

## 2 Becoming tree, becoming memory

Social-ecological fabrics in Pewen  
(*Araucaria araucana*) landscapes of the  
southern Andes

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### Introduction

Trees are rooted in a myriad of biocultural landscapes worldwide (Watkins 2016; Holmgren and Scheffer 2017). They play key ecological roles such as the creation of microhabitats for biodiversity, carbon sequestration, and the maintenance of hydrological, nutrient, and energy cycles (Lindenmayer and Laurance 2017). Trees have also long been symbols within complex bodies of human knowledge, practices, and beliefs, as they provide tangible goods (resin, bark, flowers, wood, fruits, medicines, and seeds) and intangible values (aesthetic, artistic, and religious character) (Hageneder 2009; Kohn 2013). These roles are continually unfolding in situated social-ecological systems, in which properties of the system emerge from localized interactions that contribute to the specific fabrics of differing landscapes' milieus (Filotas et al. 2014; Ibarra et al. 2020b).

These principles speak through the poet Leonel Lienlaf (1989) when he states:

*La vida del árbol invadió mi vida. Comencé a sentirme árbol  
y entendí su tristeza.  
Empecé a llorar por mis hojas, mis raíces,  
mientras un ave  
se dormía en mis ramas esperando que el viento dispersara sus alas.  
Yo me sentía árbol porque el árbol era mi vida.*

The life of the tree invaded my life.  
I started to feel like a tree and I understood its sadness.  
I started crying through my leaves, my roots,  
while a bird  
was falling asleep in my branches waiting for the wind to scatter  
its wings. I became a tree because the tree was my life.  
(Lienlaf 1989)

An outstanding property of social–ecological fabrics is the biocultural memory of the system, which emerges from the stored experiences and information (e.g., evolutionary, ecological, historical) shared by living beings with one another and with their territories (Toledo and Barrera–Bassols 2008; Ibarra et al. 2021). These records of historical events continue to influence the compositional, structural, and functional states of the system (Ibarra et al. 2020b). For example, in an ecological context, seeds are repositories of memory as they are full embryonic plants responsible for the nourishment of the embryo, the dispersal to a new location, and for becoming dormant during unfavorable environmental conditions (Nazarea 2005). For their part, large ancient trees retain the memory of past forest conditions in their tree rings and canopy structure, and often sustain complex biodiversity networks in forested landscapes (Briffa 2000; Ibarra et al. 2020b). In a social context, trees and their seeds are intertwined with many people’s livelihoods and intergenerational processes of knowledge acquisition and senses of place, thus giving and negotiating meanings of human experience with other humans and other-than-human beings (Jones and Cloke 2002; Kohn 2013).

In current studies on social–ecological systems linked with trees, we commonly find two approaches. The first focuses on biological entities, examining the ecological dynamics of tree species and associated biodiversity, and the combination of structures that make reorganization possible (Ibarra et al. 2020b). This approach is generally built on variable–driven analyses, searching for cause–effect relationships among components that allow the functioning of the system (de Vos et al. 2019); ecological dynamics are generally conceived to be shaped or disrupted by anthropogenic drivers of change (e.g., climate change, deforestation, habitat degradation, fires, etc.) (Caviedes and Ibarra 2017). A second approach focuses on people, analyzing human agency along with the historical and contemporary political drivers of change (e.g., power relations) shaping human–tree landscapes (Jones and Cloke 2002). This approach commonly explores people’s perceptions and attitudes, and how their knowledge, practices, and beliefs influence their historical and present relations with trees (Watkins 2016). A third perspective, named the relational approach, highlights integrated social–ecological relations to overcome the ecological/social and the biological entity/human agency dichotomies of the two previous approaches (Murdoch 1997; Darnhofer et al. 2016). As relations are continually reshaped through ecological and social dynamics, the biocultural memory of the system emerges from the ability to make and remake relations (Ibarra et al. 2021).

