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SOUTH AMERICAN DENDROECOLOGICAL FIELDWEEK 2016: EXPLORING DENDROCHRONOLOGICAL RESEARCH IN NORTHERN PATAGONIA

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ABSTRACT

The South American Dendroecological Fieldweek (SADEF) associated with the Third American Dendrochronology Conference was held in El Bolsón, Argentina, in March 2016. The main objective of the SADEF was to teach the basics of dendrochronology while applying specific knowledge to selected research questions. The course included participants and instructors from six different countries. This report describes activities of the course and briefly summarizes exploratory group projects. The

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Introductory Group developed an *Austrocedrus chilensis* chronology from 1629–2015 and documented a persistent decline in growth since 1977 which supports the fact that the current severe drought is the most severe in the 386-year record. Based on regional *A. chilensis* chronologies from 32° to 39°S Latitude, the Stream Flow Reconstruction Group developed a regional 525 year-long reconstruction from Río Chubut and found the most severe drought episodes from 1490 to the present occurred from 1680–1705, 1813–1828, 1900–1920, 1993–2002, and from 2011 to the present. The Drought Reconstruction Group used *A. chilensis* annual tree-ring width chronologies to develop preliminary spatial field reconstructions of the Palmer Drought Severity Index spanning the Central Andes region. The reconstructions explain up to 81% of the 1907–1975 PDSI variance, indicating this tree species is powerful for informing on historical drought especially in very arid domains. The Dendroecology Group documented three spreading fires since the 1850s with a 12-year return interval but lack of fire for the last 94 years; they also documented a persistent decline in their chronologies in recent years, dating back to 1965.

Keywords: fieldweek, South America, dendroclimatology, dendroecology, dendrochronology.

INTRODUCTION

Tree-ring analyses address many important scientific questions regarding climate (Cook *et al.* 2004; Tardiff *et al.* 2006; Villalba *et al.* 2012), ecology (Speer *et al*. 2001; Daniels and Veblen 2004; Amoroso *et al.* 2012; Srur *et al.* 2013), and human interactions with the environment (Stahle *et al.* 1998). The dating of tree rings to exact calendar years is one of the fundamental concepts of dendrochronology and it is necessary for assessing such research questions (Speer 2010). To approach these questions, there is a need for highly qualified personnel trained in dendrochronological skills: it is critical to be aware of standard and new methods to understand the most suitable techniques to apply for any given objective. Training junior scientists by offering intensive courses around the world is an important undertaking for the dendrochronological community (Speer 2006; Speer *et al.* 2006; Mundo and Suarez 2008; Touchan *et al.* 2013; Speer *et al.* 2016). Well-trained scientists produce reliable data, precise results and accurate interpretation of natural phenomena. Dendrochronology fieldweeks also help build the scientific community, stimulate new research, and potentially build chronologies that can be contributed to the International Tree-Ring Database (ITRDB; Grissino-Mayer and Fritts 1997).

To address these needs, a new South American Dendroecological Fieldweek (SADEF) was held in El Bolsón, Argentina, from 18 to 26 March 2016, in conjunction with the Third American Dendrochronology Conference - AmeriDendro 2016, which was held in Mendoza (Figure 1). The SADEF covered a range of dendrochronological issues, providing an intensive learning experience while exploring the Patagonian forests. The main goal of the SADEF was to offer a collaborative group experience for early-career scientists interested in tree-ring research through a "hands-on" approach to field and laboratory methods (*e.g.* Speer 2006; Speer *et al*. 2006; Mundo and Suarez 2008; Touchan *et al.* 2013; Speer *et al.* 2016). Hands-on research has been demonstrated to provide the best and deepest learning experience for all ages (Bransford *et al.* 1999; Donovan and Bransford 2005; Speer *et al.* 2006; McAllister and Speer 2014).

The course was hosted by the Sede Andina of the Universidad Nacional de Río Negro (El Bolsón) with the Tree-Ring Laboratory of the Instituto

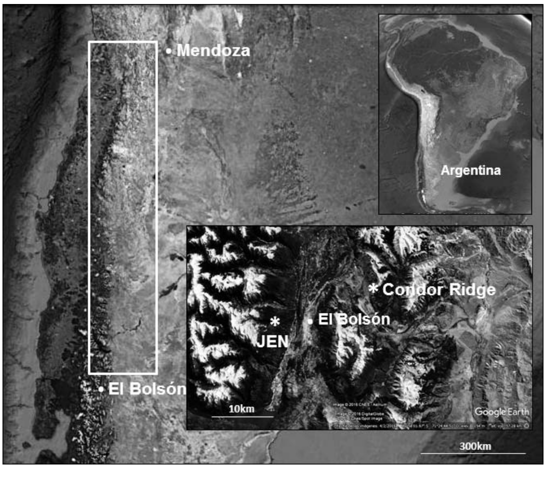


Figure 1. The fieldweek was in El Bolsón in northern Patagonia. The white rectangle is the area of the network of tree-ring chronologies for the hydrological and dendroclimate reconstructions, and the imbedded map shows the JEN and Condor Ridge sites.

Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA-CONICET). The course had a high teacher-to-student ratio, which facilitated knowledge transfer, and included 9 instructors and 17 participants from Argentina (10), United States (8), Canada (5), Brazil (1), Chile (1) and Mexico (1). The recent SADEF 2016 builds on previous Fieldweeks that have occurred irregularly in Patagonia over the past decades (see Mundo and Suarez [2008] for more information). The aim of this report is to describe the activities of the course and to summarize the results from these exploratory group projects.

Fieldweek Organization

The planning of the SADEF began during the initial meetings for the organization of the AmeriDendro 2016 conference inspired by the success of the 18th North American Dendroecological Fieldweek (NADEF), which took place in 2008 in conjunction with the first AmeriDendro in Vancouver, Canada. Local and international instructors were chosen to create a diverse group of experts as dendrochronological applications in addition to local knowledge of the ecosystems. The structure of the SADEF followed previous North and South American Fieldweeks as a 9-day workshop (*e.g.* Speer 2006; Speer *et al.* 2006; Mundo and Suarez 2008). It started with a short fieldtrip to familiarize the participants with ecology and history of the study area. The instructors divided in four groups, introduced the potential research projects and each participant joined the group in which they were the most interested (Table 1). While the first two groups (Introductory and Dendroecology) designed field methods to gather data, the two advanced groups (Dendroclimatology) focused on statistical analysis of previously collected samples.

GROUP PROJECTS

Condor Ridge: Independent Confirmation of the First *Austrocedrus chilensis* Chronology in Patagonia (Introductory Group)

Goal and Study Area

The Introductory Group's objective was to use standard dendrochronological techniques to develop a new *A. chilensis* chronology from living trees and deadwood. The group's goals were (i) conduct a test of Ed Schulman's first chronology of *A. chilensis* (1572–1949), which was based on four trees, (ii) explore the regional climate signal in the Condor Ridge *Austrocedrus* chronology, and (iii) provide a long-term tree-growth perspective on the recent megadrought in northern Patagonia. The study area, a dry ridge-top ("Condor Ridge"), was located 27 km northeast of El Bolsón (41°56′31″S, 71°22′24″W, 866 m a.s.l., Figure 1), and about 85 km south of Schulman's site at Cerro Leones (Schulman 1956). Forests in the area occur as monospecific *A. chilensis* patches of low-density or scattered trees, often on rocky outcrops, surrounded by Patagonian steppe.

Methods

The group sampled 30 radii from 19 *A. chilensis* living trees and cut cross sections from 6 pieces of remnant *A. chilensis* wood. The oldest and most climatically sensitive trees were found on the cliff-face, the ridge-top forests were heavily disturbed and dominated by younger trees. Deadwood was sampled to increase replication and to potentially extend the living chronology through accurate crossdating.

All samples were processed following standard dendrochronological methods (Stokes and Smiley 1968; Speer 2010), visually crossdated using skeleton plots and then measured using a Velmex measuring table to the nearest 0.01 mm. For exposure to additional techniques, some samples were scanned with a high-resolution scanner (Canon) before analyzing the high-quality images (2400 dpi) in CooRecorder (Cybis Elektronik 2010), which is a tree-ring width analysis software with WinDendro-like capabilities. The quality of the crossdating was assessed using the program COFECHA (Holmes 1983; Grissino-Mayer 2001).

The *A. chilensis* tree-ring series were analyzed using the statistical program ARSTAN (Cook and Krusic 2006). A spaghetti plot was created to show all series in one graph (data not shown for brevity), which showed how the floating chronologies obtained from relic deadwood were locked into the standardized living-tree chronology. ARSTAN was used to assess the statistical

Table 1. Research groups composition and project description.

