



SUPPLEMENTARY MATERIAL

MARTÍNEZ-PASTUR et al. (2010) Revista Chilena de Historia Natural 83: 159-169.

Long-term forest management research in South Patagonia - Argentina: Lessons from the past, challenges from the present

Investigación sobre manejo forestal a largo plazo en Patagonia Sur - Argentina: Lecciones del pasado, desafíos del presente

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ABSTRACT

Argentina has based its economy in agriculture and cattle production seeing forests as one of the main obstacles for future development. Forest harvesting in South Patagonia has been an activity based on colonization and exploitation of new areas. Harvesting is mainly carried out in old-growth forests without silviculture management after the first cuts. Beyond this mismanagement, scientific research defined the basis to conserve, protect and improve the present forest management for the South Patagonia native forests. The first long-term study permanent plots (1965-1966) monitored only economic and forest structure parameters, and near twenty plots were established in public forested lands of Tierra del Fuego. Most of these plots were destroyed or discontinued due to a lack of land use planning, scarce social interest for long-term researches, absence of commitment of institutions, and few contributions of forest companies. After this, a second group of nine long-term study permanent plots were established in South Patagonia (1993-2004) based in the collaboration between private companies and national research institutions. The objectives included economic as well as ecological parameters. The new plots were established on private lands based on several agreements and joint venture projects between national institutions, private companies and ranch owners. The main limitations in these processes were: a lack of commitment from the provincial forest administrations, absence of long-term financed projects and a clear forest policy from the government, and that continuity of plot measurements rely only under the responsibility of researchers. The study of the long-term plots allowed: (i) to propose new harvesting systems by maximizing yield and improving conservation value of managed forests (e.g., variable retention and silvopastoral systems), (ii) to determine the economical feasibility of the intermediate treatments, (iii) to define base-lines and impacts of different silvicultural treatments, (iv) to propose a wide spectrum of monitoring methodologies and establish demonstrative areas of forest management, and (v) to provide areas and knowledge to train professionals in forest management and biodiversity conservation practices. The surviving permanent plots in *Nothofagus* forest in South Patagonia and the obtained information could be used as a starting point to define a regional nucleus that could participate in the International Long Term Ecological Research to improve the use of native forests.

Key words: biodiversity, monitoring, *Nothofagus* forests, private companies, silviculture.

RESUMEN

Argentina ha basado su economía en la agricultura y el ganado, donde el bosque ha sido visto como un obstáculo para el desarrollo. La cosecha forestal en Patagonia Sur ha sido una actividad basada en la colonización y explotación de nuevas áreas. Ésta se realiza principalmente en bosques primarios sin ningún manejo silvícola posterior. A pesar de que el manejo actual no es sustentable, la investigación científica ha definido las bases para conservar, proteger y mejorar las propuestas de manejo forestal para los bosques nativos de Patagonia Sur. Las primeras parcelas de estudio a largo plazo (1965-1966) basaron su monitoreo en parámetros económicos y estructura forestal, estableciéndose cerca de veinte

parcelas en bosques fiscales de Tierra del Fuego. La mayoría fueron destruidas o discontinuadas debido a la falta de planificación del uso de la tierra, escaso interés social en la investigación, falta de compromiso de instituciones, y poca colaboración con empresas forestales. Posteriormente, un segundo grupo de nueve parcelas se estableció en Patagonia Sur (1993-2004) basado en la colaboración entre empresas privadas e instituciones nacionales. Los objetivos incluyeron parámetros económicos y ecológicos. Las parcelas se establecieron en tierras privadas conjuntamente con empresas privadas y estancieros, mediante la firma de acuerdos y proyectos de investigación. Los principales problemas encontrados fueron: falta de compromiso de las administraciones forestales, ausencia de proyectos financiados a largo plazo, y que la responsabilidad de las parcelas continúa bajo la iniciativa personal de los investigadores participantes. El estudio de las parcelas permitió: (i) proponer nuevos sistemas de regeneración basados en la maximización del rendimiento y el mejoramiento del valor de conservación de los bosques manejados (e.g., retención variable y sistemas silvopastoriles), (ii) determinar la factibilidad económica de aplicación de tratamientos intermedios, (iii) determinar líneas base y definir los impactos de distintos sistemas silvícolas, (iv) proponer metodologías de monitoreo de amplio espectro y establecer áreas demostrativas de manejo, y (v) proveer áreas y conocimientos para entrenar profesionales en prácticas de manejo forestal y conservación de la biodiversidad. Las parcelas permanentes ya establecidas en los bosques de *Nothofagus* de Patagonia Sur y las bases de datos obtenidas podrían servir como punto de partida para definir un núcleo regional que pueda participar en el International Long Term Ecological Research para asegurar el uso sustentable de los bosques nativos.

Palabras clave: biodiversidad, bosques de *Nothofagus*, compañías privadas, monitoreo, silvicultura.

