Another Woodland Heritage

A Forester's View of the IUFRO Conference Tour

by Richard Deffee

Introduction

Following on from the IUFRO conference on uneven-aged silviculture, in Birmensdorf (Zürich), was the five day post-conference tour.

In the safe hands of our tour guides Andreas Zingg, Professor Jean Philippe Schütz, and some of the WSL staff we set off on a journey of incredible forests throughout Switzerland and France. These forests had something in common; they were all uneven-aged, or plenter forest, or close-to-nature, or irregular forests. Besides the forests we experienced some breath-taking landscapes in the form of the Swiss Alps, the Swiss and French Jura Mountains, huge vinyards on fertile plains, and the Northern Vosges mountains.

What is a Plenter Forest?

A plenter forest is composed of a diversity of tree species and of tree sizes such that the growing stock is in a state of equilibrium, that is to say that an optimum volume of timber may be harvested regularly and sustainably in perpetuity. It is a forest where the regeneration occurs naturally and constantly. This form of silviculture respects the forest ecosystem which produces maximum benefit, not only from an economic perspective, but also from the perspective of protection, biodiversity, recreation and landscape.

Definition compiled from the work of J. Ph. Schütz

The Jungfrau (4,158m) as seen from the window of the minibus as we set out on the first leg of our journey.

Stop 1 – The Communal Forest of Rougemont (a Mountain Plenter Forest)

Our host: Serge Lüthi

High in the Swiss Alps the communal forest of Rougemont is a 'mountain forest' covering 7,800 ha. It is an example of the classic Norway Spruce/Silver Fir/Beech species mix. The study site was a one hectare sample plot installed by WSL in 1928, when in this part of the forest transformation began from an even-aged condition. Initially this was done by gap creation (without expansion following regeneration). It is now in a fully developed plenter condition. The plot's elevation of 1,400m above sea level is considered to be on the upper limit for Silver Fir yet it is still dominant. Rainfall is 1,500mm per annum.

Serge Luthi explains 85 years of monitoring in front of a huge boulder bearing the names of those who have surveyed the plot over the decades.

Since inception the plot has received 13 repeat inventories on a periodicity of five to ten years. In the centre of the plot sits a large boulder some three metres high covered in ferns and mosses upon which are inscribed the names of the mensurationists who have surveyed the site over the past 85 years.

The production and treatment is focused on the large high-quality trees which are providing stability, room for crown development and, in the case of Silver Fir, stem shading of the lower bole to prevent development of epicormic shoots. Some 50 to 60% of the stand volume is in the large size-class (52cm+), therefore the greater part of stand volume and value increment lies within these trees.

Stems are not removed to favour regeneration; it is has been proven that maintenance of the correct level of stocking is enough to secure plentiful renewal and recruitment. Age has little meaning in the plenter forest; saplings in the under-storey can be deceptively old and will remain in the 'waiting room' only to respond when light conditions improve. Intervention in the under-storey is carried out when stems are large enough to recoup their harvesting cost.

The overall stocking (m^3/ha) is the parameter used to control sustention. Throughout the 1930s and

The focus of sivicultural treatment is on the large top quality trees.

Pierre Cherbuin explains the "Growth Cells" research project.

1940s this was typically between 370 m^3/ha and 400 m^3/ha (or 28 – 30 m^2/ha basal area) after harvest, with around 50 m^3/ha of removals. During the 1960s stocking levels were allowed to creep up to 450 m^3/ha (34 m^2/ha) which resulted in the stand becoming unbalanced, stifling regeneration, and reducing stand increment. Several, more intensive harvesting operations were carried out in the 1970s and 80s with removals of over 100 m^3/ha per intervention. The stocking is currently held at around 300 m^3/ha (25 m^2/ha basal area) which has resulted in improved stand increment (now 12 m^3/ha/yr). Throughout the transformation period the species composition has little changed.