The Pewen (*Araucaria araucana*) represents one of the last remnants of the ancient, and formerly widespread, coniferous family Araucariaceae in South America (Figure 2.1). This species, considered to be a true ‘living fossil,’ remains in a global biodiversity hotspot centered in the temperate rainforests of Chile and Argentina (Donoso 1993). The Pewen reaches up to 30 meters in height and can age more than 1,500 years. It tends to form pure canopies above an intermediate stratum of broadleaf trees (*Nothofagus* spp.) in forests shaped by humans for millennia (Maestre et al. 2012). Indeed, there has been a permanent presence

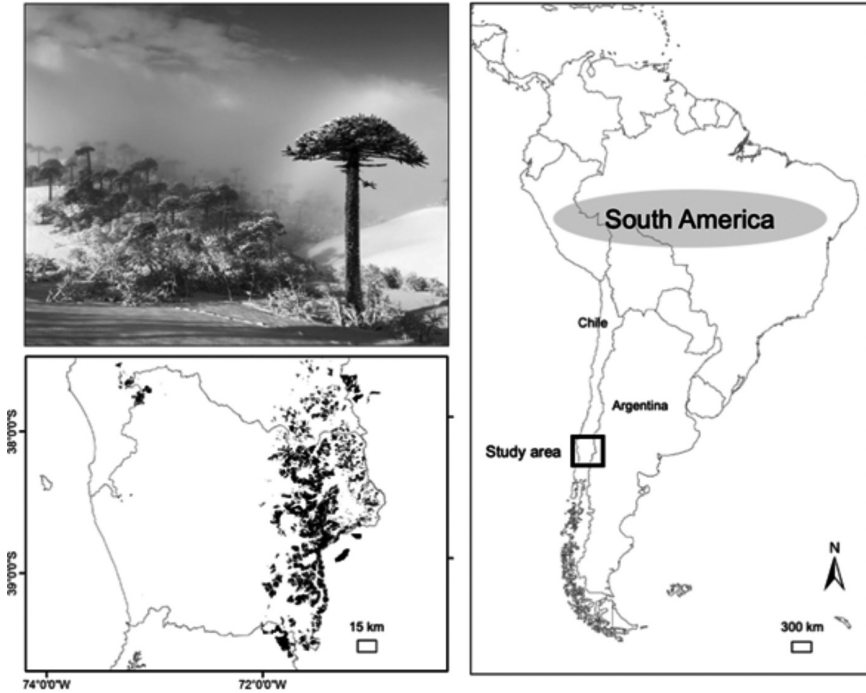


Figure 2.1 Study area in the La Araucanía Region (bottom left), showing the current extent (shaded black) of Pewen (*Araucaria araucana*) forests in the southern Andes of South America.

of human beings in the distribution range of Pewen landscapes since 4,000 BP (Reis et al. 2014). Indigenous groups facilitated the expansion of *Araucaria* forests across South American landscapes during the Holocene. But, after European colonization in Chile and Argentina in late 19th century, and mostly during the 20th century, fires from these new settlers and the logging industry cleared nearly 50% of Pewen forests (González et al. 2005; Armesto et al. 2010). Remaining Pewen populations, classified globally as endangered, are threatened by climate change, fire, overgrazing, exotic seed predators, and lack of recruitment (IUCN 2021). The importance of the Pewen would not only lie in its botanical and ecological value (Ibarra et al. 2010; Cockle et al. 2019), but also in its cultural (religious, economic, educational, commercial) importance for the Mapuche-Pewenche Indigenous people (*Pewen*: *Araucaria* and *Che*: people; Pewenche = People of the Pewen) (Herrmann 2005, 2006; Barreau et al. 2016; Cortés et al. 2019). The Pewenche are the Mapuche who inhabit the Andes mountain range in south-central Chile, where they co-inhabit with Pewen forested landscapes.

In this chapter, we examine social-ecological systems associated with the Pewen by critically reflecting and integrating the results of our long-term

(2008–2021) inter- and transdisciplinary work in the southern Andes of Chile. We first briefly describe our studies on biological entities and their interaction fabrics in Pewen forests, examining the ecological dynamics of trees and associated biodiversity. Then, we recount our work on Mapuche–Pewenche social fabrics linked to the Pewen which are constrained, but not necessarily determined, by historical and contemporary drivers of change. Finally, we elaborate a relational approach, which highlights unfolding and integrated social-ecological relations, overcoming both the ecological/social and the biological entity/human agency dichotomies. We discuss this relational approach by examining the biocultural memory of the system, which is not a fixed asset but a property of the system that emerges from situated social-ecological relations that are continuously made and remade with both past and current circumstances.