COLONIZATION AND FOREST RESOURCES EXPLOITATION IN SOUTH PATAGONIA

Historically Argentina has based its economy in agriculture and cattle production, seeing the forests as one of the main obstacles for future development. In South Patagonia, removal of forests followed by fires and substitution to grasslands was recognized as an adequate practice at the beginning of the last century (Rothkugel 1916) although later this was described as incompatible practices for sustainable forest management (Alfonso 1942, Cozzo et al. 1967, Alonso et al. 1968).

First forest harvestings in South Patagonia were carried out by clear cuts (Peri et al. 2002, Gea et al. 2004), combined with high livestock grazing. After that, other silvicultural methods were proposed (Costantino 1950), but they were always driven by economical rules to maximize benefits and minimize costs (Alfonso 1942). Beside this, forest harvesting in South Patagonia has been an activity based on colonization and exploitation of new areas (Martínez Pastur & Lencinas 2005). Harvesting is mainly carried out in old-growth forests without silviculture management after first cuts. In contrast, during the last decade of the last century a change in the forest management framework was proposed (e.g., Franklin et al. 1997), where ecological and social values acquired greater significance in the design of the new silvicultural proposals (Martínez Pastur & Lencinas 2005, Peri et al. 2005, Peri 2005, 2006, González et al. 2006).

FOREST RESEARCH IN ARGENTINA AND SOUTH PATAGONIA

Forest research in Argentina was related at the beginning with the Forest Administration. However,

the Forest Administration was affected by several changes over time, varying their functions and objectives according to national and regional policies. The first published works in South Patagonia (e.g., Alfonso 1942) were carried out for the "*Sección Técnica de Bosques*" that was founded in 1932 as a part of the "*Dirección de Tierras - Ministerio de Agricultura de la Nación*". This organization worked under the advice of foreign researchers, most of them from Croatia. Later, the "*Dirección Forestal de la Nación*" (1943) and the "*Administración Nacional de Bosques*" (1948 - National Law N° 13,273) proposed planning management of public forest under a sustainability criterion and to fully supply national markets (Piterbarg 1965). These objectives promoted research in all native forests of the country and particularly in Patagonia, with the support of National Universities (e.g., Costantino 1950, Cozzo et al. 1967, 1969, Alonso et al. 1968). This research agreement continued with the successive forest administrations (e.g., Mutarelli & Orfila 1971, 1973), through the "*Servicio Forestal Nacional*" (1968), the "*Servicio Nacional Forestal*" (1969) and the "*Instituto Nacional Forestal*" (IFONA) (1973 - National Law N° 20,531). IFONA led forest research in South Patagonia until their dissolution in 1991.

After this point, several national institutions, as "*Instituto Nacional de Tecnología Agropecuaria*" (INTA), "*Secretaría de Recursos Naturales y Ambiente Humano*" (1991 - National Decree-Law N° 2,419) renamed as "*Secretaría de Ambiente y Desarrollo Sustentable de la Nación*" (SAyDS), "*Consejo Nacional de Investigaciones Científicas y Técnicas*" (CONICET), "*Administración de Parques Nacionales*" (APN), National Universities, as well as several regional institutions and research centres (e.g., "*Centro de Investigación Forestal*", "*Corporación Forestal Neuquina*" or "*Centro de Investigación y Extensión Forestal Andino Patagónico*") continued the research

related to forest issues in Patagonia. In this context, the project “*Investigación Aplicada a los Recursos Forestales Nativos - PIARFON*” created by the SAYDS, established new foundations for long-term forest management research in Patagonia through a specific agreement for 15 years between national institutions and ranch owners.

ESTABLISHMENT OF PERMANENT PLOTS IN SOUTH PATAGONIA: LESSONS FROM THE PAST

Beyond the forest mismanagement which characterized harvesting in South Patagonia, the forest research programs defined the scientific basis to conserve, protect and improve the management of native forests (Costantino 1950, Piterbarg 1965, Mutarelli & Orfila 1969). The first long-term study permanent plots (Table 1, Fig. 1) based the monitoring plan on economic and forest structure parameters (e.g., total volume and age structure of the stands, quantity and quality of harvesting volume).

The main objectives attempted to transform the old-growth forests toward normal-stage managed forests (secondary stands) (Cozzo et al. 1967, 1969). The selected stands represented the full forest cycle, including the entire age gradient, to obtain results in a short-medium time period (Mutarelli & Orfila 1969). Near twenty permanent plots were established in Tierra del Fuego in public forests, including several management objectives: (i) Feasibility of regeneration methods (e.g., clear-cuts and high grading cuts), (ii) intermediate treatment implementations (e.g., thinning treatments), (iii) fences to avoid livestock grazing, and (iv) plantations of exotic forest species (e.g., *Pseudotsuga menziesii* [Mirb.] Franco).

