World Congress Silvo-Pastoral Systems 2016
Silvo-Pastoral Systems in a changing world: functions, management and people
Évora, Portugal, 27-30th September 2016

Fondo de Investigación del Bosque Nativo

Ministry of Agriculture
Government of Chile

INFOR INSTITUTO FORESTAL

EVALUATION OF A THINNING UNDER SILVOPASTORAL APPROACH IN A NOTHOFAGUS ANTARCTICA (ÑIRE) IN CHILEAN PATAGONIA.

Jaime Salinas[1*], Alvaro Sotomayor[2], Bernardo Acuña[1]
[*] Corresponding author. [1] Instituto Forestal, Patagonia headquarters, Coyhaique, Chile.
[2] Instituto Forestal, Biobío headquarters, Concepción, Chile.

Introduction

The structure and dynamics of Nothofagus forests of South America is associated with disturbances or periodic alterations, such as turnings by wind, fire, mass movements and tectonism. Small-scale riots, where only the fall of individual trees or group of them occurs, giving rise to a dynamic light or "gaps". Forests of ñire (*Nothofagus antarctica*) are not far from this dynamic disturbances; the development of these ecosystems for a long time has been associated with a pressure of domestic livestock and insect attack because of distribution in a steppe transition, and have been affected for decades by forest fires, resulting in a structural loss and little commercial value.

In Aysén region, native forests cover an area of 4.3 million ha (CONAF, 2012). Lenga and ñire are two of the nine species of the genus Nothofagus with presence in the southern zone of Chile, covering an area of 1,400,376 ha in the Aysén region (CONAF, 2012). In the intermediate regional area of Aysén, between the evergreen forest and the Patagonian steppe, originally dominated by deciduous forests of lenga and ñire, extensive livestock farms and scattered fragments of native forest and plantations typify the landscape of broad valleys for livestock production (Hepp et al., 1988). The livestock use in forests in the region dates back to the introduction of sheep and cattle during colonization in the nineteenth century. From the beginning, livestock exerted strong pressure on the forest, which remains today.

Ñire forests are subject to various disturbances associated with overgrazing, selective felling and fires. In its range of distribution, ñire coexists with livestock production, and this relationship of coexistence doesn't follow scientific criteria that tend to the sustainability of the production system. Therefore, in the present work it is presented silvicultural progress in ñire forests for the implementation of silvopastoral systems under sustainable criteria and guidelines.

Objetive

Define guidelines for silvicultural management for ñire forests that make viability sustainable silvopastoral production forest owned by small forest owners in the Aysén region.

Methodology

Study area. The study was carried out on two ñire forests (ñirantal) of the commune of Coyhaique, with marked differences edaphic and climate conditions. The first is located at 45° 52′ 22"Lat S; 71° 49' 08" Long W at 530 meters above sea level, on a wet site. The second site is located in a condition of a steppe transition at 45° 50' 25" Lat S; 71° 50' 01" Long W at 580 meters above sea level. In both cases, the following situations were compared:

Table 1. Treatments evaluated in two conditions of ñire forests, commune Coyhaique, Chile.

Treatment	Name treatment	Description
A	Forest witness	Ñire forest without intervention
B	Silvopastoral	Ñire Forest Thinning (40% basal area)

Forestry Component. Forest structure was evaluated from an inventory of 10 circular plots of 100 m^2. For treatment "B", the measurement was performed before and after the intervention. From inventory information basal area (m^2 ha^{-1}), density (tree ha^{-1}), quadratic mean diameter (cm) and stocks (m^3 s.w.b ha^{-1}), was estimated; for the latter, it was used the volume function proposed by Ivancich, 2013.

$$VTCC = a \cdot DAP^{b} \cdot HT^{c}$$

Where a, b, c: coefficients of the model; VTCC: total volume with bark (m^3); DAP: average diameter up to 1.30 m (cm); HT: Total height of tree (m). a: 0.0000791214; b: 2.07986; c: 0.655819.

Evaluation and annual monitoring of the dynamics and increases in long-term forest cover was evaluated in three circular permanent plots of 200 m^2 (radius = 7.98 m). In each plot the diameter at 1.3 m (DBH), total height (measured with Vertex Instrument), canopy cover (measured with hemispherical photographs) and the existing regeneration was assessed using four plots of 1 m^2, each arranged in the direction of the cardinal points (N, S, E, W). Each tree in the plot was identified, numbered and marked the height at 1.3 m for greater precision in the annual measurements.

Permanence of tree layer. To ensure permanence on time of the arboreal layer, 18 stumps were protected using two types of individual protection; the first (T1) built with chicken wire (isolating cattle and rabbit browsing), the second (T2) using smooth wire and barbed wire (isolating cattle), and (T3) without protector. For each treatment and repetition parameters of stump (DSH: diameter stump height; SH: stump height; NO: number of outbreaks; SL: shoot length, and NC: number of cores) were evaluated, and percentage of browsing.