### Setting the landscape: forests and people

Since 2008, we have studied Pewen social-ecological fabrics in the Andean zone of the La Araucanía region of Chile, which is part of the *Wallmapu*, the territory of the Mapuche people (Figure 2.1). At lower elevations, the landscape is characterized by valleys floors with a heterogeneous mosaic of human settlements, farmlands, fragments of native forest, agroforestry systems, plantations of non-native trees, shrublands, lakes, and rivers. As the elevation rises, native forest increasingly dominates the landscape. At these higher elevations, Pewen emerges progressively mixed with evergreen Coihue beech (*Nothofagus dombeyi*) at elevations 900–1,100 meters above sea level (masl) and with deciduous Lenga beech (*Nothofagus pumilio*) and Antarctic beech (*Nothofagus antarctica*) at 1,100–1,600 masl. Mapuche lands and communities are interspersed with farms owned by non-Mapuche settlers. These farms are often larger than the communities, as the Mapuche have seen their access to land disrupted by private properties and a history of State colonization policies (Huiliñir–Curio 2010), including the creation of a number of protected areas (Barreau et al. 2016). As a result of decades of discrimination, the local language, *Mapuzugun*, was progressively lost, being now mostly spoken by elders. Younger members of Mapuche communities speak mostly in Spanish and basic *Mapuzugun*. However, there is rising awareness and numerous efforts and initiatives to recover the language.

Throughout the years, we have deployed several biodiversity survey and ethnographic methodologies. For ecological research, we have used bird point counts, mist-netting, camera trapping, peeper cavity-inspecting cameras, reptile counts through transects, and vegetation plots, among others (e.g., Ibarra et al. 2010, 2017; Ibarra and Martin 2015; Altamirano et al. 2017; Caviedes and Ibarra 2017; Cockle et al. 2019). For social inquiring, we have implemented, for example, participant observation, oral histories, interviews, free-listing, food elicitation diaries, focus groups, and other means of participatory action research (e.g., Barreau et al. 2016, 2019; Cortés et al. 2019; Ibarra et al. 2021). All these methodologies have allowed us to get a broad and deep understanding of, as well as a long-term commitment to, social and ecological fabrics in Pewen landscapes.

## Biological entities: Pewen ecological fabrics

Prototypical biological entities in forested landscapes are the community of wildlife species that use tree-cavities to achieve their life history requirements. Cavity-using wildlife interact in fabrics known as ‘nestwebs’ in the ecological literature (Martin and Eadie 1999). These fabrics are generally viewed as hierarchical and commensal, with resource (cavities) flowing from trees to non-excavators (e.g., many songbirds, ducks, raptors, and other organisms), facilitated by the action of excavators (e.g., woodpeckers) and tree-decay processes (Figure 2.2; Martin et al. 2004).

In high-elevation Andean forests (>900 masl), we have reported that Pewen is one of the dominant trees, as it accounts for 30% of forest basal area. However, it provides only 2% of nesting cavities (Cockle et al. 2019). There are 26 bird species, six mammals, and at least two reptile species that breed in tree cavities in Pewen forests (Figure 2.2; Altamirano et al. 2017). Nests are placed in all tree species present in these forests, but most secondary cavity-nesting species use