These first plots were established in *Nothofagus pumilio* (Poepp. & Endl.) Krasser and *N. betuloides* (Mirb.) Oersted stands, near to harvested stands and sawmills during the 1960s (Table 1, Fig. 1). Most of these plots (Laguna Negra, Lapataia, Ensenada, Lago Roca and Cañadón del Toro) were established in Tierra del Fuego National Park (National Law N°

TABLE 1
Long-term forest management study plots in *Nothofagus pumilio* forests of South Patagonia.
Parcelas de estudio de manejo forestal a largo plazo en bosques de *Nothofagus pumilio* en Patagonia Sur.

Plot	Year	Species	Management objectives	Province
Laguna Negra ^{1,3}	1965	<i>N. pumilio</i> and <i>N. betuloides</i>	Thinnings	Tierra del Fuego
Río Tristen - Vega Café ^{1,3}	1965	<i>N. pumilio</i>	Clear-cuts	Tierra del Fuego
Lago Roca ^{1,2,3}	1965	<i>N. pumilio</i> and <i>N. betuloides</i>	Regeneration cuts	Tierra del Fuego
Río Tierra Mayor ^{1,3}	1965	<i>N. pumilio</i>	Clear-cuts	Tierra del Fuego
Agua Blanca ^{1,3,4}	1965	<i>N. pumilio</i>	Clear-cuts, thinnings and prunnings	Tierra del Fuego
Monte Redondo ^{1,2,3}	1966	<i>N. pumilio</i>	Clear-cuts	Tierra del Fuego
Cañadón del Toro ^{1,3}	1966	<i>N. pumilio</i>	Thinnings and regeneration cuts	Tierra del Fuego
Lapataia - Ensenada ^{1,2,3}	1966	<i>N. pumilio</i> and <i>N. betuloides</i>	Thinnings	Tierra del Fuego
Lago Escondido ^{1,3}	1966	<i>N. pumilio</i>	Thinnings	Tierra del Fuego
Río Milnak ^{1,3}	1966	<i>N. pumilio</i>	Thinnings	Tierra del Fuego
Moat Ranch ⁵	1993	<i>N. betuloides</i>	Thinnings	Tierra del Fuego
San Justo Ranch ⁶	1996	<i>N. pumilio</i>	Thinning method to reduce windthrow	Tierra del Fuego
Stag River Ranch	1996	<i>N. pumilio</i>	Thinnings under different overstory crown cover levels	Santa Cruz
San Justo Ranch - Stand 13 ⁷	1997	<i>N. pumilio</i>	Regeneration cuts	Tierra del Fuego
San Justo Ranch - Stand 4 ⁸	2001	<i>N. pumilio</i>	Regeneration cuts with variable retention	Tierra del Fuego
Tres Marías Ranch ¹⁰	2003	<i>N. antarctica</i>	Silvopastoral systems	Santa Cruz
Cancha Carreras Ranch ¹⁰	2003	<i>N. antarctica</i>	Silvopastoral systems	Santa Cruz
Los Cerros Ranch ⁹	2004	<i>N. pumilio</i>	Regeneration cuts with variable retention	Tierra del Fuego
Nibepo Aike Ranch ¹⁰	2004	<i>N. antarctica</i>	Silvopastoral systems	Santa Cruz

¹ Cozzo et al. (1967), ² Cozzo et al. (1969), ³ Mutarelli & Orfila (1969), ⁴ Martínez-Pastur et al. (2001), ⁵ Martínez-Pastur et al. (2002a), ⁶ Peri et al. (2002), ⁷ Martínez-Pastur et al. (1999), ⁸ Martínez-Pastur et al. (2009), ⁹ Martínez-Pastur et al. (2007), ¹⁰ Peri et al. (2005).

15,554), where further silviculture interventions of these stands were not possible because of their location in the restricted areas. Other plots (Monte Redondo, Río Tristen, Vega Café and Tierra Mayor) were partially destroyed by a gas pipeline construction, and the remaining trials were included within a natural reserve with exclusive tourism use (1994 - Provincial Decree-Law N° 2,256). At the moment three plots remain intact, but only one (Agua Blanca plot) was under a continuous monitoring plan (Cozzo et al. 1967, 1969, Mutarelli & Orfila 1969). At the Agua Blanca plot (16 ha), the forest was harvested by clear-cuts (year 1965), and subsequently six different thinning treatments were applied on the established regeneration (year 1985). These treatments included classical (fixed distances and high-quality selection cuts) and non-traditional proposals (clear-cuts in strips with different orientations and clear-cuts using a checkerboard design). On these plots a second thinning intervention with prunnings were applied during the years 1999-2000 (Martínez Pastur et al. 2001).

The failure in most of these early long-term study

permanent plots were due to: (i) A lack of land use planning by the provincial government, (ii) insufficient interest of the society on environmental conservation and long-term forest research, (iii) a complete absence of commitment of the main scientific institutions, as well as forest resource administrations to finance long-term forest studies, and (iv) the scarce contribution from ranchers and sawmill owners. The responsible institutions of the establishment of the described plots (Table 1, Fig. 1) never implemented programs to ensure their maintenance and monitoring plan, leaving the continuity of measurements of these plots under the exclusive responsibility and initiative of each scientific researcher.

