

# REGENERATION DYNAMICS OF *NOTHOFAGUS PUMILIO* IN A HIGH ELEVATION FOREST OF SOUTHEASTERN ARGENTINA

**Group Leader: Tom Levanic**

Paul Krusic, Silke Hoffmann, Jean Huffman, William Pollmann, Stéphane Ponton, Paula Vera

## Introduction

*Nothofagus pumilio* occurs from 35°35' to 55° S in the Andean Range and the Coastal Range of Chile and Argentina. It ranges in elevation from sea level to 2000 m above sea level. North of 41° it occurs only in the subalpine zone and commonly forms the upper tree limit. In the southern part of its range it occurs at both high and low elevations. In the center of the distribution mean annual precipitation is more than 5000 mm on the western side of the Andes and only 800 mm at the easternmost localities in Argentina. *N. pumilio* occurs at cooler and drier sites than the other members of *Nothofagus* genus (Veblen et al. 1996).

*Nothofagus pumilio* and *N. antarctica*, with the exception of some *Alnus* species, are some of the rare deciduous hardwood species that form upper treelines in the Southern Hemisphere. *N. pumilio* is long lived and forms annual rings making it well suited to dendrochronological studies. However, the regeneration dynamics of *N. pumilio* are not well known. Seed production and viability is highly variable from year to year. Percentage viability was near zero during the years with low production and ranged from 7 to 22% during the years of high production. Survival of seedlings highly depends on the light conditions in the gap, following the literature nearly all of the seedlings died due to low light conditions in a stand gap. Fallen logs seem to be very important for the establishment and survival of seedlings (Veblen et al. 1996).

On the upper timberline, vegetative reproduction is very important. Adventitious roots sometimes formed where branches touched the ground, but usually new stems relied on the roots of the original tree (Veblen et al. 1996).

The upper treeline is usually formed by *N. pumilio*, either as an erect form or light krummholz, or by *N. Antarctica*, which forms the typical krummholz upper timber line. The timber line in the southeastern Andes is generally between 1700 m and 1750 m, but it could be lower due to strong winds, high snow cover, avalanches, poor drainage and volcanic ash. *N. pumilio* (and *N. Antarctica*) prefer wet and cool site conditions which are found in the western and southwestern Andes and on eastern outliers of the Andes surrounded by steppe. In the lowest part of the elevation range of this forest type, the understory is dominated by bamboo (*Chusquea culeou*, *C. montana*) up to four meters tall which gradually disappears towards the upper treeline.

## Goals

The goals of the study were to:

- determine how *Nothofagus pumilio* establishes in forest gaps.
- determine how browsing effects *Nothofagus pumilio* forest regeneration
- date a forest gap and describe the affects of forest gap formation on surrounding trees.
- build a *Nothofagus pumilio* chronology for upper timber line.

## Methods

Study site. The research plot was located in the Chapelco ski resort (San Martin de los Andes, Neuquén, Argentina). The elevation of the site is about 1550 m a.s.l. with a north-northwest exposure, the soil is

deep and rich with volcanic minerals, and the bedrock is basalt. The plot was located in a fairly undisturbed area. It was difficult to find an ungrazed plot since the whole region is heavily influenced by cattle, goat, sheep and horse grazing, and by human influences related to the ski slopes.

Treeline chronology construction. Two cores were collected from each of 17 *Nothofagus pumilio* trees just below treeline. Cores were glued into wooden holders, dried and sanded using up to 400 or 600 grit sandpaper. To improve the visibility some of the tree ring cores were also stained with blue color and the contrast was enhanced using chalk. Tree-rings were examined using a binocular microscope and measured using a Velmex measuring machine connected to a personal computer running MeasureJ2x program. Measured series were synchronized and averaged into a local chronology for the upper timber line (UTL). For dating and synchronizing, skeleton plots and COFECHA were used.

Forest gap study site. We located a forest gap that was not disturbed by cows and grazing (a difficult task) in the upper part of the *N. pumilio* forests near the timber line. Within this gap we established a study plot to sample *N. pumilio* regeneration. The study plot was 2x15 m and was located along a big broken branch that caused the gap. The plot was divided into subplots of 1x 2 m and all the trees in the plot were sampled by first determining the mode of establishment (vegetative or seed) for each plant and then taking basal cross-sections of the stem. These cross-sections were sanded and the age of each stem was determined in the lab.

All trees surrounding the gap were cored. One core was taken from the adjacent gap side of the tree and the other was taken from the side opposite the gap. Cross-sections from dead trees within the gap were also collected in order to help date the age of the gap. Additionally one *N. pumilio* tree from lower elevation was cut down to determine the rate of browsing. All browsing scars were counted and the age of the tree was determined.

## Results

### a. *Nothofagus pumilio* chronology for upper timber line

The sample depth varied between 1 and 11 trees (**Figure 1**) and a 162 year long chronology was built (**Figure 2**). Period 1922-1999 is covered by all cores. Eight out of 17 trees could not be dated and synchronized. Main problems that appeared during the tree-ring width processing was that annual rings in *N. pumilio* sapwood were not easy to detect. The tree-ring boundary is due to small differences in the densities of early- and latewood. Tree rings in the heartwood are clearly visible. Density fluctuations can be observed regularly. They could vary from hardly visible, to very distinct ones which look like real tree rings. Missing rings could not be detected - further studies should be done.

