

Article

Post-Fire Abiotic and Biotic Filters Limit Native Grassland Recovery in a *Pinus pinaster* Plantation

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Abstract

Fires are an ecological force that often mediates the balance between native and exotic plants in communities. We monitored post-fire vegetation dynamics in a *Pinus pinaster* plantation and adjacent grasslands 9, 15, and 18 months after the fire, evaluating structural and compositional changes through multivariate analyses. The invasive alien *Acacia longifolia* cover increased significantly in the plantation ($p = 0.0006$), while pine needle cover declined significantly ($p = 0.0027$), and *P. pinaster* cover did not change significantly over time ($p = 0.063$), although it showed an increasing trend towards the late stage. Both *A. longifolia* and pine needles were negatively associated with native species cover. Native cover remained consistently higher in continuous grasslands, with a significant Time $\times$ Site interaction. Post-fire succession in the plantation was associated with sequential abiotic and biotic filters, and the increase in *A. longifolia* may have contributed to reduced native recovery through competitive effects. These results suggest that fire alone may be insufficient to restore native grassland conditions within afforested systems and that early post-fire control of *A. longifolia* may be necessary to redirect succession.

Keywords: post-fire succession; ecological filters; forest plantations; grassland recovery; invasive species; *Acacia longifolia*

1. Introduction

Grasslands are among the most threatened terrestrial biomes worldwide, with significant rates of habitat loss and insufficient effective protection. This situation compromises both biodiversity and key ecosystem services, including carbon sequestration, genetic resources, soil conservation, and hydrological regulation [1–3]. In southeastern South America, grasslands have been extensively transformed by agricultural expansion and other anthropogenic drivers that reduce their extent and increase habitat fragmentation [4,5]. The replacement of native grasslands by forest plantations has led to marked shifts in vegetation composition, reductions in species richness, and the loss of native grasslands [6–8].

In Argentina, relatively well-preserved grassland remnants are largely restricted to areas of low agricultural suitability, such as the coastal dune systems of Buenos Aires Province [9,10]. However, these remnants remain subject to sustained human pressure. The expansion of urban and tourist development has promoted different forms of human intervention, including afforestation projects that alter the structure and functioning of coastal grasslands. Previous studies in this region have documented the invasion of coastal



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grasslands by *Acacia longifolia*, highlighting its negative effects on native species cover and diversity [11].

The establishment of woody species in grasslands represents not merely species addition, but the introduction of a functionally distinct life form into systems where native trees are rare or absent [12]. A major ecological consequence of woody encroachment and afforestation is the alteration of fire regimes, particularly in terms of fire frequency, intensity, and severity [13]. Fire is a key structuring disturbance in grasslands, strongly influencing succession, biodiversity, and ecosystem functioning, although its effects depend on environmental conditions and landscape context [14,15].

In native grasslands, fires usually reach relatively low temperatures and are followed by rapid vegetation recovery [16]. In contrast, forest plantations often increase fuel loads and continuity, promoting higher-intensity fires [17]. The simplified understory structure typical of many plantations can enhance soil susceptibility to erosion and amplify negative impacts on vegetation and soil properties following fire [18,19]. However, post-fire conditions may also create windows of opportunity for compositional shifts, potentially facilitating the establishment of native grassland species within plantation stands [20].

The ecological trajectory of plantations after fire depends on their structural attributes, species composition, and management history [21]. Changes in canopy cover, litter depth, light availability, and soil conditions during early succession can alter competitive interactions and influence recruitment patterns [22]. These post-disturbance dynamics may determine whether plantations maintain low-diversity understories dominated by planted trees and associated species, or shift toward more diverse communities with greater representation of native species [23,24]. Additionally, plantations can influence the ecological processes of adjacent grasslands, affecting fire behavior, propagule pressure, and microenvironmental conditions, with consequences for their recovery [25–27].

Although fire effects in native grasslands have been widely studied, few studies have explored initial post-fire successional trajectories in areas modified by afforestation, particularly within plantations and in the presence of invasive shrubs such as *A. longifolia*. Addressing this gap, our study evaluates vegetation cover in a *Pinus pinaster* plantation across three post-fire stages. Specifically, we examined whether post-fire vegetation dynamics are associated with changes in understory communities that may be consistent with grassland recovery, or whether different abiotic and biotic components of the plantation are associated with lower native species cover.