COLLABORATION VALUES BETWEEN COMPANIES AND RESEARCH INSTITUTIONS: CHALLENGES FROM THE PRESENT

After IFONA was dissolved, INTA established a forest research program in Patagonia, including a strong alliance with private forest companies. In particular,

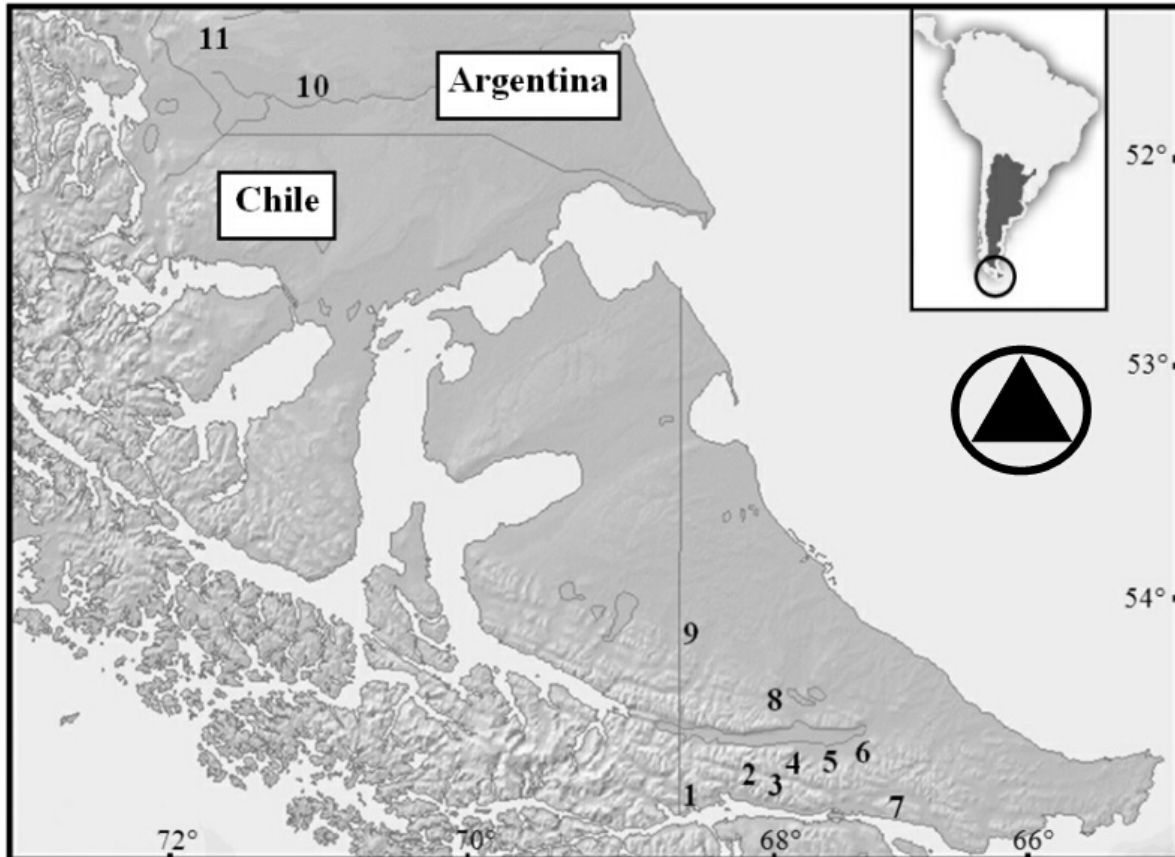


Fig. 1: Location of long-term research sites in the Argentine portion of South Patagonia.

Ubicación de las parcelas de investigación a largo plazo en el sector argentino de Patagonia Sur.

1 = Laguna Negra, Lago Roca, Cañadón del Toro, Lapataia and Ensenada; 2 = Río Tristen, Vega Café and Monte Redondo; 3 = Río Tierra Mayor; 4 = Lago Escondido; 5 = Río Milnak; 6 = Agua Blanca; 7 = Moat Ranch; 8 = Los Cerros Ranch; 9 = San Justo Ranch; 10 = Stag River Ranch; 11 = Tres Marías Ranch and Cancha Carreras Ranch.