Stop 2 – Le Buron State Forest (Research Project "Growth Cells")

Our Host: Pierre Cherbuin

We travelled down from the mountains to the Swiss lowlands between the Alps and the Jura to Le Bois du Buron in the Canton de Vaud.

Le Buron is a 72 ha woodland block on a brown hydromorphic soil, which has been divided into 38 equal divisions on a square grid pattern. Elevation is 620 m above sea level and rainfall is 800 mm per annum. Long dry spells in the summer months have been a problem for Beech in recent years.

The wood has had a long history of different ownerships and management activity including coppice with standards[1] and some, only partially successful, coniferisation. Most of the structural variation is derived from storms "Lothard" and "Martin" in 1999 which devastated much of the conifer high forest. As a result much of the forest is very young, either planted 2001-2005, or left to naturally regenerate. There exists a wide range of species which are intimately mixed, both broadleaf and conifer.

1 In continental Europe coppice is generally understood to be of many broadleaf species (commonly Hornbeam) grown on long rotations for fuel-wood. Coppicing of Hazel is a practice peculiar to the UK.

Growth Cells Research:

The objective is to define a low cost management system for small woodland for non-professionals. The 'growth cell' is a systematically placed unit (7.5 m radius circle). The circle centres are 15 m apart and landmarked. Within each cell the best quality tree is selected as the future stem and is marked. The silvicultural management is focused on the development of the future tree. Regular pruning is carried out and competing trees are removed to allow optimal crown development. Some attention is also given to maintaining species diversity. The three cells

The centre of the cell is 'land-marked' and a single tree selected for individual attention.

demonstrated contained future trees of Silver Fir, Hornbeam and Oak.

It was still 'early days' for the project but, to me, this approach seemed rigid, highly prescriptive, and requiring significant time investment. But perhaps this is ideal for a keen amateur, small woodland owner, with time on their hands.

Stop 3 – Les forêts de la Montagne de Boudry (the Marteloscope)

Our host: Pascal Junod

On day two we travelled east to Lake Neuchâtel, in the shadow of the Jura Mountains. The Jura are a series of low parallel ridges consisting of Jurassic[2] Limestone folded in the Pliocene period; they are the ripples around the edges of the more violent geological pile-up of the Alps. Les forêts de la Montagne de Boudry are located on the ridge overlooking the lake. It is a large multi-function forest which covers the entire mountain, the top of which is wood-pasture. 57% of the forest is public and 43% is in private ownership (with many private owners). Rainfall ranges from 1,632 mm on the north-west side to 976 mm in the rain shadow on the south-east side. The forest is operated under four silvicultural systems: single tree plenter, group plenter, mosaic, and pasture. With the exception of the pasture system each has a Marteloscope training plot.

The Marteloscope is a one hectare square plot principally used for training in stem selection but also for monitoring changes. All the trees within the plot are numbered, geo-located, and quality assessed. The elite trees (or 'plus' trees) are highlighted on a plan and are given special attention. There are four Marteloscopes within the forest at different stages within the ten year felling cycle; they cannot practically be used as a training aid for several years following selective felling.

The first stop was a plot worked on the mosaic system. The mosaic system is somewhere between group plenter and traditional single-tree plenter and is used in stands of mixed shade tolerant, and light demanding species. It requires the marker to vary his/her approach at the small scale to reflect the silvicultural needs of the species in the locale. The plot contained 17 species (six conifer and eleven broadleaves). This site had been harvested during the winter of 2013/14, it contained 331 stems and was standing at 400 m^3/ha pre-felling. The volume removed was 140 m^3/ha with an average stem volume of 1.37 m^3 per tree.

The second marteloscope had, again, 17 species present but with a higher percentage of light-demanding broadleaves it was managed under the group-plenter system, in which the marker is required to create small discrete gaps. The target pre-thin standing-volume is 300 m^3/ha (27 m^2*BA*). The gaps created during the last intervention contained an impressive diversity and abundance of regeneration.

A fantastic 'cone' of regeneration in the group-plenter Marteloscope.

