Cambios en el suelo post-fuego afectan plántulas de *Nothofagus* en Patagonia Sur

MJ Ruggirello[a], GN Bustamante[a], P Rodríguez[a], PZ Fulé[b], RM Soler[a]
[a]Centro Austral de Investigaciones Científicas (CADIC - CONICET). Ushuaia, Tierra del Fuego, Argentina.
[b]Northern Arizona University (NAU). Flagstaff, Arizona, United States

Contexto

Los incendios pueden producir cambios drásticos en las propiedades de los suelos forestales. En Tierra del Fuego, Argentina, estos cambios pueden acentuar ciertas limitantes naturales e impedir la regeneración natural de árboles nativos.

Objetivo

Objetivo: evaluar cambios en el suelo producidos por fuego y sus impactos sobre la regeneración de *Nothofagus antarctica* (ñire) y *N. pumilio* (lenga).

Métodos

- Se establecieron 192 parcelas (quemadas = 160, controles = 32) en incendios de ~1940, 1978, 2008 y 2019 en que se sacaron muestras de suelo y se registraron plántulas (<30cm) por hectárea (Fig. 1).
- Se analizaron las propiedades del suelo por edad de fuego con GLMM y se correlacionó la regeneración arbórea con dichas variables (Pearson (r)).

Figura 1. a) Recolección de suelo con cilindro; b) muestras de suelo secándose a T ambiente; c) determinación de materia orgánica en mufla a 500° C; d) determinación de pH.

Resultados

- La densidad del suelo fue 0,35 g/cm^3 mayor en suelos quemados que en los no quemados (F=15,31; p<0,001). La densidad del suelo fue 0,82 g/cm^3 mayor (F=3,82; p=0,01) y el pH 0,5 menor (F=20,62; p<0,001) en el incendio más reciente comparado con el más antiguo.
- La humedad (F<0,001; p>0,05) y materia orgánica (F=8,2; p <0,001) fueron mayores en el incendio de ~1940.
- La regeneración de ñire se correlacionó negativamente con la densidad de suelo (r= –0.57; p> 0,001) (Fig. 2) y positivamente con el pH (r=0,44; p>0,001), la humedad (r=0,6; p>0,001) y la materia orgánica (r=0,37; p>0,001).
- La regeneración de lenga se correlacionó negativamente con la densidad de suelo (r= – 0,24; p=0,02) (Fig. 2).