at the middle of the 1990s a collaboration program was established in South Patagonia among national institutions (INTA and CONICET), national universities (Universidad Nacional de La Plata, Universidad Nacional de la Patagonia Austral and Universidad Nacional del Sur), ranchers and forest companies (sawmills and carpenter workshops). The primary objectives were to improve the economy of the forest companies by studying the biometry and forest yield during the harvesting processes (e.g., Martínez Pastur et al. 2000) and to define the feasibility of a long-term forest management in South Patagonia. For these reasons, a new network of long-term study permanent plots was established. The first plots were designed to study the most adequate silviculture practices in secondary forests of *N. pumilio* and *N. betuloides* (Table 1, Fig. 1) by the implementation of intermediate treatments through different thinning and pruning alternatives: (i) Moat Ranch (since year 1993) in 1 ha, (ii) San Justo Ranch (since year 1996) in 2 ha, and (iii) Stag River Ranch (since year 1996) in 2 ha (Martínez Pastur et al. 1997, 2001, 2002a, Peri et al. 2002). After that, a permanent

plot was established in San Justo Ranch - Stand 13 (since year 1997) in 2 ha to define most effective harvesting strategies and their impact over forest regeneration (Martínez Pastur et al. 1999). Through these plots it was possible to obtain valuable data to analyze the economical feasibility of different thinning treatments (e.g., Fig. 2), or the effectiveness of a silvicultural practice, in example, a shelterwood cut using the remnant overstory and seedling bank dynamics (establishment, growth and mortality) as indicators (Fig. 3).

During the last ten years, some forest companies began to analyze the feasibility of participation in new international markets, but first they needed to certify their activities (e.g., Forest Stewardship Council). In this context, several studies were carried out in *N. pumilio* forests by analyzing forest management impact on biodiversity (Deferrari et al. 2001, Spagarino et al. 2001, Martínez Pastur et al. 2002b), as well as their compartmentalization at the landscape level (Lencinas et al. 2007, 2008a, 2008b). As a consequence, long-term agreements were signed in order to study the feasibility of implementation of

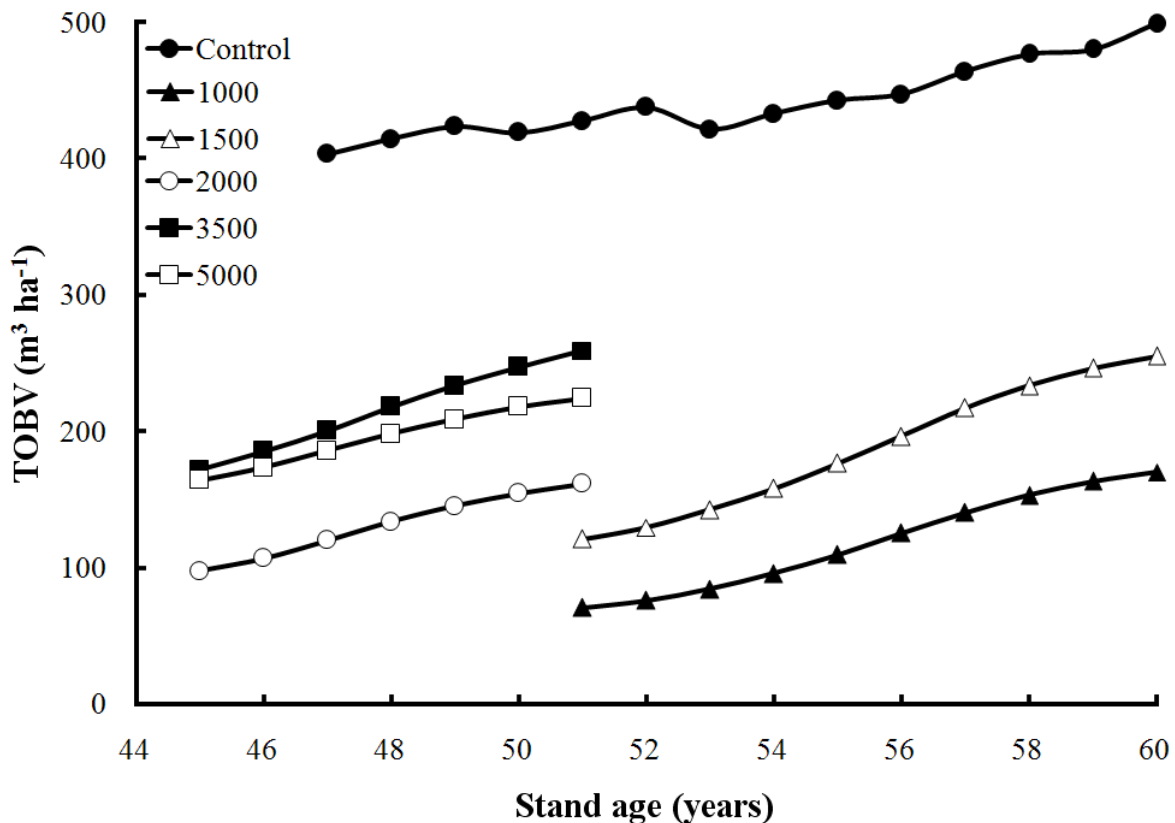


Fig. 2: Example of data obtained in long-term research plots: total over bark volume (VTCC) of thinned (1,000 to 5,000 trees ha⁻¹) and control unthinned stands in *Nothofagus betuloides* forests of Ea. Moat plot (Tierra del Fuego - Argentina) (data from 45 to 51 years of the stand were published in Martínez-Pastur et al. 2002a and from 51 to 59 years of the stand are unpublished data).

