

# Silviculture treatments for old-growth mixed deciduous - evergreen *Nothofagus pumilio* – *N. betuloides* forests in southern Patagonia, Chile.

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## Background

Naturally old-growth mixed deciduous – evergreen *Nothofagus pumilio* - *N. betuloides* forests in southern Patagonia are uneven-aged. Since the 19<sup>th</sup> century these forest types have been selectively logged in southern Patagonia and Tierra del Fuego, leaving productive forests with a lack of regeneration. The silvicultural prescriptions that are allowed by the Chilean Forest Law are either a shelterwood or a selection system. However, in the scarcely managed forests, only the shelterwood system has been applied, which has homogenized and simplified the stand structures.

## Objective

The objective is to analyze the first cut of a shelterwood system and the first cut of a selection system, the latter being a new silvicultural approach in this old-growth forest type in southern Patagonia.

## Methods

In 2005, a shelterwood and a selection system were applied following the silvicultural prescription of the Chilean Forest Law. The first cuts of the two silvicultural treatments at an operational scale were in two representative stands of approximately 3.5 ha each. Prior to harvesting, skid trails were marked in order to minimize the risks of damage to the soil, the forest regeneration and the residual trees.

In the first cut of the shelterwood system 40% of the original basal area was removed. Mature and over-mature trees were left standing as residual trees of the canopy. Residual trees were chosen on the basis of spacing, crown and stem health, size and apparent wind stability. Merchantable trees were selected following the company's standards for commercial quality sawlogs.

In the first cut of the selection system, 20% of the basal area was removed. A percentage of the mature trees (DBH  $\geq$  30 cm) were harvested taking into account the company's commercial quality standards for sawlogs. A selective thinning of the intermediate and overtopped trees was carried out simultaneously, in order to improve the diameter growth of the retained juvenile trees and to maintain the uneven-aged and multi-layer structure of the stand.

The canopy composition and the stand structures were assessed before and after the operation. In each stand, 5 inventory plots of 1,000 m<sup>2</sup> were established. All trees  $\geq$  5 cm in DBH were considered. The total stand volume was calculated using a local volume function. The original regeneration status was also described. For both silvicultural treatments the sawn wood timber production after the harvest was calculated.

## Results

The stand before the harvesting presented an uneven-aged structure (Figure 2). It has a density of 898 tree ha<sup>-1</sup>, a basal area of 79 m<sup>2</sup> ha<sup>-1</sup>, and the total volume was calculated in 740 m<sup>3</sup> ha<sup>-1</sup> (Table 2).

The number of trees of *N. betuloides* was lower than that for *N. pumilio* and they were concentrated in the lower and in the middle DBH-classes (Figure 2).

Table 2 Tree density, basal area, and stand volume, before and after the first cut into a shelterwood system and a selection system

Original Stand	Residual stand after	
	Shelterwood cutting	Selection cutting
Density (trees ha <sup>-1</sup> )	898	690
Basal area (m <sup>2</sup> ha <sup>-1</sup> )	78,5	63,8
Volume (m <sup>3</sup> ha <sup>-1</sup> )	740	595

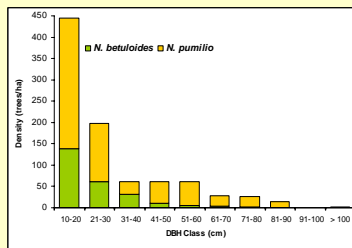
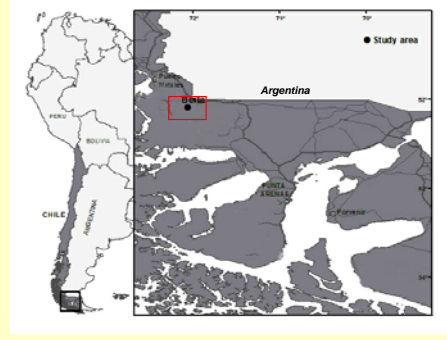


Figure 2. Diameter distribution by species before the cutting of the study stand.

## Study site

A primary temperate and mixed deciduous-evergreen *N. pumilio* – *N. betuloides* forest, located at the "Estancia Berta" from the "Monte Alto" sawmill company, on the west side of the Río Rubens (52°04' 04"S; 72°07'30"W; 340 m.a.s.l.), was selected for the study (Figure 1).

Figure 1. Location of the studies stands in South Patagonia, Chile



The number of *Nothofagus* seedlings present on the stand was high before the harvesting, with a mean of 49.5 and 14.8 seedlings and saplings m<sup>-2</sup> for *N. pumilio* and *N. betuloides*, respectively (Figure 3).

The dominant seedlings of *N. pumilio* were concentrated in the lower regeneration layers. In contrast, the more shade-tolerant dominant seedlings of *N. betuloides* were concentrated in the upper regeneration layers (Figure 3).

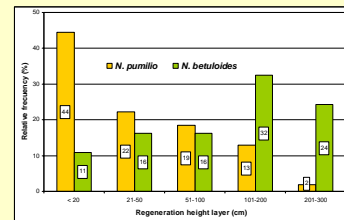


Figure 3. Relative frequency seedlings and saplings of *N. pumilio* and *N. betuloides* before the cuttings by size class.

## Shelterwood system (Figure 4).

46 sawlogs per ha were obtained with the first cut of the shelterwood system, with a commercial volume of 30 m<sup>3</sup> ha<sup>-1</sup> of sawn wood. This commercial volume represents 4% of the original stand volume. A final removal cut of the residual trees to release the established regeneration has been scheduled for approximately 10 years. By this time the regeneration would be homogeneously distributed and would have reached around 2 m in height.

## Selection system (Figure 5).

29 sawlogs per ha were obtained with the first cut of the selection system, with a commercial volume of . 25 m<sup>3</sup> ha<sup>-1</sup>. This represents 3% of the original stand volume, being 20% lower than the volume obtained in the first cut of the shelterwood system.

## Conclusions

The traditional first cut of the shelterwood system applied in the *Nothofagus* forests of southern Patagonia and Tierra del Fuego has always had a high harvest intensity – about 50% of the overstory basal area and with a regular spacing. Over-mature, mature and juvenile trees must be harvested. Therefore, a high percentage of trees with small diameters are cut, which has a potential timber quality. These are left in the forests in most cases, because the wood cannot be marketed in the region.

The selection system could be applied in old-growth mixed deciduous – evergreen *N. pumilio* - *N. betuloides* forest to maintain the natural uneven-aged and multi-layer structures of this forest type. This would avoid a homogenization and simplification of the stand structure. The harvest intensity by the first cut could be about 20% of the overstory basal area and a high percentage of trees with potential timber quality remain in the retained canopy. By the following harvest, the accumulated yield volume of the stand could be removed, with cutting cycles of between 10 and 20 years, which would be evaluated.

Because the management of forests requires a long-term commitment, the stands studied have been implemented as "permanent demonstration forest areas" to provide scientific and technological knowledge for sustainable forest management in the old-growth *Nothofagus* forests of southern Patagonian.



Figure 4. Stand structure before (links) and after (right in fall season) the first cut into a shelterwood system.



Figure 5. Stand structure before (links) and after (right) the first cut into a selection system.

## Acknowledgments