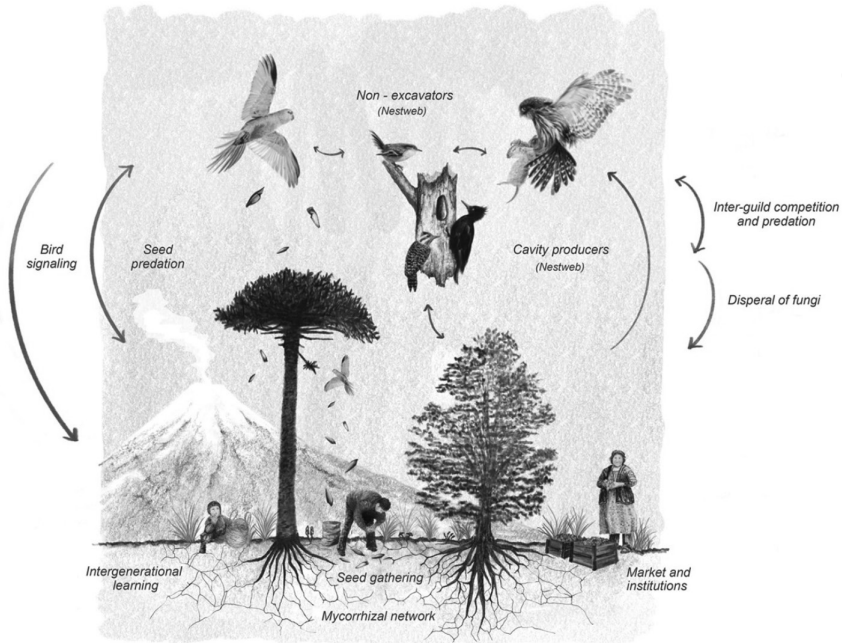


Figure 2.2 Pewen landscapes in the southern Andes integrate multiple entities/agents that co-produce each other in complex and sympoietic social-ecological fabrics that vary across space (from the seed to the country and beyond) and time (building on and revisiting the past). Thus, the Pewen, as it is currently, is but a stable moment in a continuing process of ‘becoming’ (see main text for details on the arrows and specific social-ecological interactions).

Source: Illustration by M. Medina.

cavities formed by tree-decay processes in *Nothofagus* spp. (98% of nest cavities in Pewen forests). Broadleaf trees that coexist with Pewen, especially the Lenga beech, thus play a key role at the base of complex nestwebs of interacting birds, mammals, reptiles, and trees. The Austral parakeet (*Enicognathus ferrugineus*) is the only species showing a relatively important use of cavities produced by Pewen (11% of its nests; Díaz and Kitzberger 2013). Austral parakeets also play an important role in facilitating seed germination and regeneration of Pewen (Speziale et al. 2018). Therefore, the Austral parakeet, through its feeding and nesting habits, is an example of a biological entity that links Pewen and *Nothofagus* trees as they feed on and disperse Pewen seeds and, simultaneously, nest chiefly in cavities available in coexisting old-growth *Nothofagus* trees in the southern Andes. The latter example highlights that cavity nesters interact through mutualisms, facilitation, competition, and predation, as well as through the dispersal of seeds of future nest trees (Blanc and Walters 2007; Ibarra et al. 2014; Altamirano et al. 2017). Furthermore, cavity nesters disperse spores of wood-decay fungi that facilitate cavity-formation as well (Jusino et al. 2016), while some species may also reduce recruitment of cavity trees through seed predation (Figure 2.2; Shepherd et al. 2008).

In Pewen landscapes, repositories of memory in ecological fabrics include, for example, long-lived system entities such ancient Lenga beech, Coihue beech, Pewen, and forest patches whose presence and influence extend over a long time. Indeed, in these old-growth forest stands, the cavity-tree species with the highest density of useful cavities for wildlife are large decaying trees of Lenga beech (66% of all cavities) and Coihue beech (16%); species that accompany Pewen trees (Ibarra et al. 2020c). Furthermore, these fabrics are influenced by disturbance events such as fires, with wildlife community responses depending heavily on time since the fire. These responses are related to the progress of vegetation succession with an associated gradual increase in structural complexity of Pewen landscapes (Infante et al. 2021; Novoa et al. 2021).

The above-ground community of cavity nesters is connected to a below-ground fabric of mycorrhizal fungi that links current and future generations of trees (Simard et al. 2013). Mycorrhiza is the symbiotic association between plant roots and fungi, and it is present in most plants around the world. Plants can translocate up to 30% of the carbohydrates to their root-associated fungi. In return, fungi behave as skilled root extensions that explore and interact formidably with soil, nurturing and protecting their host. Furthermore, the exploring mycelium of the fungi can associate with several other trees simultaneously, enabling forest trees to physically link together and establish complex below-ground communication networks (Molina and Horton 2015; Simard 2018). In Pewen trees, studies have shown a high degree of mycorrhizal fungal colonization on their roots (Diehl and Fontenla 2010; Godoy and Marín 2019). Mycorrhiza is particularly important to Pewen trees after fires, because the symbiotic fungi extend their range of exploration, finding and uptaking scarce and immobilized nutrients such as phosphorus (Figure 2.2; Diehl and Fontenla 2010).

