarily non-native European annual grasses that were introduced to California in the mid 19<sup>th</sup> century and have subsequently become naturalised. One of the main features of the landscape was the slow growing, gnarled *Quercus douglasii* that dot the landscape. Slightly further up, dense thickets of sclerophyllous shrubs are the main feature of this community. Many of the chaparral species such as *Quercus douglasii*, *Arctostaphylos* spp. and *Ceanothus* spp. have

specific adaptations to fire and drought, both of which have a strong influence on life within this community. At the upper limits, the vegetation type blends into a dominated woodland of *Pinus ponderosa* and *Quercus velutina*.

The next vegetation type gives way to mixed coniferous forest between 900 (275m) – 5,500 feet (1,650m). Here an extreme diverse of conifers are found. At its lower limits, *P. ponderosa* is the major species, while at its upper limits this belt is comprised mainly of *Abies concolor*, *P. lambertiana*, with *P. jeffreyi* replacing *P. ponderosa*. Common associates include *P. lambertiana*, *Calocedrus decurrens*, *Pseudotsuga menziesii*, *Q. velutina*, *Q. chrysolepis*. Less common associates include *Arbutus menziesii*, *Notholithocarpus densiflorus* alongside small scattered groves of *S. giganteum*. At this point, many of the trees begin to show



*Sequoia sempervirens* old stand. Harry Baldwin.

tremendous heights and ages.

When the applicant set first site on the large *S. giganteum*, he could not quite believe his eyes. The sheer largeness of the species completely towers over anything beneath it. When driving through the National Park, it came apparent that you see the odd the species dotted amongst the forest, but then suddenly coming across small groves – which may be due to historical logging. Yet the stand structure and species frequency vary substantially with elevation, latitude, exposure, soil moisture and fire disturbance. According to some interpretation, the prevention of fire amongst the groves has resulted increased prevalence of *A. concolor*, reduced regeneration of *S. giganteum*, and reduced density of shrubs. The applicant also noted that the age-class distribution of *S. giganteum* also varies widely amongst the groves. But it was surely evident that the groves lacked a younger cohort which certainly puts pressure on the future of the groves.



*Ribes sanguineum* a common understory. Harry Baldwin.

The understory vegetation is made up of shrubs and small trees. Of the tree species, *A. concolor* saplings is fairly abundant in some groves alongside *Q. velutina* and *Q. chrysolepis*. Two common shrubs that can deal with the low light levels were *Ceanothus cordulatus* and *Castanopsis sempervirens*. In addition, *Corylus rostrata*, *Cornus nutallii*, also seemed to survive well in these shaded conditions.



*Arctostaphylos mariposa* cloacking the hillsides and a common understory. Harry Baldwin

The vegetation of the groves themselves are almost exclusively just *S. giganteum*. The uppermost layer is the vegetation of the canopy, comprised of the crowns of the giant *S. giganteum* and occasionally *A. concolor*, *P. lambertiana*, *P. ponderosa*, and often at slightly lower elevation *C. decurrens*. At higher elevations, it includes *A. magnifica*. At one grove the applicant visited, amazingly *Pseudotsuga menziesii* was prevalent amongst *S. giganteum* which is its absolute southern limit.

A wide variety of perennial plants characterise the ground layer. The perennials are highly efficient to deal with such low light levels and short growing season due to snow. The ground cover plants vary greatly in kind and abundance from grove to grove. The most common found are; *Adenocaulon bicolor*, *Osmorhiza chilensis* and *Viola lobata*. These three species live in an environment where they only receive 5% light – a good indication of

their ability to survive on shaded forest floors. Bracken fern, *Pteridium aquilinum* was another which was present in dark

conditions. On occasion where a stream was present *Rhododendron occidentale* would be in abundance.

A major observation that the applicant must make in this report, is the fact that more than 70 percent of *P. lambertiana* and 50 percent of *P. ponderosa* growing within the Sierra's have been decimated by bark beetles. Amongst the sequoias large poles of dead trees were present; but the sense of scale was brought to eye when you see a landscape full of dead trees. According to the US Forest service, 102 million trees had died since 2010. The beetle releases pheromones that attract other beetles until a mass attack overcomes the tree. The eggs are relayed within the cambium, then pupate and fly to the next tree, which is what causes the huge mass of destruction in the Sierras.



Old growth *sequoia sempervirens*. Harry Baldwin

## Conclusion.

The applicant undertook a large trip which consisted of about 3000 miles worth of driving. Whilst planning he was unsure whether this much travelling would cause a hindrance and prevent spending not enough time in each place. In hindsight, the applicant feels that this was not a problem and in fact the driving was almost the resting part of the trip as the large roads in America certainly made it less stressful. In terms of timing, it was on the whole brilliant as the applicant managed to see a great deal of plants in flower as well as many endemics. The only problem what was encountered in terms of timing was the snow. When planning this trip a year in advance, it was particularly hard to gauge how long the snow would persist for, sadly this year it was barely impossible to get above 9000 feet without encountering 15 feet of snow. This prevented the applicant from visiting a few sites such as Alta Peak at Sequoia as well as many conifers that were above that elevation range. Luckily the applicant had the chance to visit Crater Lake which the park services cleared the roads which allowed people to visit the site. Crater Lake allowed the applicant to view a few species of high elevation range such as *Tsuga mertensiana*. The applicant felt like he made a good balance of self-discovery as well as with meeting experts in the field. It became obvious that you glean a huge amount more when you are with experts than being on yourself, yet experiencing times alone offers you the chance to test your knowledge at certain times.

In hindsight, the applicant would have spent more time in the Siskiyou Mountains as there is a huge endemic diversity owed to the geology of the landscape. Over 20 species of conifers can be found within the area, but with such little time and knowledge of the area, applicant focussed on just two areas. Perhaps in hindsight organising a couple of hikes with conifer experts and perhaps even ecologists and geologists would have given the applicant a bigger insight to the area. Money also became hard at times, despite the applicant investing much time into researching costings, he was unable to predict the vote to Brexit which lowered the dollar to 1.17 to the pound. This made it particularly difficult, yet the applicant was happy to forfeit the additional remuneration.

The applicant would very much like to visit the west coast of the US again to undertake a similar study but visit other areas such as Mount St Helens, San Bernardino Mountains in Los Angeles, visit the Bristlecone Pines and among many more. There is so many biodiverse hotspots for conifers on the west coast, it was impossible to visit them all. Considering the trip, the applicant had a trip of a lifetime and is hugely thankful to all those who contributed.

## References

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## Costing's

Flights: £600

Car hire: £1200

Insurances: £150

Accommodation: £1500

Food: £1100

Additional extras such as: car parking, fuel, National Park Pass and tips:  
£400

Total: £4, 950