Group and Project Title	Group Leaders	Students
Introductory: Condor Ridge: Independent confirmation of the first *Austrocedrus chilensis* chronology in Patagonia	Dave Stahle, Ana Srur, Jacques Tardif, France Conciatori	Eugenia Aciar, Anabela Bonada, Miriam Isaac-Renton, Juliana Magalhães, Pablo Meglioli, Rose Oelkers
Dendroecology: Fire impacts on vegetation dynamics in an *Austrocedrus/Nothofagus* forest in Patagonia	Mariano Amoroso, Lori Daniels, James Speer	Jennifer Haney, Milagros Rodriguez Caton
Dendroclimatology I: Stream flow reconstruction of Chubut river Argentina, using tree-ring series from *Austrocedrus chilensis*	Ricardo Villalba, Ed Cook	Julieta Arco, Eugenia Marcotti, María Sol Montepeluso, Marin Pompa, Pamela Soto
Dendroclimatology II: Drought analysis reconstruction in the Central Andes	Ed Cook, Ricardo Villalba	Bethany Coulthard, Amanda Young, Jessie Pearl, Johanna Robson

properties of the data, to graph the raw and detrended ring-width data, and to compute a standard ring-width index chronology (Figure 5a). A Signal Free chronology (Melvin and Briffa 2008; Cook *et al.* 2014) was also created to preserve medium frequency variance in the derived chronology (*i.e.* less than the average length of the individual dated and measured radii) using an age-dependent cubic smoothing spline (Cook and Peters 1981; Melvin *et al.* 2007; Figure 2b). To assess the relationship between the Condor Ridge chronology and climate, the Signal Free Condor Ridge chronology was uploaded to the KNMI *Climate Explorer* (http://climexp.knmi.nl/select.cgi?id=someone@somewhere&field=pdsi) and correlated with the December Palmer Drought Severity Index (PDSI; Dai *et al.* 2004) for 1981–2011, the time period believed to be covered by the

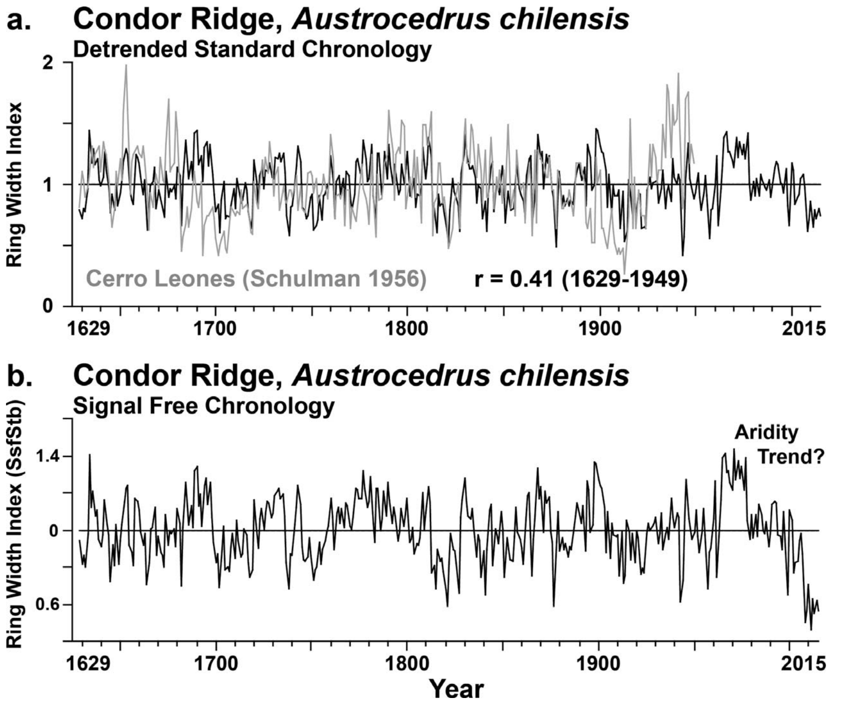


Figure 2. a. Comparison of the Condor Ridge and Cerro Leones standard chronologies developed in ARSTAN. b. The chronology computed with the Signal Free Method. Note the steep decline in growth during the past decade.