Despite that mycorrhizal networks in Pewen forests have not been explored in detail, the formation of a common mycelium that links trees within and between species has been reported for temperate forests elsewhere (Smith and Read 2010). Simard et al. (1997) showed evidence of bidirectional inter-plant carbon transfer between conifer and deciduous broadleaf trees. This may be a dynamic occurring between Pewen and coexisting *Nothofagus* species. These links, nevertheless, might occur differently in southern temperate forests because Pewen and *Nothofagus* associate with different groups of mycorrhizal fungi; Pewen is arbuscular and *Nothofagus* is ectomycorrhizal. There is no evidence of arbuscular and ectomycorrhizal mycelium linking together and establishing common pathways between plants. However, it has been suggested that *Nothofagus* trees can be dual mycorrhizal, potentially associating with arbuscular and ectomycorrhizal mycelium (Smith and Read 2010; Teste et al. 2020). While mycorrhizal fabrics still need to be examined in Pewen ecosystems, it might be hypothesized that *Nothofagus* trees may facilitate the access of Pewen to a larger pool of nutrients. Ectomycorrhizal fungi have higher capabilities to capture organic nutrient and are able to form more extensive mycelium across the forest ground compared to arbuscular fungi (Talbot et al. 2008; Carteron et al. 2020). Nevertheless, arbuscular fungi persist or recover better than ectomycorrhizal fungi after fire events. Therefore, the empirically validated and hypothesized interconnectedness of the biological entities (fungi, trees, cavity nesters) and dynamics in Pewen forests underlie their nature as self-organized complex adaptive systems (Simard et al. 2013; Ibarra et al. 2020b). Here, processes as disparate as disturbances, facilitation, competition, dispersal, and nutrient cycling are connected through cross-scale below- and above-ground fabrics.

### Human agency: Pewen social fabrics

because before, everyone ate piñones and went out to fetch them. . . . People began well in advance the preparations. Some traveled with carts to live for days in the mountains to gather their piñones, and the whole family was there. It was a very nice life!<sup>1</sup>

Mapuche people who live relatively close to Pewen landscapes have, for centuries, temporarily moved to highland forests during the summer and fall with enough provisions to stay a week or more.<sup>2</sup> Early fall is the time when families prepare in advance to make a trip up to the mountains to look for *piñones* or *ngüilliu*, the relished and highly nutritional Pewen seeds. In some territories, gathering *piñones* is a not-to-miss social event. These are also instances for collecting other useful medicinal and edible plants only found in highland forests (Figure 2.2).

For some people, this journey is repeated several times prior to the end of the gathering season. In the past, most families would prepare their wooden carts pulled by a pair of oxen and saddle horses (if available) to get to the *pinaladas* (Pewen forest-stands). They traveled for a couple of days to reach their

traditional gathering spot and would camp until they had gathered enough *piñones* for the winter. Nowadays, people are often using trucks to get faster to the gathering spots, which generally allows them to carry a larger amount of *piñones*. Some families prefer to travel longer distances to reach more favorable or preferred gathering spots. “They (grandfather and uncles) liked going to the Kūra kūra because the piñones were bigger and it was cleaner (meaning open vegetation) to gather or to collect.”<sup>3</sup> These gathering trips were also instances for learning and interacting with each other. “*Piñonear* (the act of gathering *piñones*) was a social act because there you met other neighbors who were also hanging around with their families, and they made a fire and elders would sit up most of the night chatting among themselves.”<sup>4</sup> The *ngüilliu* is generally considered a ‘sacred food’ and it is still gathered and consumed with respect to the ancestors and spirits of nature, by asking permission before collecting seeds and praying ‘rogativas’ before starting the *piñoneo* (Herrmann 2005; Ibarra et al. 2020a). Some community members remember that, in the past, elders would tell stories (*epew*) or historic narratives (*ngütram*) as a way of teaching children about life and especially about how to behave in these forests, teaching philosophies of respect and values for other life-forms. Community gatherings, such as trips to gather *piñones*, were seen as times to reinforce these values. Stories, often interlaced with personal experiences, all impart ecological knowledge as well as cultural perceptions of resources for the benefit of people, to encourage appreciation and also avoid over-extraction (Cruikshank 1990; Turner et al. 2003; Berkes 2012). These traditional modes of communicating, teaching, and learning are tremendously valuable in learning about and practicing sustainable harvesting of wild edible plants (Turner 2000; Turner et al. 2011). They are also instances of nurturing biocultural memory, validating Indigenous epistemologies, and sharing knowledge (Iseke 2014). Stories that our research participants recount always reflect how important these gathering expeditions used to be for the family and community as a whole. They expressed how significant these expeditions were not only for social cohesion and knowledge transmission, but also for securing families with a food of high nutritional value for the winter, when provisions were scarcer.