2. Materials and Methods

2.1. Study Area

The coastal dunes of the Austral Pampa [28] are located in the southwestern region of Buenos Aires Province, Argentina. This coastal strip, ranging from two to seven kilometers in width, comprises beaches, bare dunes, vegetated dunes primarily covered by psammophilous grasslands, and interdunal depressions with shallow lagoons associated with wet grasslands [29]. The climate is temperate and strongly influenced by maritime conditions. Mean annual precipitation in the region is approximately 669 mm, and mean annual temperature is around 14 °C, with moderate seasonal variation typical of temperate grasslands [30]. During the study period, climatic conditions remained within the historical range for the region, with no evidence of anomalous temperature or precipitation patterns [31].

Vegetation communities are dominated by grasses such as *Imperata brasiliensis*, *Poa lanuginosa*, *Panicum uroilleanum*, *Panicum racemosum*, *Schizachyrium plumigerum*, and *Aristida spegazzinii*, accompanied by other herbaceous species including *Tessaria absinthioides*, *Solidago chilensis*, and *Ambrosia tenuifolia*. The flora also includes locally endemic species

such as *Poa schizantha*, *Neosparton darwinii*, *Senecio bergii*, and *Baccharis divaricata*. Interdunal depressions are characterized by *Cortaderia selloana*, *Juncus acutus*, *Schoenoplectus americanus*, and other hygrophilous herbs [32–34] (Figure S1b).

The study was conducted in a plantation approximately 30 years old, based on local knowledge (personal communications with land managers). The total area was approximately 30 hectares. *P. pinaster* was the dominant species, with small, scattered populations of *A. longifolia* shrubs occurring at the edges of the forest plantation (38°54'54" S; 60°32'48" W; Figure S1a). The plantation was established over former coastal grasslands, and field observations suggest that no major soil removal or leveling occurred prior to afforestation. The current topography of the plantation still reflects the original dune system, with trees planted across both dune crests and interdunal depressions, mirroring the physiognomy observed in adjacent non-forested grasslands. In addition, grassland patches of varying size were observed within the plantation matrix, reinforcing the idea that the original spatial heterogeneity of the grassland was at least partially retained. Therefore, it is likely that at least part of the original soil seed bank was retained.

Field data were collected after a fire that affected both the plantation and adjacent grasslands. The fire originated in the surrounding grasslands and spread into the plantation. The fire resulted in complete aboveground vegetation dieback within the sampled area, including all adult individuals of *P. pinaster* and *A. longifolia*. Field observations indicated that surface litter was largely consumed during the fire. However, the emergence of seedlings of both species, as well as native species such as *Hydrocotyle bonariensis*, within three months after the fire suggests that soil heating was not sufficient to eliminate the entire soil seed bank. Post-fire recruitment of both species occurred through seed germination, with no evidence of resprouting.

2.2. Study Design and Field Sampling

A sector of the plantation in which all *P. pinaster* individuals were dead was selected to minimize structural heterogeneity and avoid confounding effects of live versus dead trees on vegetation dynamics. Two study environments were defined: (1) the burned forest plantation and (2) a burned native grassland free of trees, used as a reference site representing the regional grassland condition [35]. The grassland site did not contain woody species, including *A. longifolia*, prior to the fire. Each environment was represented by a single site (Figure 1).

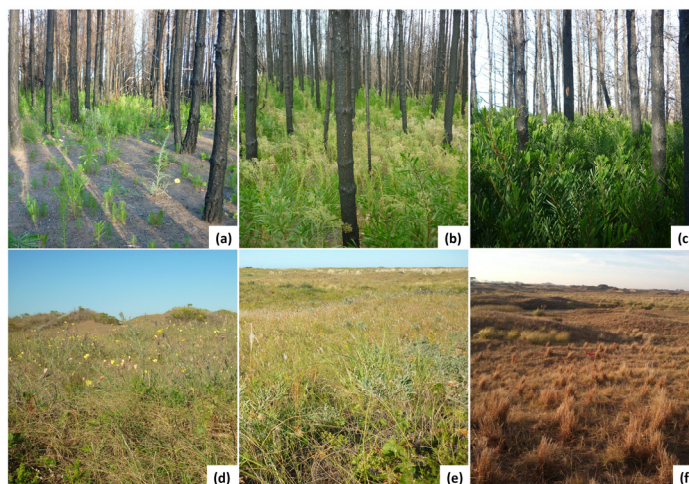


Figure 1. Vegetation sampling in forest plantation (a–c) and grassland (d–f) at 9, 15, and 18 months after fire (left-to-right columns).