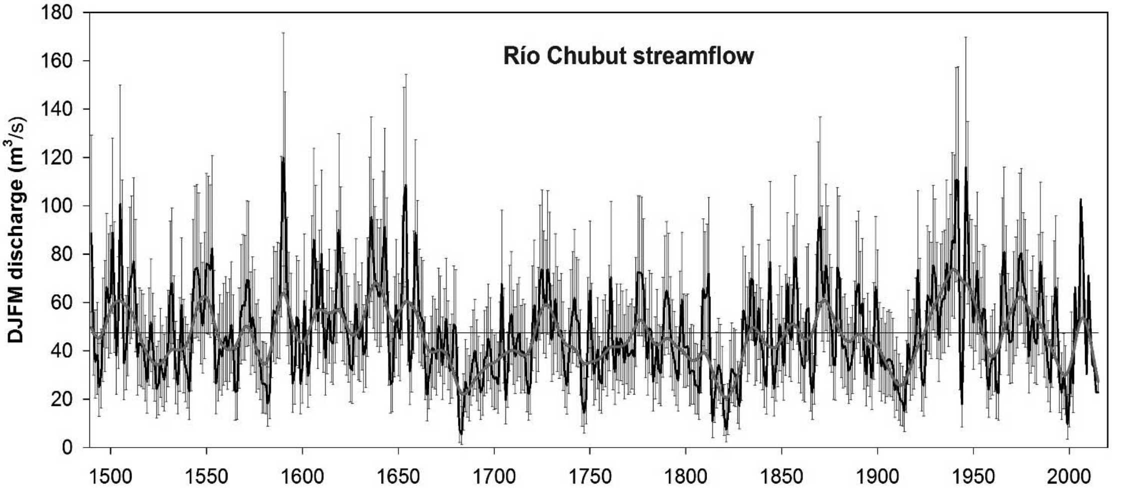


Figure 3. Reconstruction of December–March discharge at Los Altares gage station on the lower Río Chubut since 1490. The annual reconstruction (black) is shown with 32-year lowpass filtered smooth (grey) and the 90% MEBoot uncertainties (error bars) as described in the text. The long-term mean (48 m^3/s) is indicated by the horizontal line.

highest quality instrumental climate data for the region. The KNMI *Climate Explorer* is an online climate analysis platform (Trouet and van Oldenborg 2013) and was also used to generate gridded maps of South America to display the grid point correlations of the chronology with PDSI.

Results and Discussion

The Introductory Group developed a well replicated ring-width chronology dating from 1629–2015, including the successfully crossdated remnant wood (Figure 2a). The Condor Ridge chronology is correlated with Schulman's Cerro Leones 4-core chronology at r = 0.41 for the full common period of 1629–1949 (Figure 2a).

The correlation between the Signal Free Condor Ridge chronology and the December Palmer Drought Severity Index (PDSI) for 1981–2011 documents the strong regional climate signal in this new proxy. The strongest correlations are located in the vicinity of the collection site in Northern Patagonia and exceed r = 0.6 (not shown). The Signal Free chronology from Condor Ridge illustrates a dramatic decline in tree growth during the last decade. Continuous below-average growth was recorded at Condor Ridge from 2008–2015, but growth has fallen steadily from the decade of maximum growth that ended in 1977 (Figure 3b). The recent episode of dramatically suppressed growth coincides with severe drought across Patagonia (*e.g.* Garreaud *et al.* 2015), and appears to be unprecedented in the Condor Ridge chronology dating back to 1629. The Introductory Group noted the differences in the magnitude of the recent growth trend between the "empirically-detrended" standard chronology and the Signal Free chronology (Figure 2a, b). However, the Group decided that the sharp downward trend in the Signal Free chronology is a reasonable estimate of recent tree growth at Condor Ridge because of the extensive tree mortality (data not shown) apparent across the Condor Ridge collection site. The Signal Free chronology therefore seems to provide a better expression of the severity and persistence of the recent drought on radial growth and tree mortality at Condor Ridge.

Stream Flow Reconstruction of Chubut River, Argentina, Using Tree-Ring Series from *Austrocedrus chilensis* (Dendroclimatological Group I)

Goal and Study Area

Previous studies have demonstrated that tree-ring records from *A. chilensis* are useful as a proxy for reconstructing past hydrological variability in

South America (Villalba *et al.* 1998; Lara *et al.* 2008; Le Quesne *et al.* 2009; Mundo *et al.* 2012; Urrutia *et al*. 2015). Dendroclimatology Group I aimed to reconstruct the past stream flow variability of the Chubut River using 29 existing *A. chilensis* tree-ring chronologies from the North Patagonian Andes (Figure 1).

Methods

Based on geographical proximities, the 29 chronologies (see Villalba and Veblen [1997] and Villalba *et al.* [1998] for detailed information about the chronologies) were grouped into seven, well-replicated, regional chronologies. Chronologies were developed using the signal-free standardization method (Melvin and Briffa 2008, 2014), which enhances the common-dominant signal in tree-ring series. Four regional chronologies were selected as predictors of Rio Chubut discharge at Los Altares gage station (1943–2015) based on correlation analyses between the chronologies and stream flow. December–March streamflow was calibrated over the period 1964–2002 and verified over 1943–1963. The point by point regression (PPR) program (Cook *et al.* 1999; Cook *et al.* 2004) was used for calibration and verification of Rio Chubut stream flow reconstruction using a power transformation of tree-ring width data.