We have reported that the historical grabbing of Mapuche land by the Chilean state and foreign settlers, the lack of access to forests that used to be traditional gathering grounds by increasing land privatization, and formal schooling are key historical and contemporary drivers of biocultural homogenization of the local food system and the disruption of knowledge transmission associated with the Pewen and other plants (Barreau et al. 2016, 2019). As the gathering of seeds of the Pewen is at the center of human agency and local social fabrics, these processes should be critically analyzed not only in terms of subsistence, but along many dimensions of culture such as identity, social dynamics, institutions, health, and cosmology. Mapuche people who relate to the Pewen are, however, not passive recipients of these drivers of change. They are active agents in the processes of generating activities of community resistance, education, and conservation (e.g., “*Mesa Pewenche por la Araucaria*” of *Trawün Lonko*



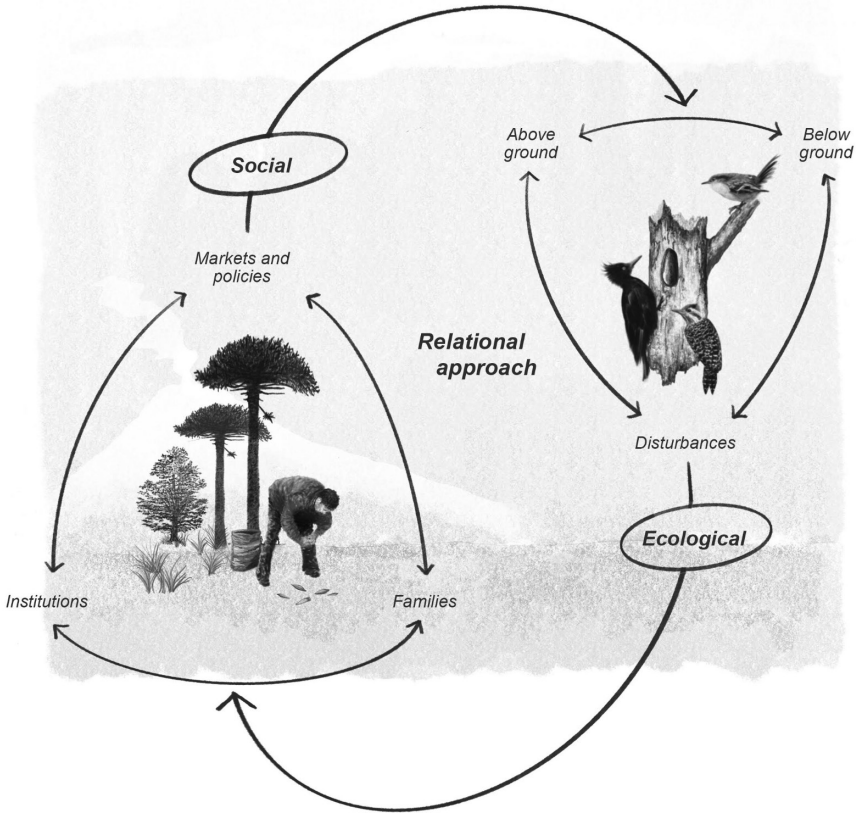


Figure 2.3 A first approach has examined biological entities and their interactions with below- and above-ground fabrics in Pewen forests, examining the role of disturbances shaping ecological dynamics of trees and associated biodiversity. A second approach has explored Mapuche-Pewenche social fabrics linked to the Pewen, which are constrained by historical and contemporary drivers of change such as markets and policies. We propose a third perspective, a relational approach, which highlights unfolding and sympoietic social-ecological relations, overcoming both the ecological/social and the biological entity/human agency dichotomies.

Source: Illustration by M. Medina.

in Lonquimay); creating new market opportunities; and reinforcing spiritual aspects of seed gathering and community bonding. We have reported that local practices related to the gathering of Pewen seeds show the intrinsic and material importance of this seed for both Mapuche people and for long-term non-Mapuche settlers. These practices include the gathering, through the bulk sale of the seeds, to the commercialization of elaborated products (with added value) based on seeds, and a growing offer of tourism experiences that integrate Pewen forests, culture, and local landscapes (Cortés et al. 2019). Therefore, gathering, uses, and commercialization processes associated with the Pewen seeds have at

least two main components that establish a continuous dialogue: an economic component, in the commercial and livelihood vein, and a biocultural memory component, in the spiritual, social, and food sense. Along with the physicality of Pewen landscapes, materials, symbolic meanings, and institutions join to constitute the biocultural memory of the landscape (Barthel et al. 2010). This would constitute the basis to nurture situated knowledge about gathering-related practices and rituals associated with the seeds of the Pewen and other multiple cultivars and biodiversity entities in the southern Andes.