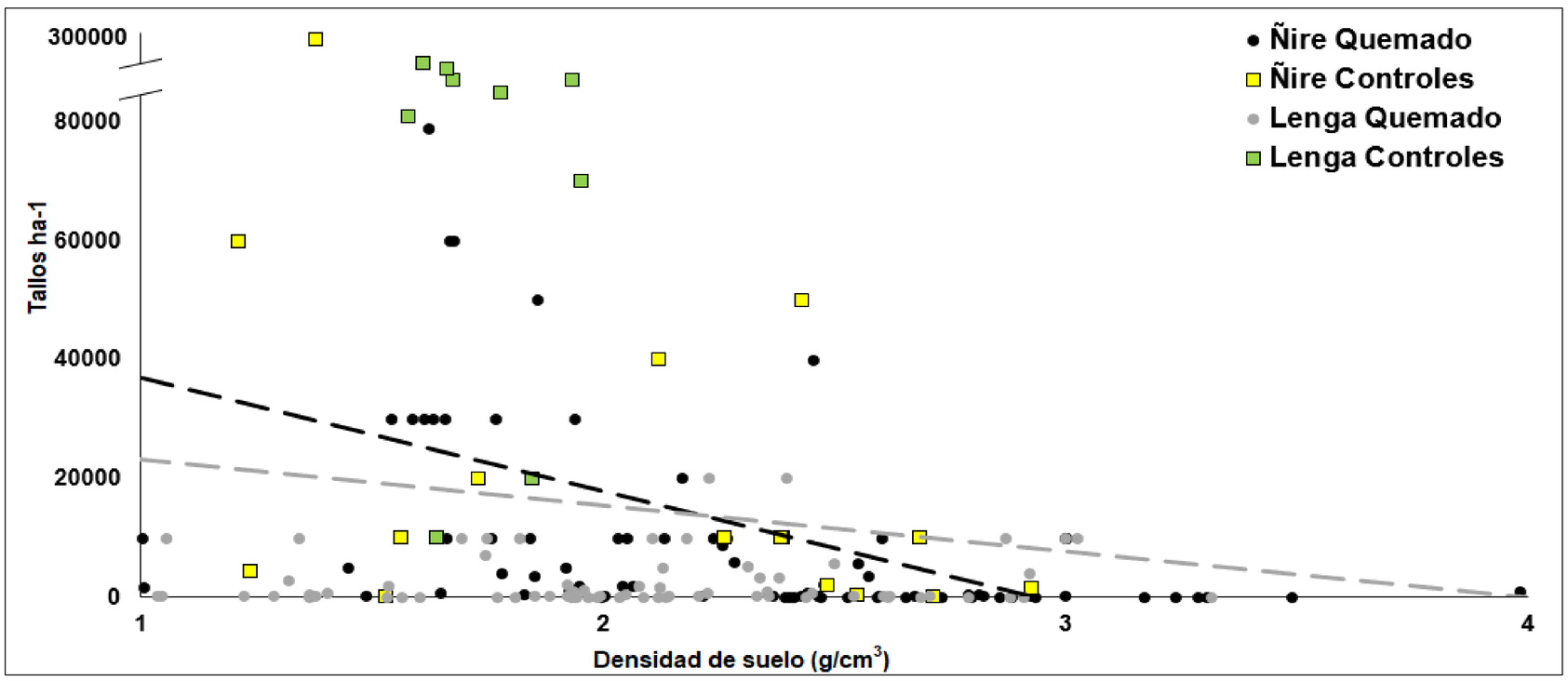

Figura 2. Densidad de plántulas (tallos.hectárea^{-1}) de ñire y lenga en parcelas quemadas y no quemadas (controles), según la densidad de suelo (g/cm^3). Las líneas representan la correlación para ñire (negra) y lenga (gris).

Conclusiones

La pérdida de estructura de suelo post-fuego incrementa la compactación del suelo, afectando negativamente la regeneración del bosque. Algunas propiedades del suelo se recuperan con el tiempo. En zonas quemadas, se deberían considerar estrategias para reducir la pérdida de estructura del suelo (por ej., cubriendo el suelo con mantillo) y aumentar la materia orgánica post-fuego.

8TH INTERNATIONAL WILDLAND FIRE CONFERENCE
GOVERNANCE PRINCIPLES: Towards an International Framework
www.wildfire2023.pt
Porto-Portugal May 16-19th 2023

Experimental post-fire restoration of *Nothofagus pumilio* and *N. antarctica* forests in Tierra del Fuego, Argentina

MJ Ruggiero*, GN Bustamante*, PZ Fulé**, RM Soler*
*Centro Austral de Investigaciones Científicas (CADIC - CONICET). Ushuaia, Tierra del Fuego, Argentina.
**Northern Arizona University (NAU). Flagstaff, Arizona, United States
*presenting author

Background

Wildfires in the native *Nothofagus* forests of Tierra del Fuego, southern Argentina, impede post-fire regeneration of *N. pumilio* (lenga) and *N. antarctica* (ñire). Densities are lowest in the interior of burned areas where microsites are dominated by grasses and forbs rather than leaflitter.

Objective and Methods

- Objective: test strategies to restore forest in burned areas.
- We collected 19,000 lenga and 36,000 ñire seeds from different provenance sources (fig. 1). We tested the viability of these seeds and selected the fullest individuals.
- In burned plots 30 and 270 m from the unburned forest edge and in unburned controls (n = 96), we selected five microsites per plot (bare soil, bush, grass/forb, leaflitter, woody-debris), and within a 20 cm^2 subplot at each microsite we removed naturally-deposited seeds and sowed 30 pre-selected ones.
- Seed germination was recorded in December, 2022, and survival was measured in March, 2023 (fig. 1). Germination differences between plot locations were analyzed using Fishers LSD Test. Total seedling mortality was correlated to mortality by microsite using the Pearson correlation coefficient (r).

Figure 1. Collecting ñire seeds (top), and a lenga seedling that survived the summer in the foreground of a burn scar (bottom).

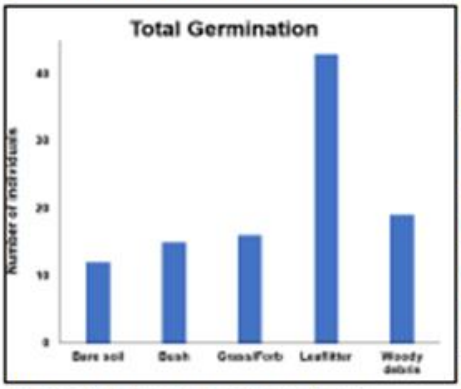

Figure 2. Total number (burned and unburned) of lenga seeds that germinated in different microsites by December, 2022.