Results and Discussion

Precipitation-sensitive chronologies from *A. chilensis* were used to reconstruct streamflow changes of Río Chubut over the period 1490–2014 (525 years; Figure 3). The four regional chronologies explain 48.7% of the total variance in the December–March (*e.g*. the austral growing season spanning two calendar years) instrumental records of Río Chubut streamflow over the 1964–2002 calibration period. The PPR Program provided several options for developing tree-ring based reconstructions of hydroclimatic records. A bootstrap non-symmetric estimation technique was used to determine the Río Chubut reconstruction confidence intervals (Cook *et al.* 2013). Relationships between Standardized Precipitation Evapotranspiration Index (SPEI; Vicente-Serrano *et al.* 2010) and reconstructed streamflow data showed a synchrony between drought and low streamflow records; reduced flows are concurrent with low SPEI values during 1943–1944, 1978 and 2008–2009 (data not shown). Over the full reconstruction from 1490 to the present, the most severe drought episodes occurred from 1680–1705, 1813–1828, 1900–1920, 1993–2002, and from 2011 to the present. Spectral analysis of the reconstruction showed a dominant 85-year cycle explaining 32% of the total variance. The 85-year cycle has been reported in other streamflow reconstructions in Patagonia (Lara *et al.* 2008; Muñoz *et al*. 2016), suggesting the presence of a long-term persistent oscillation in regional climate likely induced by the adjacent Humboldt Current off the Chilean coast.

Drought Reconstruction in the Central Andes (Dendroclimatological Group II)

Goal and Study Area

Dendroclimatology Group II developed a preliminary spatial field reconstruction of drought, as measured by the Palmer Drought Severity Index (PDSI), for the Central Andes region of South America, using 19 *A. chilensis* chronologies from sites between 32°S to 39°S in the central Andes of South America (Figure 1) with an overlapping period ranging from 1823–1976 (see Villalba and Veblen [1997], Le Quesne *et al.* [2006, 2009] and Christie *et al.* [1998] for detailed information about the chronologies).

Methods

Tree-ring measurements were standardized and compiled using a variety of detrending methods with the programs ARSTAN ((Version 44h3) (Cook and Holmes, LDEO 2016)) and RCSsigfree (Melvin and Briffa 2008) to examine the stability of the low-frequency signal in the records. The final tree-ring chronologies were developed using signal-free standardization (Melvin and Briffa 2008, 2014) and an age-dependent spline as these methods retained the important low-frequency climatic variance. The PDSI gridded data spanned 49 grid points from 32°S to 39°S at 0.5° resolution (Dai *et al.* 2004). Exploratory point-by-point regression (PPR) and orthogonal spatial regression (OSR) models (Briffa *et al.* 1986; Cook *et al.* 1994) were evaluated using the tree-ring