TRADITIONAL PROTECTOR


MESH PROTECTOR


BRANCHES PROTECTOR


WITHOUT PROTECTOR

Results

Forestry component. The intense sampling allowed having a first structural view of the forest on both site conditions prior to thinning. Intervention in the dry site removed 45 % of the basal area, extracting 99 m^3 ha^{-1}.

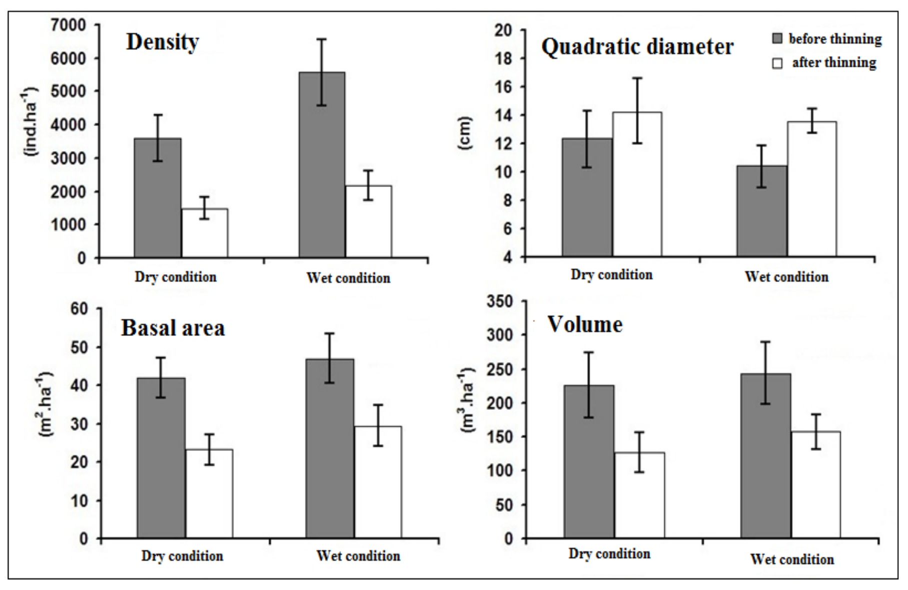
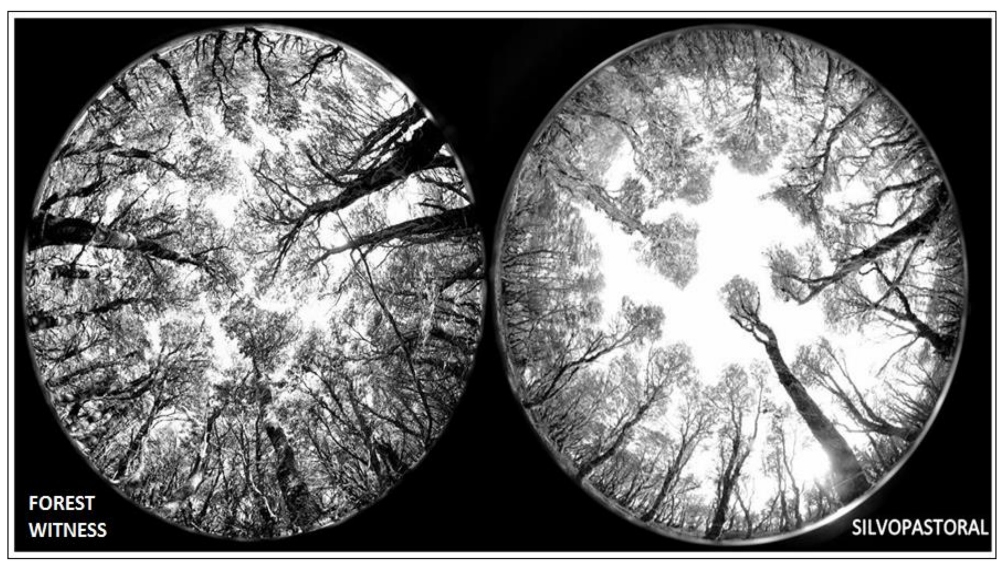


Figure 1. Changes in forest variables after thinning two ñire forest conditions, commune of Coyhaique, Chile.

While on the wet site, 37 % of the basal area was removed and harvested a total of 85.9 m^3 ha^{-1}. The population density decreased about 60 % in both sites due to thinning. This extraction allowed an increase of 15 % and 30 % for quadratic diameter for sites mentioned. The diametric increases were estimated from each permanent plot. For control treatments increments of 0.13 ± 0.1 and 0.05 ± 0.04 cm $year^{-1}$ for dry and wet sites were recorded, while the silvopastoral treatments had increments of 0.57 ± 0.1 and 0.2 ± 0.1 cm yr^{-1} respectively.