Ejemplo de datos obtenidos en parcelas de estudio a largo plazo: volumen total con corteza (VTCC) de rodales raleados (1,000 a 5,000 árboles ha⁻¹) y testigo en bosques de *Nothofagus betuloides* en Ea. Moat (Tierra del Fuego - Argentina) (los datos desde 45 a 51 años del rodal está publicado en Martínez Pastur et al. 2002a y desde 51 a 59 años del rodal son inéditos).

different silviculture alternatives such as variable retention in forests of San Justo Ranch - Stand 4 (since year 2001) in 61 ha (Martínez Pastur et al. 2009), focusing mainly on measurements of biodiversity variables (Ducid et al. 2005, Lencinas et al. 2007, 2008c, 2009). Finally, a large plot was established in Los Cerros Ranch (since year 2004) in 70 ha of native forests to analyze long-term implementation of a variable retention system into the planning of a middle size forest company (Kareken Sawmill) and with the support of the PIARFON project of SAYDS and the Agencia Nacional de Promoción Científica y Tecnológica (Argentina).

Similar to the *N. pumilio* trend, during the last years, the interest to attain a sustainable use of *N. antarctica* (Foster) Oerst. forests increased significantly in Patagonia (Peri et al. 2005, Peri 2005, 2006). Three long-term study research plots were established to monitoring the silvopastoral management, analyzing different thinning intensities, the improving of understory grass production, livestock carry capacity, and to provide strategies to preserve the native tree strata over time: (i) Tres Marias Ranch (since year 2003) in 6 ha, (ii) Cancha Carreras Ranch (since year 2003) in 16 ha, and (iii) Nibepo Aike Ranch (since year 2004) in 5 ha, the latter plot was established during the PIARFON project of SAYDS (Peri et al. 2005).

The design of these network plots considered the lessons from the past, trying to improve the feasibility

of the monitoring plan in the future: (i) The new plots were established on private lands, (ii) location, design and establishment of permanent plots were carried out together with private companies and ranch owners, (iii) several agreements were signed between national institutions for the study and monitoring of the permanent plots, (iv) joint venture projects were financed between national institutions and private companies in a short-term period to survey the data of the monitoring plan, and (v) a campaign to increase the awareness of the importance of long-term forest studies was implemented for sawmills, ranch owners and foresters. The main limitations found in the process were: (i) the lack of commitment from the government (e.g., Provincial Forest Services), (ii) the absence of long-term financed projects (> 5 years), and (iii) the responsibility for the continuity of plots monitoring relies on the exclusive initiative of the researchers. Finally, it is important to highlight that most of the permanent plot studies compare variable values before and after the silvicultural practices (Before-After-Control-Impact or BACI approach) to determine the extent of variation in biodiversity prior to the implemented treatment (Wardell-Johnson & Williams 2000, Watherhouse & Armleder 2007).