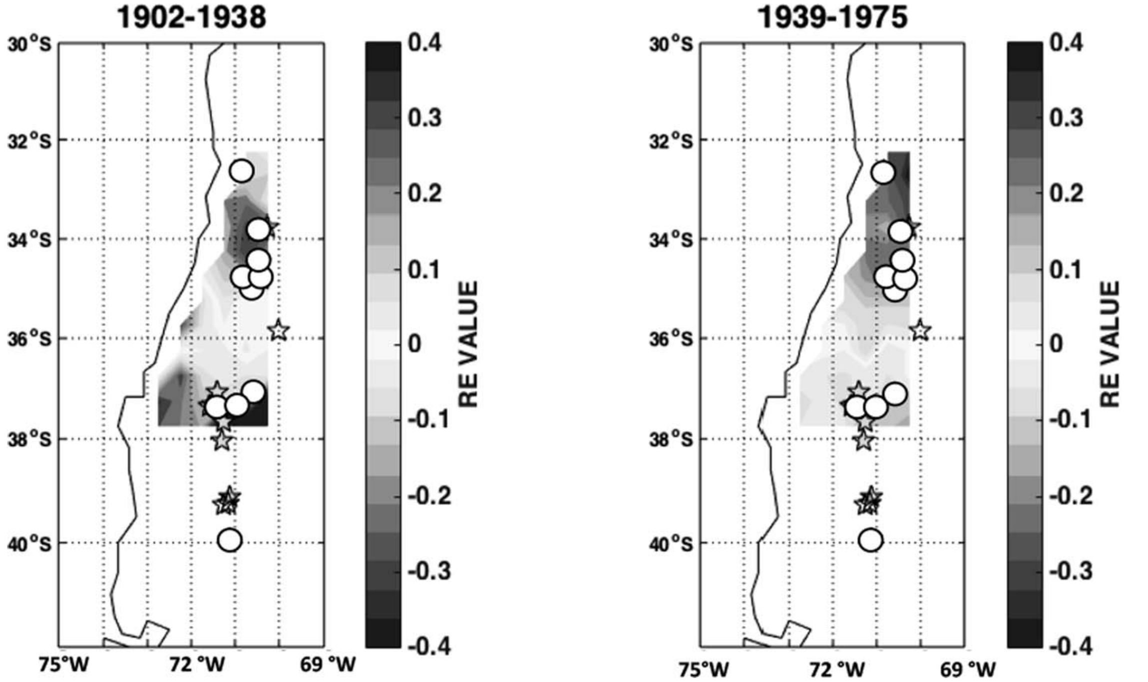
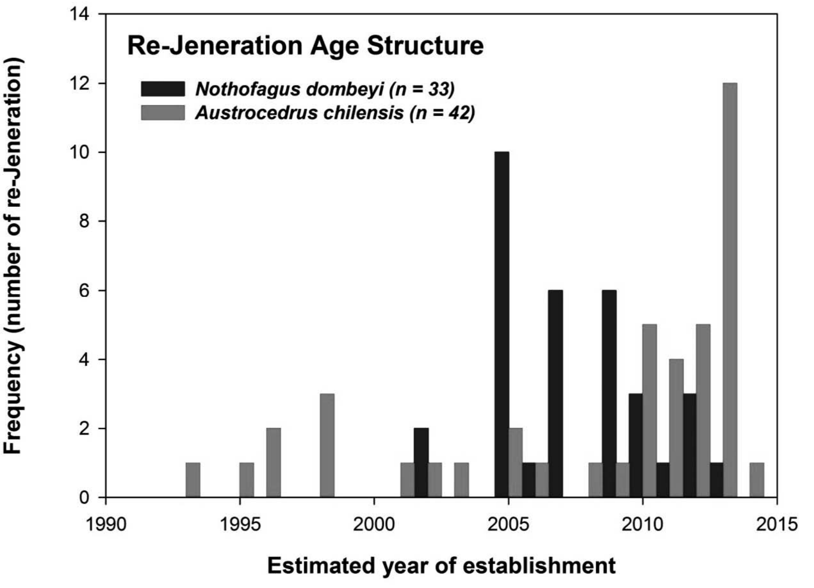


Figure 4. RE values for each grid cell, from the early- and late-period model verifications. The model is skillful in the northern grid points (positive RE values) and not in the southern grid points (negative RE values) in the shaded area 32°S–38°S. Grey stars: *A. chilensis* chronologies with negative reconstruction model beta values. Circles: *A. chilensis* chronologies with positive reconstruction model beta values. White Stars: *A. chilensis* chronologies that were not included in the reconstruction due to poor correlation with the predictand data.

chronologies as predictors and four 'test' seasons of PDSI data (DJF, MAM, JJA, SON; austral summer, fall, winter and spring), confirming that the tree-ring chronologies were most strongly correlated with gridded PDSI over the summer months. Differences in performance between the PPR and OSR methods were carefully evaluated based on individual model strength and validation statistics (*i.e.* R^2, Reduction of Error [RE]) and the overall number of summer PDSI gridpoints that were successfully reconstructed. Influences of model predictor pre-screening based on correlation with PDSI, the entry of 1-year lagged model predictors, and a random shock predictor prewhitening, were also explored.

Results and Discussion

This preliminary research demonstrated the excellent potential for using the annual ring-width records of *A. chilensis* trees for reconstructing drought in the Central Andres region using spatial field reconstruction. The OSR model was selected for the final reconstruction, mainly because of the comprehensive reconstruction coverage offered by the OSR method (all gridpoints). The gridded reconstructions of the PDSI explained up to 81% of the 1907–1975 PDSI variance, spanned the interval 1823 to 1975, and were only powerful over the northern, more arid portion of the target domain (*ca.* 32°S–35°S; Figure 4). The southern portion of the domain (*ca.* 35°S–38°S; Figure 4) could not be modeled using PPR, and was poorly modeled using OSR. However, OSR offered the capacity to quantify and visually present the southern portion of the domain. Tree-ring chronologies from outside of the spatial field reconstruction domain were used as predictors in the gridded reconstructions based on their sensitivity to similar regional climate variability (Figure 4). Positive beta coefficients of the predictors clustered in the north compared with negative beta values of those