### **Becoming memory: a relational approach to Pewen social-ecological fabrics**

As large as some trees are, it is generally hard for us to think of trees as movable, but they do nevertheless, usually slowly. We are not good at thinking about ‘movement’; our instinctive skills favor the static, the separate, and the self-contained in its determined subordinating of flux, change, and transformation (Chia 1999). Pewen biocultural landscapes do not consist of static components, but of unpredictable and unfolding ‘sympoietic relations’ (sympoiesis meaning ‘making-with’ Haraway 2016). Pewen and its seeds, other plants, wildlife, fungi, soil, climate, people, institutions, the market, and other entities/agents are inseparable from their temporal and spatial dynamic contexts. These entities/agents co-produce each other in complex and sympoietic social-ecological fabrics that vary across space (from the seed to the country and beyond) and time (building on and revisiting the past; Figure 2.2; Darnhofer et al. 2016). Thus, the Pewen, as it is currently, is but a stable moment in a continuing process of ‘becoming’ (Chia 1999).

Returning again to the example of the Austral parakeet, we can depict how social and ecological fabrics, which were previously allocated to their respective conceptual ‘boxes’ and posted to either the ‘natural sciences’ or the ‘social sciences,’ are inextricably intertwined (Figure 2.3). Mapuche people who gather seeds usually consider the presence of flocks of parakeets on a tree as an indicator of a highly productive Pewen. When people approach these specific trees to collect *piñones*, parakeets escape and leave partially eaten seeds behind, which can still germinate, but people avoid harvesting seeds munched by these birds. The escape from human gathering promoted by the parakeet eating behavior is important for maintaining the population viability of Pewen forests (Speziale et al. 2018). In a different example, the largest woodpecker in South America, the Magellanic woodpecker (*Campephilus magellanicus*), is considered a keystone habitat facilitator for several co-occurring species in nestwebs (Altamirano et al. 2017). Simultaneously, this species is identified by Mapuche people as a reliable weather indicator. According to local participants, Woodpeckers descend from Pewen high-elevation forests when snow, storms, or heavy rain are imminent, advising people to gather wood and prepare themselves to face these harsh weather conditions. Using this bird as a weather forecasting method provides Mapuche farmers with a means for reducing uncertainty while improving decisions in resource management (Dayer et al. 2020).

By eating Pewen seeds or *piñones*, Pewenche become the ‘People of the Pewen.’ However, a long history of seed collection, dispersion, and planting indicates a deeper relationship between Mapuche-Pewenche and Pewen forest ecology in volcanic lands of the southern Andes. In an ethnographic account, Rozzi (2018) describes that Pewen seeds contain methionine, which is an essential amino acid that cannot be synthesized by the human body. Interestingly, a scientific biogeochemical perspective offers an ecosystem examination of these habits that concurs with the Mapuche worldview. This amino acid contains sulfur in its molecules. Sulfur input to the biogeochemical cycle from volcanoes is transported by the wind and the water of the streams to the soil, where the microflora conduct processes of oxidation and reduction, permitting sulfur to be absorbed by the roots of the Pewen. Therefore, when Pewenche eat the seeds of the Pewen, they also eat the sulfurous rocks and ashes of the volcano. Hence, the Pewenche not only are ‘People of the Pewen,’ but also Mapuche, ‘People of the Land’ (Rozzi 2018). This historical people–tree relationship has been based on respect and care. For example, not all cones, neither all trees, are selected for harvesting, and sites with higher yields are favored (Herrmann 2005, 2006). Communities often exclude livestock from their gathering grounds. Also, unsustainable gathering practices like cutting green cones or branches to get down the cones, are recognized and rejected by communities (Cortés et al. 2019). Furthermore, Mapuche-Pewenche have historically helped Pewen forests to thrive by protecting them from fires and logging companies. The case of the Quinquen community in Lonquimay is emblematic, in which Mapuche-Pewenche people of Quinquen allied with environmentalist organizations to reclaim their lands from a forest company that was exploiting Pewen in their historical gathering territories in late 1980s. Moreover, they pressured the government to effectively reinstate the nation-wide protection of the National Monument status of Pewen (Bengoa 1992). Many Pewen trees are currently in their ancestral forested lands because of their interaction with the Mapuche-Pewenche, who have historically dispersed seeds, planted tree saplings, or impeded habitat destruction. These social–ecological interactions nurture the biocultural memory of Pewen human–tree landscapes and have had implications for evolutionary and ecological processes (Herrmann 2006; Reis et al. 2014; Speziale et al. 2018).