Of interest was a good quality** Juglans nigra **marked as a "plus tree"; in the UK this species is commonly considered too light-demanding to be grown in a mixed high-forest setting.

The third and final Marteloscope plot consisted of the traditional Silver Fir/Norway Spruce/Beech mixture associated with the plenter system, however Beech was far more dominant than in previous examples with each species contributing approximately a third by volume, with minor elements (2%) of Sycamore, Yew and Whitebeam. It was being managed under the group-plenter system and, at the last measurement in spring 2013, was standing at 316 m^3/ha (28 m^2*BA*). A LIDAR image revealed differentiation in tree-sizes and species. The number and size of the groups was also clearly defined from the image.

This visit demonstrated the diversity that could be achieved at the 'forest level' whereby different silvicultural approaches (all uneven-aged) had been selected in response to stand species composition.

Stop 4 – Forêt de Envers, Couvet: Henri Biolley

Our Guide: Prof. J. Ph. Schütz

Not far from Boudry, on a parallel ridge of the Jura sits the forest of Envers at Couvet. It sits at an average 900 m above sea level and receives 1,600 mm of annual rainfall. This is the archetypal Silver Fir/Norway Spruce/Beech plenter forest began by Henry Biolley in 1890, following the principles devised by Adolph Gurnaud. Since this time there has

2 The name "Jurassic" is derived from the Jura – it is the type area for the Jurassic system 205-137 million years ago. At this time it would have been a shallow sea, the Jurassic lime stone being made up of millions of years of coral formation.

A plaque honouring the achievements of Henry Biolley.

been continuity of silvicultural management, and monitoring using the *'method du controle'* or check method. It is now understood, by use of the check method, that 360 m³/ha is the optimum stocking density, with a balance of large wood (52.5cm+)/ medium wood (32.5-52.5cm)/small wood (17.5-32.5cm) of approximately 50/30/20 by standing volume. Harvesting is carried out on an eight year cutting cycle which results in a current annual increment of 11 m³/ha/yr.

The incredible fact is that during the 110 year period from 1891 to 2001 the standing volume, as measured in 2001, has been harvested 3.4 times; that is approximately 1,000 m³/ha per century, without ever exposing the soil or significantly depleting the standing capital value.

Professor Jean Philippe Schütz (centre), with the 24 cu m Silver Fir "Le President" (right).

Ultimately the silvicultural aim to transfer this forest to an all aged plenter forest, in a state equilibrium, within a century has been achieved.

Stop 5 – La Joux-Pélichet

Our guide: Prof J. Ph. Schütz

From Envers, still in Couvet, we travelled to the forest La Joux-Pélichet near the Swiss/French border. La Joux-Pélichet was planted on pasture land between 1899 and 1923, principally as a flood defence following severe and repeated flooding of the nearby town of Le Locle. The subsoil is cretaceous chalk, the soil above varies in depth from 20-70 cm. The site is 990 - 1,040 m above sea level and receives 1,400 mm of rain per annum. The mean temperature is only 6.7°C; a frost can be experienced in any month of the year.

The 42.2 ha woodland was planted as dominantly Norway Spruce, supplemented by nine other conifer species and six broadleaf species. These were mixed, both in space and time, in a chess board effect to deliberately create diversity in species and structure. Later failure of some species, notably Weymouth Pine due to blister rust *(Cronartium ribicola)*, Stone Pine and Scots Pine due to snow pressure, and various Spruces because of root and stem rot, led to further diversification when the gaps were filled by natural regeneration of Ash and Sycamore.

Transformation to the plenter system began in 1938. Since then it has been monitored using the *method du controle*, or check method, it has been inventoried eight times since. The average increment over this period was 11.9 m³/ha/yr.