Within each environment, five permanent plots of 630 m² (0.063 ha; 21 × 30 m) were randomly selected. Their locations were established in the field using a GPS, maintaining a minimum separation of 100 m to reduce potential spatial autocorrelation. Plots were surveyed at all three sampling times. In each plot, vegetation cover was recorded in the field using the Braun-Blanquet method [36], estimating percentage cover for each species. Cover estimates represent the relative ground area occupied by each component, following standard Braun-Blanquet field estimation criteria, and include herbaceous and shrub layers, as well as litter and bare soil. No explicit vertical stratification was distinguished, and cover components were estimated independently.

In the forest plantation, species-level cover values were subsequently grouped into the following categories: *P. pinaster*, *A. longifolia*, pine needles, bare soil, native species, and other exotic species (Tables S1 and S2). The latter category included only exotic herbaceous species (identified at species level), excluding *A. longifolia*. In the grassland, vegetation cover was also recorded at the species level using the same method. Species were subsequently classified into native and exotic categories, and bare soil cover was estimated separately (Tables S1 and S2).

Field surveys were conducted at three post-fire times: 9 months (t1), 15 months (t2), and 18 months (t3), corresponding to spring, autumn, and winter, respectively. This sampling scheme was designed to capture early post-fire vegetation dynamics across contrasting seasons within the first 18 months following the disturbance.

2.3. Data Analysis

Percentage cover data were arcsine square root transformed to improve compliance with assumptions of normality and homoscedasticity. Assumptions were evaluated through inspection of residuals and normal probability plots, and homogeneity of variances was assessed using Levene's test.

To analyze temporal dynamics within the forest plantation, repeated-measures ANOVAs were performed for each structural cover variable (*P. pinaster*, *A. longifolia*, pine needles, and bare soil), with post-fire time as a fixed factor and plot included as a random blocking factor to account for non-independence among repeated observations through time. Spatial independence among plots was assumed based on the minimum distance established between them during sampling. Post hoc comparisons were conducted using Fisher's LSD test. These variables were selected as key structural attributes because they represent functionally relevant gradients in post-fire community structure [37]. The primary objective of this analysis was to describe temporal trends rather than to conduct strict confirmatory inference.

Compositional trajectories were examined using Principal Component Analysis (PCA) based on a correlation matrix. Active variables included cover of *P. pinaster*, *A. longifolia*, pine needles, and bare soil, as they define the main structural gradients of the post-fire forest plantation. Cover of native species and other exotic species were incorporated as supplementary variables and projected onto the ordination space defined by the active variables. This approach allows interpretation of their association with major structural gradients without influencing the construction of principal components, following standard PCA procedures with supplementary variables [38].

To assess the relationship between forest plantation attributes and native species cover, an exploratory analytical framework was adopted due to the limited sample size. Separate simple linear regressions were fitted for each predictor variable and sampling time. These models were interpreted descriptively, focusing on the direction and relative magnitude of relationships rather than on formal hypothesis testing, given the limited statistical power. To support these interpretations, Spearman rank correlations were calculated for each time

period to evaluate the direction and strength of associations between native species cover and each biotic or structural forest plantation variable.

Given that the intermediate post-fire stage (t2) represents a transitional successional phase and showed contrasting patterns among potential filters, additional correlations were explored between *P. pinaster* cover and the remaining predictor variables to identify potential indirect associations or spatial decoupling involving this structural component. These analyses were interpreted cautiously and solely as indicators of potential relationships, without causal inference. Such additional exploration was not conducted for early (t1) or late (t3) post-fire stages, where dominant filters showed more consistent directional effects.

To compare early post-fire changes in native species cover between the two study sites (forest plantation and reference grassland), we analyzed temporal trajectories using a repeated-measures framework including Time and Site as fixed factors and plot as a random factor to account for within-plot dependence. Because each environment was represented by a single site, Site was treated as a fixed contrast rather than a replicated treatment. Therefore, the analysis was intended to describe and quantify differences in temporal trajectories between these two specific sites rather than to infer general effects of environment type. The Site $\times$ Time interaction was used to evaluate whether vegetation trajectories converged or diverged over time. Post hoc comparisons were conducted using Tukey's HSD test.