Mapuche-Pewenche regard Pewen trees as their protectors. The Pewen allowed the survival of Pewenche in the harsh weather of the Andes mountains, especially during the European and Chilean settler invasion: “[Piñón] is the vital element of survival and of living and resistance of the Mapuche people, and the resistance and survival have to do with the history of how our ancestors came to this territory to take refuge, and to live from the resources that Mother Nature provided. Therefore, that is the teaching that we have of how we value this product and how we value this tree.” These memories are still shared today by Mapuche-Pewenche elders, and they remind younger people about the importance of Pewen, and the importance of respect toward this sacred tree. The protector role of the Pewen is part of Mapuche-Pewenche biocultural memory, and it is the basis of a sympoietic relationship between Pewen trees and people.

## **Final remarks**

The Mapuche poet Leonel Lienlaf (1989) recalled that “I became a tree because the tree was my life,” embracing the notion that Pewen social-ecological fabrics are never stable but dynamic complex systems that need to be nurtured and performed every day through biocultural memory (Ibarra et al. 2021). These coupled, complex, and sympoietic social-ecological fabrics are nourished with possibilities that can be enriched with novel meanings and understandings. In our own experience working for over a decade in the southern Andes, this implies a radical reconsideration of both how we think about being human and relations with the various entities that make up Pewen landscapes (Murdoch 1997).

Understanding the properties emerging from social-ecological entanglements, such as the biocultural memory of the system, is politically relevant. Negotiations and decisions on social-ecological systems, which affect local human and non-human lives, are based on the understanding of system properties. Neglecting the history of lived interactions and shared experiences, from where the biocultural memory of the system emerges (Toledo and Barrera-Bassols 2008), can reinforce social inequalities affecting Indigenous Peoples’ livelihoods, trigger conflicts and, more broadly, reproduce colonialism through an environmental management under preservation approaches (Ludwig 2016; Aedo et al. 2017; Muller et al. 2019). Mapuche-Pewenche and the Pewen have an entangled history that has shaped the becoming of both. Their shared social-ecological experiences nurture a biocultural memory that plays an important role in the present and future life of trees and people. They have protected each other, enabling their survival, and their current sympoietic interrelation and mutual caring is based on this heritage.

In landscapes beyond our case in the southern Andes, how the biocultural memory of the system unfolds, with trees (and their seeds) as repositories of this memory, depends on the history of social-ecological relations, on how local people, institutions, biodiversity, and other actors are constituted through these relations, and how these relations project diverse futures (i.e., the “future memory of the system”; Nazarea 2006; Ibarra et al. 2021). These continuous unfolding materials and symbolic relations will be influenced by events or processes occurring beyond the situated people-tree localities that will constrain some development while making possible other means of ‘becoming memory.’

## **Acknowledgements**

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## Notes

- 1 [porque antes todos comían piñones y los iban a buscar. La gente se preparaba con tiempo. Algunos iban con carros a vivir sus cuatro días en la cordillera para sacar sus piñones y la familia entera. ¡Esa era una vida muy bonita!] (E ♀6).
- 2 Only the Pewenche, a subgroup of the Mapuche people, live in between the Pewen trees and they have historically depended on Pewen seeds for their livelihoods as their main staple food.
- 3 [A ellos (abuelos y tíos) les gustaba ir al Kúra kúra porque eran más grandes los piñones y era más limpio para recolectar o recoger] (D ♀ 1).
- 4 [Piñonear era un acto social porque allá se encontraba con otro vecino que también andaba con toda su familia y ahí hacían fogata y se amanecían conversando los viejitos] (E ♀ 6).

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