Brightness. The hemispherical photographs (fisheye lens SUNEX, visual field 185°), were taken avoiding direct influence of the sun (Roxburgh & Kelly 1995). The analysis allowed to estimate coverage of about 70 % in the forest without intervention, and between 45 and 50 % in thinned forests. On the other hand, the diffuse solar radiation (ISF) that reaches the thinned wood is 61% and 66 % for wet and dry sites respectively.



Site	Treatment	COVERAGE CANOPY (%)						Average (± DE)
		North - South			East - West			
		P1	P2	P3	P1	P2	P3	
Wet	Forest witness	69,49	70,24	69,3	71,3	74,22	74,13	71,4 ± 2,2
	Silvopastoral	46,6	47,71	48,57	45,75	46,45	46,4	46,9 ± 1,0
Dry	Forest witness	72,76	72,55	71,1	74,45	73,25	70,59	72,5 ± 1,4
	Silvopastoral	49,5	45,04	44,9	46,2	44,9	46,61	46,2 ± 1,8

Figure 2. Hemispherical photographs (HP) before (Control) and after thinning (Silvopastoral) and results in the opening of the canopy of ñirantal according cardinal position, site and treatment, estimated by HP, commune Coyhaique, Chile.

Permanence of tree layer. Profitability and long-term sustainability of a silvopastoral system depends, among other aspects, to maintain the tree layer (Peri et al. 2009). To do this, one of the strategies is the natural regeneration of these forests, which are currently evaluated in this study using permanent plots. Another way to keep the forest, is through the protection of stumps, to ensure the development of the sprouts.

Table 2. Evaluation parameters and percentage of browse stump sprouts ñire, based on two types of individual protective in two forest conditions ñire.

	DRY CONDITION				WET CONDITION			
	2015	2016	2015	2016	2015	2016	2015	2016
	Htot (cm)	Htot (cm)	Long shoots (cm)	Long shoots (cm)	Htoc (cm)	Htoc (cm)	Long shoots (cm)	Long shoots (cm)
P1	40,9	80,9	17,2	47,6	41,2	68,6	32,2	38,1
P2	44,3	50,9	10,3	18,6	41,8	44,6	12,7	13,4
P3	42,3	44,6	10,1	9,11	43,8	45,8	4,9	10,1

Growth of sprouts were evaluated (Table 3) and percentage of sprouts from stumps browsed was evaluated, finding a percentage of grazing on the dry site of 0, 70 and 90 % for the mesh, and witness traditional treatments respectively. A similar situation occurred in the mallín site with an attack of 4, 58 and 74 % for the same treatments.

Conclusions

The application of thinning in secondary forest stands caused a substantial increase in diameter , especially in the dry site where the DMC was 397 % higher than the control. The FH are an tool effective to differentiate the light impact on forests ñire. A strategy to ensure continuity ñire Forest, is the application of individual savers stump, activity inexpensive and easy applicability that can reduce the percentage of domestic livestock grazing and naturalized from 90 % to 0 %.

References

- CONAF, 2012. Catastro Vegetacional del Bosque Nativo. Actualización de la XI región de Aysén. Coyhaique, Chile.
- Hepp, C., Thiermann, H., Ramírez, C., 1988. Praderas en la zona austral XI región (Aysén). In: Ruiz Núñez, I. (Ed.), Praderas para Chile. Instituto de Investigaciones Agropecuarias, Santiago, Chile.
- Ivancich, H.S. 2013. Tesis doctoral: Relaciones entre la estructura forestal y el crecimiento del bosque de *Nothofagus antarctica* en gradientes de edad y calidad de sitio. Director: G. Martínez Pastur, Codirectora: M.V. Lencinas.
- Peri PL, N Hansen, V Rusch, L Tejera, L Monelos, M Fertig, H Bahamonde, M Sarasola. 2009b. Pautas de manejo de sistemas silvopastoriles en bosques nativos de *Nothofagus antarctica* (ñire) en Patagonia. In Actas del Primer Congreso Nacional de Sistemas Silvopastoriles, Posadas, Misiones, Argentina mayo de 2009. Actas. p. 151-155.
- Roxburgh, JR & D Kelly. 1995. Uses and limitations of hemispherical photography for estimating forest light environments. NZ J Ecol 19:213-217.

Acknowledge

The authors thanks the Research Fund for Native Forest (FIBN), administered by the Corporación Nacional Forestal of Chile (CONAF), for financing project 022/2013- Guidelines for Silvopastoral Management in ñire forest, in the Aysén region, Chile.