All statistical analyses and graphical outputs were performed using Infostat [39] and XLSTAT (versions 5.7.2 and 2018.2.50198, respectively).

3. Results

3.1. Temporal Dynamics of the Forest Plantation

The post-fire forest plantation showed significant temporal changes during early succession for cover of *A. longifolia* ($F = 21.56$; $p = 0.0006$), pine needles ($F = 13.61$; $p = 0.0027$), and bare soil ($F = 10.30$; $p = 0.0061$; Figure 2).

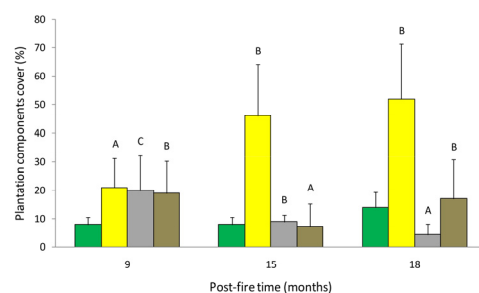


Figure 2. Percentage cover of forest plantation components across post-fire successional stages: *P. pinaster* (green); *A. longifolia* (yellow); pine needles (gray); bare soil (brown). Bars represent changes over time. Values are mean $\pm$ standard error. Different uppercase letters indicate statistically significant differences among sampling times within each plantation component (ANOVA followed by Fisher's LSD test, $p < 0.05$).

Cover of *A. longifolia* increased significantly from the early post-fire stage (t1) to the intermediate stage (t2) and remained high at the late stage (t3). In contrast, pine needle cover declined progressively over time, with maximum values at t1 and minimum values at t3.

Bare soil exhibited a non-linear temporal variation, with significantly lower values at t2 compared to t1 and t3, which did not differ from each other.

Cover of *P. pinaster* did not differ significantly among post-fire times ($F = 3.98$; $p = 0.063$; Figure 2), although mean cover values were highest at the late stage (t3).

3.2. Compositional Trajectories

The PCA performed on active post-fire forest plantation cover variables showed that the first two axes (F1 and F2) explained 78.0% of the total compositional variation. Axis F1 separated *A. longifolia* cover from that of *P. pinaster* and bare soil, whereas F2 distinguished pine needles from *A. longifolia* and *P. pinaster*. Among active variables, *A. longifolia* showed the highest contribution to F1, while *P. pinaster* contributed less strongly. Supplementary variables (native species and other exotic species cover) were not strongly associated with the first two axes (Figure 3).

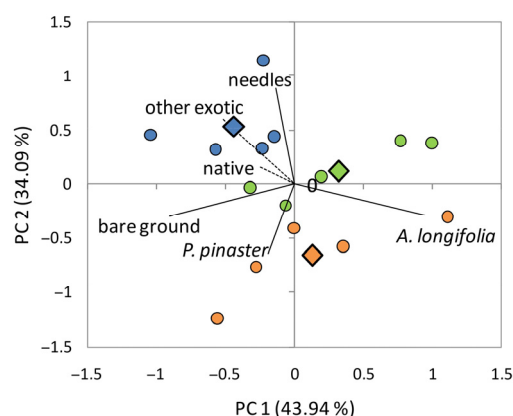


Figure 3. Principal Component Analysis (PCA) of sampling units at different post-fire successional stages based on forest plantation cover variables. Individual observations are represented by circles colored according to sampling time (t1 = blue, t2 = green, t3 = orange). Group centroids (mean position per successional stage) are indicated by rhombuses. Solid arrows represent active variables (used in the PCA), and dashed arrows represent supplementary variables.

Temporal centroids indicated that nine months after the fire (t1), plots were primarily associated with pine needles and bare soil. At 15 months (t2), plots occupied intermediate positions in multivariate space. At 18 months (t3), they shifted toward higher *A. longifolia* cover. The temporal trajectory in PCA space did not follow a linear pattern (Figure 3).

3.3. Effects on Native Species

Descriptive regressions and Spearman correlations indicated that relationships between forest plantation components and native species cover varied by sampling time (Table 1; Figure 4). Both *A. longifolia* cover and pine needles were negatively associated with native species cover at the intermediate and late stages (t2 and t3). Bare soil was positively associated with native species cover across all sampling times (Table 1; Figure 4b–d).