Results

- 105 lenga seeds germinated (1.5%), 93 (3.9%) in unburned plots and 12 in burned plots (0.25%). No ñire seeds germinated.
- No seedlings in burned plots germinated in grass/forb microsites common post-fire. Nearly half of seedlings that germinated in control plots did so in leaflitter (fig. 2).
- Distance to fire boundary did not impact seedling germination, but total germination was significantly higher in control plots than burned plots ($F = 12.61$, $p < 0.001$).
- 54 seedlings survived through the summer. Total seedling mortality was most closely tied to mortality in grass/forb microsites ($r = 0.97$, $p = 0.001$). This correlation was weakest between mortality in leaflitter and total mortality ($r = 0.43$, $p = 0.2$)

Conclusions

Post-fire conditions are harsh for seedling germination and survival due in part to the ubiquity of grass- and forb-dominated microsites post-fire. This cannot be mitigated by sowing seeds in leaflitter, bare soil, or protected by bushes or logs. Restoration via seed sowing is likely a poor strategy. Continuing research should be directed at improving techniques for seedling transplantation or planting of greenhouse stock.

8TH INTERNATIONAL WILDLAND FIRE CONFERENCE
GOVERNANCE PRINCIPLES: Towards an International Framework
www.wildfire2023.pt
Porto-Portugal May 16-19th 2023

Determining burn severity and its impact on post-fire regeneration in the *Nothofagus* forests of Tierra del Fuego, Argentina

MJ Ruggiero, GN Bustamante, PZ Fulé*, RM Solar
*presenting author

Background

In southern Argentina, recent wildfires in *Nothofagus* forests have produced post-fire conditions commonly associated with high burn severity. Still, fire severity has not been systematically categorized in the region. We sought to test the relationship between simple field methods for determining burn severity and seedling regeneration densities.

Methods

- In two wildfires (2008 - "Lote 93" and 2019 - "Lenga Patagonia"), we established 80 burned and 16 unburned plots in *N. pumilio* (lenga) and *N. antarctica* (ñire) forests (fig. 2). We estimated burn severity, measured live tree basal area, estimated bare-ground cover, and tallied seedlings. The "Lote 93" fire was lenga-dominated and "Lenga Patagonia" was ñire-dominated.
- Plots were classified as high severity (>90% overstory mortality, >50% bare ground), not high severity (<90% overstory mortality, <50% bare ground, presence of fire scars on live trees (fig. 1)), or as unburned. Bare-ground criteria were only used in the 2019 fire.
- Seedling density was correlated to burn severity, bare-ground cover, and live basal area using Pearson's correlation coefficient (r). We fit GLMM to determine the effect of burn severity on seedling density.

Figure 1. Fire scars in lenga (left) and ñire (right).

Figure 2. High-severity burn patches in ñire (top) and lenga (bottom) forests.

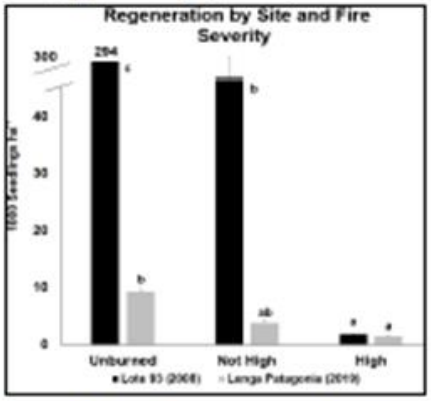

Figure 3. Seedling regeneration by site and burn severity; bars = S.E.

Results

- Of burned plots, 71% burned at high severity and 29% did not.
- Live basal area increased from 0 m^2ha^{-1} in high-severity plots, to 5 m^2ha^{-1} in not high severity plots, to 41 m^2ha^{-1} in controls.
- Bare-ground covered 57% of high-severity plots, 27% of not high-severity plots, and 0.5% of controls (2019 fire only).
- Seedling density was negatively correlated with visual estimates of burn severity ($r = -0.43$, $p < 0.0001$) (fig. 3) and bare-ground cover ($r = -0.19$, $p = 0.06$), and was positively associated with live basal area ($r = 0.48$, $p < 0.0001$).

Conclusions

Burn-severity classifications will be recategorized using the Composite Burn Index (CBI) for comparison and to incorporate moderate-severity fire. Field date will also be used to calibrate burn severity band ranges for the Normalized Burn Ratio (NBR). Still, simple field delineation of plots into high severity and not high severity categories correlated well with seedling regeneration. To maximize limited restoration resources, field estimates of burn severity should be used to inform planting decisions. Areas with high overstory mortality, dominated by bare ground should be prioritized in post-fire restoration efforts.