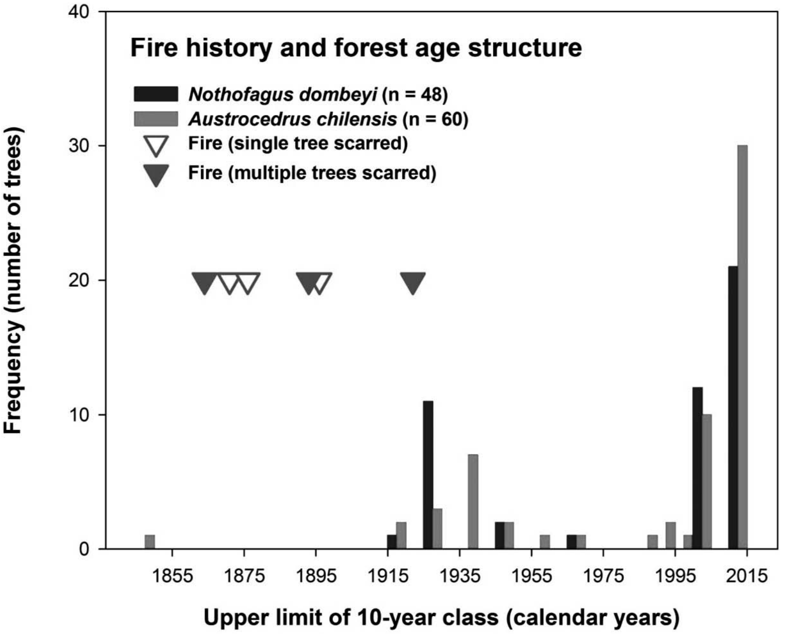


Figure 5. Fire history and forest demography of a mixed *Austrocedrus–Nothofagus* forest near El Bolsón. Fire-scarred trees were sampled in a 1ha circular plot and were generally older than the trees (dbh $\geq$ 5 cm) and regeneration of *Austrocedrus chilensis* and *Nothofagus dombeyi* sampled near plot center.

clustered in the south suggest the two chronology sets inform differently on PDSI in the target domain. The credibility of the reconstruction is enhanced by the model's ability to estimate abnormally wet conditions measured in 1905 and a historical drought measured in 1925, and the reconstruction of average drought anomalies from 2010 to 2012 differenced from the long-term mean PDSI is in line with current reports of ongoing regional drought.

Fire Impacts on Vegetation Dynamics in an *Austrocedrus–Nothofagus* Forest in Patagonia (Dendroecological Group)

Goal and Study Area

The Dendroecology Group studied the fire history and related forest dynamics of a single site in a mixed *Austrocedrus chilensis–Nothofagus dombeyi* forest. This study was motivated by the relative lack of research on fire history and dynamics in mixed-species forests and the lack of fire records for the area, and some particularly interesting local forests with fire-scarred trees and evidence of crown dieback in the mature trees. In the forests surrounding El Bolsón, *A. chilensis* forests form dense stands mixed with *Nothofagus* species, principally *Nothofagus dombeyi*. *A. chilensis* is a long-lived conifer that dominates on drier sites, while the broadleaf deciduous *N. dombeyi* dominates on moister sites. The relative proportion of *A. chilensis* is inversely related to site moisture and the distribution of *A. chilensis* reaches its highest altitudinal limit in these forests. The study was conducted on an upper-elevation site on a southeast-facing slope in the Area Natural Protegida Río Azul–Lago Escondido overlooking the city of El Bolsón (41°55′48″S, 71°34′17″W, 653 m a.s.l.) (JEN site in Figure 1).

Methods

The study plot was randomly located and the N-tree sampling design (Lessard *et al.* 2002) was used to sample 15 trees or snags (DBH $\geq$ 5 cm) each of *A. chilensis* and *N. dombeyi*; all regeneration of both species were collected in a circular plot with an 11.6-m radius. Using a chainsaw, partial sections were cut from living and dead fire-scarred trees within a 1 ha search area around the plot center.

All samples were processed following standard dendrochronological methods (Stokes and Smiley 1968; Speer 2010), visually crossdated using skeleton plots and then measured using a Velmex measuring table to the nearest 0.01 mm. The quality of the crossdating was assessed using the program COFECHA (Holmes 1983; Grissino-Mayer 2001). Ring-width series from the increment cores and fire-scarred veteran tree disks were combined in master chronologies for each species.