Table 1. Relationships between native species cover and forest plantation components across sampling times. Regression slopes and Spearman correlation coefficients (ρ) indicate the direction and strength of the associations between each plantation component (*P. pinaster*, *A. longifolia*, litter, and bare soil) and native species cover.

Time (Months)	Forest Plantation Component	Regression Slope	ρ
9	<i>P. pinaster</i>	−0.59	−0.29
9	<i>A. longifolia</i>	−0.24	−0.53
9	Needles	−0.28	−0.53
9	Bare ground	0.38	0.97 *
15	<i>P. pinaster</i>	1.19	0.87 *
15	<i>A. longifolia</i>	−0.38	−0.97 *

Table 1. Cont.

Time (Months)	Forest Plantation Component	Regression Slope	ρ
15	Needles	−2.44	−0.71
15	Bare ground	0.31	0.90
18	<i>P. pinaster</i>	−0.07	0.00
18	<i>A. longifolia</i>	−0.40	−0.90
18	Needles	−0.90	−0.95 *
18	Bare ground	0.36	0.87 *

* Asterisks indicate statistically significant Spearman’s rank correlations ($p < 0.05$).

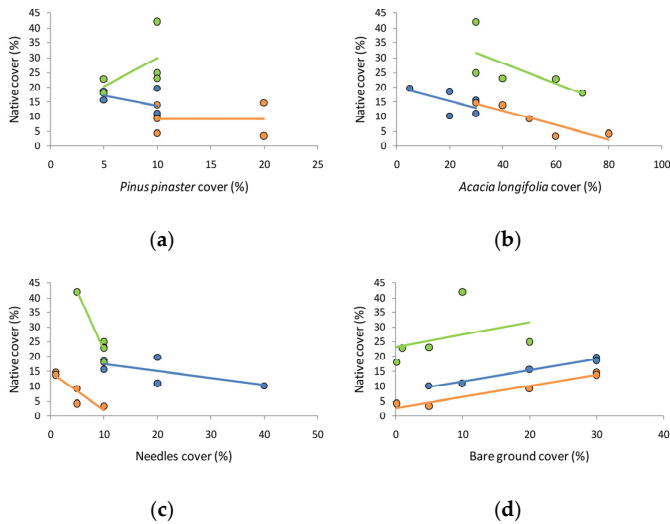


Figure 4. Native species cover versus active forest plantation components over time since fire: (a) *P. pinaster*; (b) *A. longifolia*; (c) pine needles; (d) bare soil. Points and simple regression lines illustrate the relationship with native cover. Sampling times are represented by colors (t1 = blue, t2 = green, t3 = orange). Corresponding Spearman’s rank correlation coefficients (ρ) and regression slopes are reported in Table 1.

Cover of *P. pinaster* was negatively related to native cover at t1, positively related at t2, and showed a near-zero association at t3 (Table 1; Figure 4a). Correlations with the remaining components of the forest plantation revealed that at t2, *P. pinaster* cover was negatively associated with *A. longifolia* cover, weakly associated with pine needles, and positively associated with bare soil (Table 2).

Table 2. Correlations between *P. pinaster* and other forest plantation components at t2. Spearman correlation coefficients (ρ) indicate the direction and strength of the associations. These relationships were evaluated to explore potential indirect effects and to better understand the inconsistent patterns observed for *P. pinaster*.

Forest Plantation Component	ρ
<i>A. longifolia</i>	−0.89 *
Needles	−0.41
Bare ground	0.87 *

* Asterisks indicate statistically significant Spearman’s rank correlations ($p < 0.05$).

3.4. Native Species Cover Comparison

Native species cover showed contrasting temporal trajectories between the two study sites (post-fire forest plantation and burned grassland), as indicated by a significant

Time $\times$ Site interaction ($F = 6.606$; $p = 0.006$). Across all post-fire sampling times, native cover was consistently higher in the grassland site than in the forest plantation (Figure 5).