The key challenge here, as described by Prof. Schütz, was in the development of uneven-aged Norway Spruce stands on relatively high nutrient sites. The first stop was at a stand which had received a fairly uniform reduction in basal area some 20 years previously. Generally on this site the weed competition had been too aggressive and failed to produce sufficient Spruce regeneration. The understorey consisted predominantly of low-quality broadleaves and shrub species with a high contingent of Bramble.

At the second stop an alternative method had been employed: the stocking in this stand had been maintained relatively high, but small discreet gaps (no bigger than 0.1 ha) had been created. The gaps were not inserted systematically but rather were created opportunistically by removing groups of poor quality trees. The success of this method was apparent from the natural Spruce regeneration above browse height within these gaps. The intention at next intervention is not to expand these gaps but to create new gaps.

The lesson here is that transformation is often an iterative process; there is no 'one size fits all' approach. One must take into account the species and site characteristics in choosing a suitable method.

Stop 6 – Forêt Jardinée: Bois de la Motte and Côte (Pontarlier)

Our host: M. Leforestier

On day three, still in the Jura, we left Switzerland and entered France – at Pontarlier and the Bois de la Motte. Pontarlier is located on a plateau, 900-1,100 m above sea level, with a harsh climate, on Jurassic limestone. Rainfall is 1400 mm per annum (400 mm as snow); 180 days with rain (50 days of which are as snow). The average annual temperature is 7°C. The area is in private ownership with management entrusted to the Cabinet Leforestier for the past 25 years, it consists of 70 ha of Silver Fir/Norway Spruce/Beech forest and 35 ha of pasture land which is attached to the farm for summer grazing.

A management plan was drawn up in 1984 with the aim of gradually transforming the even-aged forest to plenter forest. The main objective of the owner is to "produce quality timber, ensuring the proper functioning of the forest ecosystem by maintaining ecological diversity".

Thinning control is carried out by using the 'check method' with inventory always carried out just before a planned harvesting intervention. The basal area is maintained at between 22 and 28 m^2/ha coniferous plus 2-3 m^2/ha of broadleaves. Harvesting is currently on a six year felling cycle with the aim of removing between 20-25% by volume.

The area which we were shown had been allowed to creep up to 31.3 m^2/ha basal area. The effect of this capitalisation of the growing stock on the sustainability of the plenter management was plain to see. The young poles were few, and had become suppressed, whilst regeneration was very sparse. It was however marked for harvesting but, as has been seen before, the effects of allowing the growing stock to creep up can be costly and very long-lasting.

M. Leforestier explains the thought process behind stem selection when marking harvesting cuts in the Bois de la Motte.

Stop 7 – Forêt irrégulière de Cosges

Our host: Fabien Rebeirot

From Pontarlier, travelling westward, we stepped down to the plain between the Jura Mountains and the Burgundy hills, the Bresse.

The Forêt de Cosges is a mere 200 m above sea level and receives 1,000 mm rainfall per annum. The site is dominated by deep brown leached soils with some gleying. The 78.86 ha mixed broadleaf forest was formerly treated as coppice with Sessile Oak standards (coppice species: Hornbeam, Aspen, Birch and Beech), it was enriched with Red Oak between 1960 and 1979. It is broken up into small (approximately three hectare) compartments bounded by tracks or skiding trails.

The conversion to mixed irregular high-forest started in 1993. The only stand data comes from an AFI research stand installed in 1995. There is no fixed silvicultural approach; our host describes this as an "adaptive freestyle silviculture" encouraging quality, structuration, and species diversity. The Red Oak has been an issue; although of good timber quality and marketability, the regeneration is highly aggressive to the detriment of all other species. The basal area seems to be optimal at around 17 m^2/ha which produces on average 1.3 m^3 of logs and 3.1 m^3 of fuel wood per hectare per year. Annual costs are very small consisting mostly of some minor respacing in the understorey to encourage development of saplings of Sessile Oak with apparent success.