### b. Regeneration of *N. pumilio* in a gap

Following our results, the gap established 15-18 years ago. The majority of the samples (6 out of 11) exhibit abrupt growth changes in the period 1982-1986. Vegetative reproduction predominates and seedlings are rare. The power of vegetative reproduction is very high. We found broken branches with diameters more than 5 cm that have made roots and lived on, even one branch collar was able to make roots and continue to grow. This high reproductive power was connected to favorable climatic conditions - high air humidity and frequent precipitation, as indicated by the great abundance of lichens (*Prot-Usnea* spp.) on the trees.

The effects of snow should not be neglected. The weight of the snow pushes down on young plants and causes the bending of young stems - krummholz appear and formation of the erected form of the trees is prevented.

### c. Effect of browsing on *N. pumilio*

We analyzed one tree that was browsed by domestic animals. The age of the analyzed tree was only 10 years (aged at sample taken at the height of 5 cm), and was browsed 198 times in the last two years. This obviously shows us that domestic animals are the most important factor affecting *N. pumilio* forest regeneration. The majority of trees have been grazed and stunted in growth. In the long term this represents a big problem in the regeneration of the *N. pumilio* forest and since the dieback of this forests is a fact, the regeneration of the forest will be questionable.

### **Conclusions**

In the gap

- Vegetative reproduction predominates.
- Seedlings are rare and suppressed.

Gap age

- The age of the gap is between 15 and 18 years years old.
- Seedlings in the gap are approximately 15 years old.
- A growth release could be observed in all of the trees surrounding the gap between 1981 and 1983.

Upper timber line

- A 162 year long chronology of *Nothofagus pumilio* of the upper timber line was constructed. It had sufficient sample depth to adequately cover the last 77 years.

Browsing

- Grazing pressure might be an important factor affecting forest regeneration

### **Literature Cited**

Veblen T.T., Hill R.S., Read J., 1996: The Ecology and Biogeography of *Nothofagus* forests. Yale University Press, New Haven and London, 403 pp.

### Chapelco Upper Tree Line (dated) Tree-Ring Series

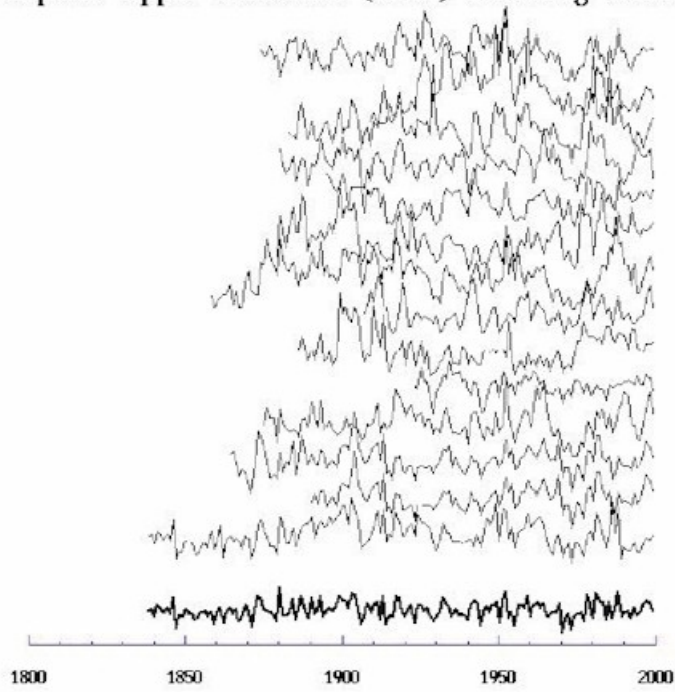


Figure 1

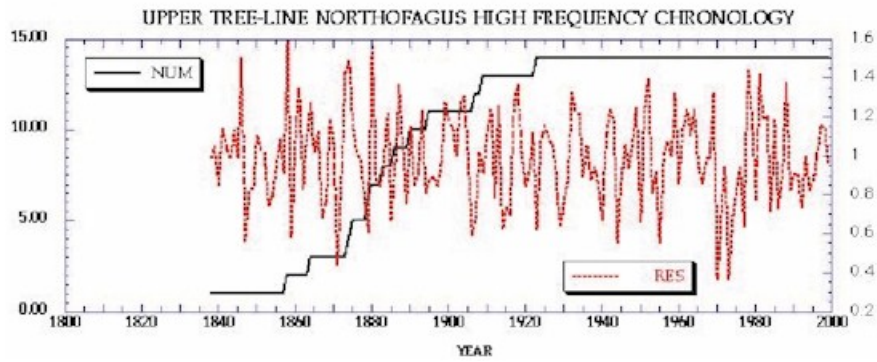


Figure 2