LONG-TERM STUDIES IN FOREST MANAGEMENT OF SOUTH PATAGONIA

The monitoring of permanent plots included

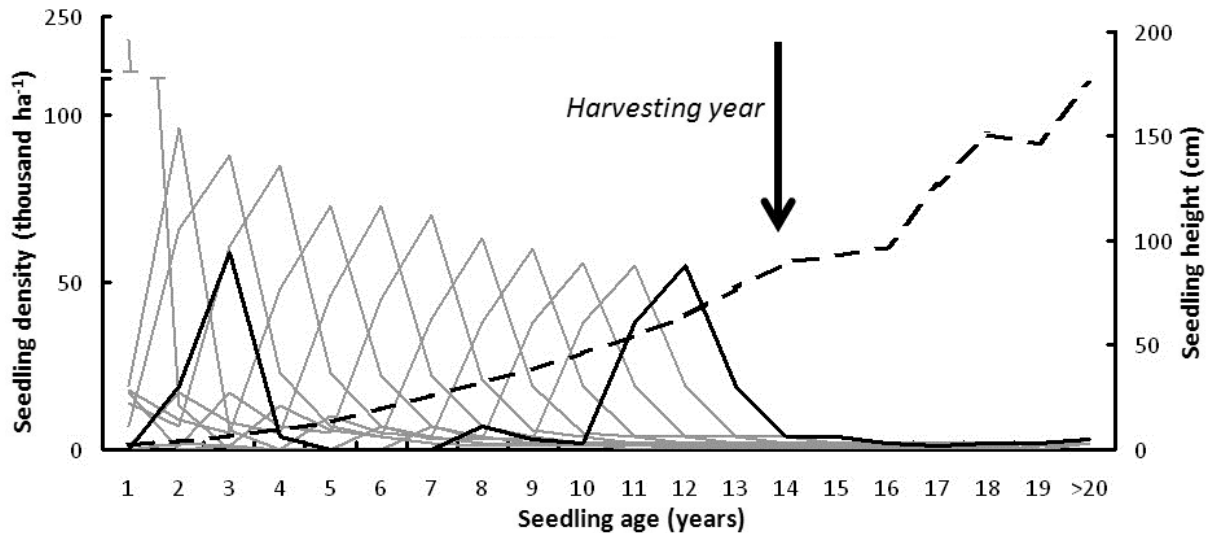


Fig. 3: Example of data obtained in long-term research plots: age structure of *Nothofagus pumilio* seedling bank in a harvested stand 13 years ago in San Justo Ranch - Stand 13 (Tierra del Fuego - Argentina). Black line = seedlings age structure in year 2009, grey lines = seedlings age structure in years 2001-2008, dotted line = seedling height. Arrow indicates the harvesting date, where seedlings density data at the right of the arrow were established prior to harvesting (unpublished data).

Ejemplo de datos obtenidos en parcelas de estudio a largo plazo: estructura de edades del banco de plántulas en un bosque de *Nothofagus pumilio* cosechado hace 12 años en la Ea. San Justo - Rodal 13 (Tierra del Fuego - Argentina). Línea negra = estructura de edades de la regeneración en el año 2009, líneas grises = estructura de edades de la regeneración en los años 2001-2008, línea punteada = altura de las plántulas. La flecha indica el año de la cosecha, donde las plántulas que aparecen a la derecha de la flecha se establecieron previo a la corta (datos inéditos).

economic, silvicultural and ecological parameters (Table 2). The economic and silvicultural parameters were: (i) tree and stand growth in managed and unmanaged stands (e.g., Moat Ranch) (Fig. 2) under different overstory crown classes (e.g., Stag River Ranch), or with different economical alternatives implementation including prunnings (e.g., Agua Blanca), or proposals to reduce the wind-throw risks (e.g., Ea. San Justo), or silvopastoral systems applications (e.g., Tres Marías Ranch, Cancha Carreras Ranch, Nibepo Aike Ranch) (Martínez Pastur et al. 2001, 2002a, Peri et al. 2002, 2005); (ii) harvesting yield for sawmill or firewood-pole yield in secondary forests (e.g., San Justo Ranch) and old-growth forests harvested by using shelterwood cuts (e.g., San Justo Ranch - Stand 13), variable retention (e.g., San Justo Ranch - Stand 4) or the application of silvopastoral systems (e.g., Tres Marías Ranch, Cancha Carreras Ranch, Nibepo Aike Ranch) (Martínez Pastur et al. 1999, 2009, Peri et al. 2002, 2005); and (iii) remnant overstory dynamics after harvesting (e.g., San Justo

Ranch - Stand 4 and Stand 13, Los Cerros Ranch, Nibepo Aike Ranch) (Peri et al. 2005, Martínez Pastur et al. 2007, 2009).

The ecological parameters included: (i) flowering and seeding patterns, as well as regeneration dynamic in shelterwood cuts, variable retention and silvopastoral systems along crown cover gradients (e.g., San Justo Ranch - Stand 4 and 13, Los Cerros Ranch) (Fig. 3), and water soil contents (e.g., Tres Marías Ranch, Cancha Carreras Ranch, Nibepo Aike Ranch) (Martínez Pastur et al. 1999, 2007, 2008, Peri et al. 2005); (ii) microclimatic variables measured by weather stations (Davis Weather Wizard III and accessories - USA) and data loggers (HOBO ONSET and Watchdog Spectrum - USA) to quantify air and soil temperatures, relative air humidity, wind speed and direction, rainfall and soil moisture (Watermark Spectrum - USA) (Peri et al. 2005, Martínez Pastur et al. 2007); (iii) biodiversity assesments, including birds, insects, vascular plants, ferns, mosses and fungi (Peri et al. 2005, Ducid et al. 2005, Lencinas et al.

TABLE 2
Research studies carried out in the current long-term plots of South Patagonia.
Investigación llevada a cabo en las actuales parcelas de estudio a largo plazo en Patagonia Sur.