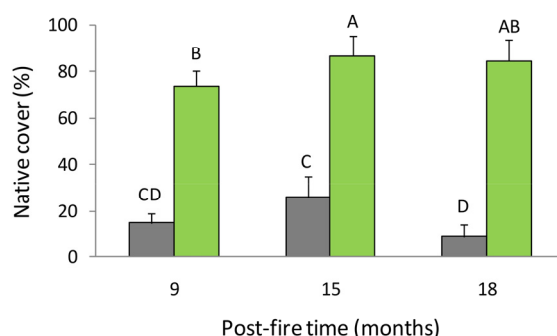


Figure 5. Cover of native species in the forest plantation (gray) and grassland site (green) across post-fire successional stages. Bars represent changes over time. Values are means $\pm$ SE. Different uppercase letters indicate statistically significant differences between sites within each sampling time (ANOVA followed by Tukey's HSD, $p < 0.05$).

4. Discussion

Our results indicate that fire did not lead to a convergence toward a grassland-like condition and that the post-fire succession was associated with an increasing dominance of the invasive *A. longifolia*. Post-fire succession was associated with a sequence of abiotic and biotic constraints that likely influenced community assembly. Initial physical legacies, including pine needle accumulation and bare soil, structured early establishment. These conditions were followed by rapid expansion of *A. longifolia*, which became a dominant component of the understory and was strongly associated with changes in community composition, while *P. pinaster* played only a minor role. These changes were associated with lower native species cover compared to the reference grassland, which showed more consistent recovery through time. Overall, our results highlight the importance of early post-fire assembly processes in shaping observed short-term vegetation dynamics.

Early post-fire dynamics in the plantation were initially associated with abiotic legacies, particularly pine needle accumulation and bare soil exposure. At nine months after the fire, plots were strongly associated with these variables in PCA space, suggesting that substrate conditions likely played an important role during initial establishment. Pine needles were negatively associated with native plant cover, whereas bare soil showed a positive relationship. These contrasting patterns may reflect differences in how these substrates influence vegetation establishment. Pine litter can inhibit seed germination and seedling emergence by creating a physical barrier and altering microclimatic conditions [23], whereas bare soil may create heterogeneous microsites that favor the establishment of rapidly colonizing species. In this context, pine needle accumulation and bare soil exposure represent important ecological legacies that influenced the initial conditions of vegetation recovery. These patterns are broadly consistent with models of succession that emphasize environmental filtering during early post-disturbance stages [40,41]. Disturbance may also interact with biological legacies, such as persistent seed banks, potentially facilitating the establishment of invasive species.

Our results suggest a temporal shift in the relative importance of abiotic and biotic factors during post-fire succession. The increase in *A. longifolia* cover and its negative association with native species at intermediate and late stages suggest that this invasive plant became an increasingly important component of the understory. This pattern was also reflected in the PCA ordination, where *A. longifolia* showed a strong contribution to the first axis and was associated with later sampling periods. Fire may have stimulated germination from persistent seed banks, as reported for *A. longifolia* in other systems [42,43]. Once established, it may

further influence community dynamics through processes such as shading, litter accumulation, and competition [42]. These processes may contribute to reinforcing its persistence and reducing opportunities for native species establishment. This pattern is consistent with the idea that early colonization following disturbance can influence successional trajectories through priority effects and historical contingency [44,45].

Despite being the plantation species, *P. pinaster* showed only a weak and non-significant tendency to increase in cover over time. This limited response suggests that post-fire dynamics were not associated with pine recovery, but rather with the expansion of invasive shrubs. Regeneration of *P. pinaster* depends on factors such as seed availability, fire severity, and competitive context [46,47], and may be further constrained under conditions of rapid shrub establishment. Rather than indicating a clear return to pine dominance, these patterns may suggest a tendency toward shrub-influenced trajectories [48], associated with species characterized by traits such as rapid post-fire germination and persistence in the soil seed bank.