Crossdated fire scars, accurate at an annual level of resolution, indicated the years when fires burned and were used to compute fire intervals. Tree establishment dates were estimated from crossdated inner-ring dates; regeneration ages were from ring counts of multiple radii on basal disks. The age structure of the stand was represented using histograms with 10-year establishment classes. We used fire scar dates, stand age structure, and tree growth rates to reconstruct the stand history.

Results and Discussion

The Dendroecology Group found evidence of 6 fires, including three spreading fires in 1864, 1893, and 1922, which had significant effects on the forest dynamics (Figure 5). Most fire scars occurred in the late earlywood of annual rings, consistent with the occurrence of wildfires during mid-growing season droughts in the El Bolson region. The mean fire return interval was 12 years (range = 3–26 years), but it had been 94 years since the last fire, which was unusually long relative to observed fire intervals.

The majority of the stand established after the 1922 fire. *N. dombeyi* (456 ha^{-1}) established first, dominated the canopy and were larger in diameter (dbh = 41 $\pm$ 14 cm) than *A. chilensis* (355 ha^{-1}; dbh = 18 $\pm$ 18 cm) that lagged by a decade, on average and dominated the subcanopy. Recent regeneration of both species was triggered by a disturbance other than fire. Shattered trees and abundant dead wood are consistent with damage from a windstorm. The master chronologies for both *A. chilensis* and *N. dombeyi* showed declining growth since approximately 1965 (data not shown).

CONCLUSIONS

The SADEF provided an excellent opportunity for participants and instructors to intensively explore and study the fundamentals, applied knowledge, and cutting edge techniques in dendrochronology. For many participants this was their first experience in dendrochronology and for most of them the first time exploring the forests of Northern Patagonia. This learning ensures technical competency in future research, and this positive experience helps to promote continued interest in the discipline.

Although previous SADEF's have taken place in Patagonia, this was the first in El Bolsón and has some important legacies. A new tree-ring lab will shortly be established at the Sede Andina of the Universidad Nacional de Rio Negro and the Fieldweek provided an excellent opportunity to learn from the experience of other tree-ring labs, and promote more dendrochronological research at the university.

Overall, the findings from the Fieldweek, were extremely helpful in identifying areas of promising research. We developed an *A. chilensis* chronology from 1629–2015 that confirmed the dating of the first tree-ring chronology in Argentina that was made by Edmund Schulman in 1949. Furthermore, a persistent decline in growth since 1977 was documented, which is the most severe drought of their 386-year record. A regional 525-year-long chronology was developed from chronologies previously collected from 32°S to 39°S. The most severe drought episodes from 1490 to the present occurred from 1680–1705, 1813–1828, 1900–1920, 1993–2002, and from 2011 to the present. This record shows a strong 85-year cycle that is likely influenced by the nearby Humboldt Current off the Chilean coast. The current drought that was recorded at Condor Ridge starting in 1980 was also represented by two of the most extreme dry periods for Río Chubut in 1993–2002 and from 2011 to the present. This current event is harsh enough that we also documented forest decline in the mixed *A. chilensis* and *N. dombeyi* forest to the west of El Bolsón (JEN site). Corroborating these findings, the streamflow reconstruction documents extreme drought over much of northern Patagonia both at a site level and in a regional hydrological reconstruction of Río Chubut. This event starts around 1980 and is one of the most extreme dry episodes in the last 500 years. *A. chilensis* was confirmed as a suitable species for the development of spatial field reconstructions of PDSI in the central Andes Region. The preliminary gridded models range from no skill to very high skill and perform best in more arid settings. The reconstructions accurately capture historical wet and dry periods as well as the current and ongoing severe regional drought in the central Andes, and we anticipate these methods can be broadly applied across the species range. Natural disturbances are also important drivers of forest dynamics in Northern Patagonia. The dendroecological study at the wetter JEN site documented three spreading fires between 1850 and 1922 but none for the last 94 years; these are the first dendrochronological fire records for the area and samples obtained were archived at the university to expand future research. Regeneration pulses were noted after the fire events and the most recent regeneration pulse in the 20th Century seems to be due to a possible wind storm. Last, but not least, the relationships built among the participants at the Fieldweek remained during the AmeriDendro 2016 conference, both at presentations and social events. Participating in the Fieldweek helped some junior scientists feel more integrated into the "Dendro community" and these new connections also facilitate international research collaboration in future.

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