Of all the stands visited on the tour Cosges reminded me most of lowland broadleaf stands back home. These mixed broadleaf stands often have fairly diverse structures, mostly due to long periods of neglect or disturbance events. They are often relatively uneven-aged of mixed species and of variable quality. As a result they present ideal subjects for transformation – the dominant trees have been used to fairly open conditions, have large crowns and provide a stable framework. The many poor quality stems of all sizes provide a useful tool for manipulation of the stand as well as providing financial returns. The long-term aim is to fill these stands with healthy, vigorous, trees and production of high quality timber.

Stop 8 – Forêt Jardinée de Folin

Our host: Roland Susse

Not far from Autun, situated in the Commune de Roussillon en Morvan, is the Forest of Folin. At an elevation of 580-846 m above sea level the 530 ha forest of Folin is split into 17 compartments of approximately 30 ha each. Originally coppice and coppice with standards, it was largely coniferised when purchased by the current owners in 1926.

Plentiful regeneration of Douglas fir in the forest of Folin.

Currently the composition is 320 ha of conifer (including 110 ha of Douglas Fir, 172 ha of Silver Fir and Spruce, and 38 ha of Grand Fir and Larch) and 210 ha of broadleaves (96 ha of which is Beech dominant).

Our host, Roland Susse, is one of the founding members of the Association Futaie Irrégulière (AFI). "The AFI was founded in 1990 by a working group whose mission it was to study and disseminate forest management practices that would provide both income to the owner while also working in harmony with the natural functions of the forest"[3]. Research plots have been set up in woodlands throughout France and other countries to demonstrate the relevance of this approach. In Folin 169 permanent sample plots were installed in 2002 to follow the evolution of the population. The volume emerged at 310 m³/ha, 64% conifer and 36% broadleaf. The increment by species is approximately 15 m³/ha/yr for Douglas Fir, 10 m³/ha/yr for Silver Fir, 3 m³/ha/yr for Beech, and 2 m³/ha/yr for Oak.

Management guidelines in the forest of Folin

Harvesting in all stands of 15-20% by volume on a six year felling cycle with the following principles of stem selection:

- ***Harvesting of trees which have reached an optimum diameter***
- ***Sanitary cuts: removal of trees which might be lost before the next intervention***
- ***Improvement: removal of trees which are suppressing a better quality neighbour***
- ***Regeneration: to give light to seedlings, saplings, or pole stage trees***
- ***Dead or dying trees with cracks or cavities are retained for ecological benefit***
- ***Enrichment planting of gaps which fail to regenerate and in low value coppice***

Despite an average annual rainfall of 1,500 mm per annum, recent dry summers have bought drought problems to some species – Grand Fir has been totally removed from Folin, and the future of Beech in the natural flora is questionable.

Stop 9 – Dambach (Forêt Jardinée et irrégulière)

Our host: Evrard de Turckheim

We travelled east and, just north of Strasbourg, turned north into the hills of the Northern Vosges Mountains to the forest of Dambach.

The forest area is 4600 ha, it sits at an elevation of 210 to 510 m above sea level, and receives 840 mm of rain per annum. The dominant soil type is a deep free draining acidic Vosges sand.

Before the 19th Century (when coal became available) the region's industrial activities were based on, and limited by, the production of wood as the only source of fuel for the foundries. The forest then employed around 400 workers and produced 80,000 cubic meters of fuel wood per year, more than double the current production. The forest was managed under the clear-cut system until 1978 and since then has been managed under the principles of Pro Silva.

The principle species present are Scots Pine 30%, Norway Spruce 16%, Beech 28% and Oak 16%. The forest has been under FSC certification since 2000 and, after some discussion, limited enrichment planting with Douglas Fir has been permitted over recent years. The aim is to plant in gaps capable of containing a minimum 200 trees at close spacing (any less is considered too small and uneconomic). Small groups of Oak (10 to 15 plants to a group) are also planted where soil nutrients are higher.

Harvesting is carried out on a six to eight year cycle. Monitoring via the check method (complete enumeration) is being phased out in favour of a network of permanent sample plots. The sample data reveals an average 310 m³/ha with 20% in large timber. There is a desire, in the long term, to recruit a greater volume of large trees from the medium sized trees to create a more balanced structure.