Research studies	Plot									
	Agua Blanca	Moat Ranch	San Justo Ranch	Stag River Ranch	San Justo Ranch - Stand 13	San Justo Ranch - Stand 4	Tres Marías Ranch	Cancha Carreras Ranch	Los Cerros Ranch	Nibepo Aike Ranch
Thinning treatments	1985 P ¹	1993 P ²	1996 P ³	1996 P			2003 P ⁹	2003 P ⁹		2004 P ⁹
Prunning treatments	1999 P									
Natural forest stand dynamics	1999 P	1993 P ²	1996 P ³	1996 P						2004 P ⁹
Forest yield			1999 ³		1997 ⁴	2001 ⁵	2003 ⁹	2003 ⁹		2004 ⁹
Remnant overstory dynamics					1997 P	2001 P ⁵			2005 P ⁷	2004 P ⁹
Seed production						2002 P	2003 P ⁹	2003 P ⁹	2006 P ^{7,8}	2004 2006 ⁹
Regeneration dynamics					1997 P ⁴	2001 P	2003 P ⁹	2003 P ⁹	2004 P ⁷	
Microclimatic variables						2002 2005	2003 P ⁹	2003 P ⁹	2005 P ⁷	2004 2006 ⁹
Biodiversity					1997	2001 2005 ⁶	2003 P ⁹	2003 P ⁹	2005 P ⁷	2004 2006 ⁹
Pastures							2003 P ⁹	2003 P ⁹		2004 2006 ⁹
Eco-physiological studies							2007	2007	2005 P	
Litter production						2002 P	2003 P ⁹	2003 P ⁹	2006 P	
Nutrient cycles						2003 2007	2003 P ⁹	2003 P ⁹	2006 P ⁷	
Soil properties						2003 P	2003 P	2003 P	2006 P ⁷	

P = to the present (2008). Partial published results appear in: ¹Martínez-Pastur et al. (2001), ²Martínez-Pastur et al. (2002a), ³Peri et al. (2002), ⁴Martínez-Pastur et al. (1999), ⁵Martínez-Pastur et al. (2009), ⁶Ducid et al. (2005) and Lencinas et al. (2007, 2008c, 2009), ⁷Martínez-Pastur et al. (2007), ⁸Martínez-Pastur et al. (2008), ⁹Peri et al. (2005).

2007, 2008c, 2009, Martínez Pastur et al. 2007); (iv) pasture productivity for different silvopastoral system alternatives, site classes and shade conditions (e.g., Tres Marías Ranch, Cancha Carreras Ranch, Nibepo Aike Ranch) (Peri et al. 2005); (v) eco-physiological processes including photosynthesis, plant moisture stress, biomass partitioning and light requirements; and (vi) litter production, nutrient cycles (decomposition, mineralization and immobilization in N and P) and soil properties changes in variable retention treatments and silvopastoral systems (Peri et al. 2005, Martínez Pastur et al. 2007). Beside this, several abiotic and biotic variables were not included in the present sampling, but should be included for a better understanding of the analyzed treatments, e.g., fungi and lichens, non-vascular flora, ecology of affected species (e.g., coleopterons), mammals including bats, regeneration dynamics including inter-specific competition or facilitation, aquatic insects, water cycles, and social aspects of the economical proposed activities.

FINAL REMARKS

The forest industry plays an important role in the social-economic development of South Patagonia mainly in Tierra del Fuego (Mutarelli & Orfila 1969). Forest research programs in Argentina had demonstrated the feasibility for improving the sustainable use of *Nothofagus* forests by improving their regeneration, conservation and development and by stabilizing the industries in defense of the forest national patrimony (Mutarelli & Orfila 1973).

The study of long-term plots allowed: (i) To propose new harvesting systems by maximizing yield and improving conservation value of forests under management (e.g., variable retention and silvopastoral systems) (Martínez Pastur et al. 2009, Peri 2005, 2006), (ii) to determine the economical feasibility of intermediate treatment implementations, (iii) to define base-lines and impacts of different silvicultural treatments, (iv) to propose a wide spectrum monitoring methodologies and establish demonstrative areas of forest management, and (v) to provide areas and knowledge to train professionals in forest management and biodiversity conservation practices. The surviving permanent plots in *Nothofagus* forest in South Patagonia and the information obtained over the last 15 years could be used as a starting point to define a regional nucleus that could participate in the International Long Term Ecological Research (ILTER) to improve the use of native forests. However, the long-term research network implemented not includes the same sampling methodologies nor the same design and size. It is important to highlight the importance of the future sampling designs to make comparable the data taking in these network and other networks around the World.

The current network of long-term research plots is not enough to define the sustainable forest management proposals for all the forest types and environmental variability. However, these plots can provide good decision tools to propose new lineaments for an adaptive management in a wide spectrum of objectives (e.g., biodiversity conservation and timber production). Better understanding the results of existing long-term studies and also realizing the existence of permanent plots in Patagonia for future research will hopefully contribute to solve regional ecological and socio-economic challenges in the sustainable use of our native forests. However, research and administrative institutions, forest companies, ranches and sawmills must cooperate and have a sustained commitment to finance and maintaining these large unique long-term plots and research platforms.

ACKNOWLEDGEMENTS

To the sawmills and companies that contributed to long-term research in South Patagonia. To Ricardo Vukasovic (Servicios Forestales), Rosina Soler Esteban (CADIC), Horacio Ivancich (CADIC), Lucas Monelos (UNPA), Héctor Bahamonde (INTA), and Verónica Gargaglione (INTA) for active collaboration in the projects, and the organizers of the international workshop "Confronting global change with a network of long-term socio-ecological research sites in the south of the Americas" (MIDEPLAN ICM P05-002, CONICYT PFB-23).

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