Comparison with continuous native grasslands further supports the presence of divergent post-fire trajectories between the two systems. Native species cover remained consistently higher in the grassland site, and the significant Time $\times$ Site interaction indicates that the plantation did not converge toward the reference condition within the study period. This divergence appears to be associated with both structural legacies and the increasing dominance of *A. longifolia*, which may limit native species establishment by altering competitive interactions [24,44,45]. Although the soil seed bank was not directly assessed, field observations suggest that soil disturbance during plantation establishment was likely limited, indicating that at least part of the original propagule pool may have been retained. This would suggest that reduced native recovery is more likely explained by post-fire abiotic and biotic constraints rather than by a complete absence of propagules. The relatively short monitoring period (18 months) captures early post-fire dynamics but may not fully represent longer-term successional trajectories. However, sampling encompassed contrasting seasons (spring, autumn, and winter), capturing the expected seasonal variability in temperate grassland systems. Despite this, the plantation showed a consistent divergence from the grassland across all sampling times, primarily driven by the increasing dominance of *A. longifolia*. This consistent pattern suggests that the observed differences between systems cannot be attributed solely to seasonal dynamics. In addition, climatic conditions during the study period were within the expected range for the region, with no evidence of anomalous temperature or precipitation patterns, indicating that the observed patterns are unlikely to be driven by short-term climatic variability. Furthermore, the limited regeneration of *P. pinaster* contributed to the plantation following a trajectory distinct from both the original grassland and a pine-dominated system. These results are consistent with the concept of ecological memory, whereby structural and biological legacies persist after disturbance and influence subsequent recovery [22,41]. More broadly, they suggest that afforestation may promote conditions that favor woody species persistence and limit grassland recovery [49,50].

From a management perspective, our results suggest that fire alone may be insufficient to restore native grassland composition in afforested systems under the conditions studied. Post-fire recovery in the plantation was associated with structural legacies and the rapid establishment of *A. longifolia*, which may limit the recolonization of native species. These findings suggest that post-fire conditions can create windows of opportunity that may be rapidly occupied by invasive species, potentially influencing subsequent vegetation trajectories [21,41,51]. In many *Acacia* species, fire can act as a strong germination trigger by breaking seed dormancy and stimulating the emergence of individuals from persistent soil seed banks, often resulting in massive recruitment following disturbance [42,43].

Consequently, the structure remaining after disturbance and the biological legacies associated with invasive species likely influence which species recolonize and how community assembly unfolds.

Our findings suggest broader implications for grassland management and restoration, as under similar conditions, early interventions are crucial to redirect successional trajectories. Targeting the establishment of *A. longifolia* through mechanical removal, repeated burning, or the active reintroduction of native grassland species may help reopen recruitment windows and reduce competitive feedbacks that stabilize shrub dominance [52,53]. Recent syntheses indicate that prescribed fire can effectively reduce populations of woody invasive species in many ecosystems, particularly when applied repeatedly and combined with other management actions, although its success depends strongly on factors such as fire frequency, intensity, and long-term monitoring of vegetation responses [53]. Because invasive *Acacia* populations are often maintained by persistent seed banks and vigorous resprouting, effective restoration typically requires sustained and integrated management efforts combining disturbance management with invasive plant control [42].

From a community assembly perspective, these interventions are particularly important during early successional stages, when priority effects can strongly influence long-term community trajectories [45]. Without such interventions, feedbacks generated during early succession may promote the persistence of shrub-dominated understories, limiting long-term recovery of native grassland biodiversity and leading to trajectories that diverge from both the original plantation structure and the reference grassland condition. More broadly, these results underscore that restoring afforested grasslands requires integrating disturbance regimes such as fire with active management of invasive species and promotion of native colonizers, particularly in systems where tree establishment can contribute to reinforcing patterns of dominance that hinder grassland recovery [49].

5. Conclusions

Fire did not restore the afforested system toward a native grassland state within the 18-month study period, suggesting that fire alone may be insufficient for grassland recovery under the conditions studied, a pattern consistent across seasons and unlikely to be driven by short-term climatic variability.

Post-fire succession was characterized by a shift in filtering processes, from initial conditions associated with plantation legacies to increasing influence of the invasive shrub *A. longifolia*, which was associated with lower native grassland cover.

Consequently, effective restoration will require early management interventions targeting invasive species and promoting native grassland plants.

More broadly, these findings highlight the importance of considering post-disturbance conditions and historical legacies in restoration planning for afforested grasslands.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/grasses5020021/s1>, Figure S1. Pre-fire landscape conditions of the two study environments: forest plantation (a) and adjacent native grassland (b). Table S1. Raw species-level vegetation cover data in post-fire forest plantation and coastal grassland [54]. Table S2. Categories analyzed. Cover percentages are presented by category.

Author Contributions: A.L.Y., A.J.N. and S.M.Z. contributed to the study conception and design. Data collection and analysis was performed by A.L.Y. All authors analyzed the results and contributed to the writing of the paper. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflicts of interest.

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