At the first stop we saw some encouraging regeneration, in the form of Pine, Spruce and Beech, following significant damage from storm "Lothard" in 1999. There is a will to favour the Scots Pine over Spruce, which suffers from root rot, bark beetle, and deer, and Beech, for which there are few market opportunities but has a tendency to dominate. This was evident at stop two where a felling coupe created some fifteen years earlier was full of Beech regeneration to the exclusion of all else. When our host posed the question – what could be done here? The majority conclusion was – work with what you have got! Or to quote Professor Jean Philippe Schütz: "The train has left the station".

It was clear that the desire to maximise Scots Pine although not fruitless could be labour intensive and costly.

3 For further information about the AFI see "Management of Irregular Forests" by Roland Susse, Charles Allegrini, Max Bruciamcchie and Roland Burrus (English translation by Phil Morgan)

Encouraging recovery following damage form storm "Lothard" in 1999 in the forest of Dambach.

Concluding Remarks

We were shown a fantastic range of sites from those fully developed over the last 100 years to those just beginning the journey to plenter forest. The latter were probably of more immediate interest to most UK foresters. Kick-starting the transformation process from even-aged forest is a considerable challenge, this was evident at La Joux-Pélichet, with the example of Norway Spruce, where the regeneration initiation stage had failed on the site of uniform basal area reduction on these high nutrient sites. I suspect that this is not just the case with Spruce. I have encountered similar problems with Norway Spruce and with Douglas Fir, where Bramble growth has been too aggressive in the improved light environment.

Under these circumstances it would appear that the forester needs to be proactive in pushing for greater spatial variation, creating light and shade. In the better evolved stands of shade tolerant to moderately tolerant mixtures, in seeking an optimum stocking, they are fairly similar with ideal growing stocks ranging from 360 m^3/ha in the forest of Envers to 300 m^3/ha in Rougemont, delivering 11 m^3/ha/yr and 12 m^3/ha/yr respectively of increment. This would equate to an approximate basal area of between 25–28 m^2/ha.

Two of the forests (Dambach and La Buron) showed remarkable recovery in the fifteen years since being devastated by storm "Lothard", both now show a great degree of structural diversity. This can only be of encouragement to managers who are still clearing up storm damage received during the series of storms during winter 2013/14. Other threats to the forest ecosystem, common to all of the forests which we visited, were familiar to most UK foresters – browsing due to excessive deer populations[4], not so familiar to the UK – the European bark beetle *Ips typographus*, and of course climate change – recent summer droughts have bought into question the future of Beech in the native flora. Interestingly the better developed plenter forests were little affected by storms.

One gets a sense that these forests are very much alive; that they are healthy and vibrant. There exists superlative utilisation of the vertical and horizontal space; every niche is exploited by an abundance and variety of plant species. The growing stock is not only the product, but also the production machinery.

Nature is the driving force, regulated (in the form of harvesting interventions) to provide for multiple ecosystem services. Trees of the upper canopy have large crowns with free growth able to sustain high levels of diameter increment, whilst renewal in the half-light of the understorey is both spontaneous and patient, waiting for the light environment to be appropriate for growth.

The irregular forest is not an objective in itself. It is the result of a thoughtful approach to forest management which seeks to harmonise multiple objectives. But perhaps of greatest significance in light of recent, and as yet unforeseen, threats in the form of storms, pests and diseases, and potential climate change, is the ability of the forest to recover. What better way of building in stand resilience than seeking maximum diversity in all population elements?

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Lastly, on a personal note, I would like to thank Woodland Heritage for financing what was for me an unforgettable experience.

The organisers and participants of the 9th IUFRO International conference on uneven-aged Silviculture, post conference tour.

4 The return of the grey wolf to parts of France and Switzerland may offer comfort to forest managers at least, not a sentiment shared by all however.