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RECEIVED 03 April 2025

ACCEPTED 09 September 2025

PUBLISHED 07 October 2025

CITATION

Letelier Cosmelli J, Nuevo-Delaunay A,
Méndez C and Reyes O (2025) Beyond
rupture: archaeological insights into
resilience, resistance and adaptation in
industrializing Aysén Patagonia.
Front. Environ. Archaeol. 4:1605519.
doi: 10.3389/fearc.2025.1605519

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Beyond rupture: archaeological insights into resilience, resistance and adaptation in industrializing Aysén Patagonia

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Introduction: The Aysén region in central-western Patagonia, inhabited for over 12,000 years, presents a valuable case for examining the long-term resilience and adaptation of non-industrial societies to industrial expansion. During the twentieth century, state-driven policies promoted livestock farming, logging, and mining, resulting in profound socioecological transformations that reshaped landscapes and challenged indigenous and rural Creole communities. Rather than an abrupt rupture, industrialization is best understood as part of a longer-term process of environmental and social change.

Methods: This research employs a multiscale approach that integrates archaeological, historical, and environmental data to examine long-term human–environment interactions. Special attention is given to overcoming archaeological selection bias, whereby large industrial sites dominate the record and obscure smaller-scale adaptations critical to local dynamics.

Results: The analysis reveals that preindustrial strategies of resilience persisted, adapted, and transformed during the industrial expansion of the twentieth century. These findings highlight how indigenous and rural communities navigated industrial pressures while maintaining elements of continuity with earlier lifeways.

Discussion: By tracing these processes across various temporal scales, this study demonstrates how archaeological perspectives can enrich research on global change. Long-term records illuminate resilience, resistance, and sustainability in contexts of industrialization, while also underscoring methodological challenges in identifying such processes in the archaeological record.

KEYWORDS

Aysén, Patagonia, human–environment interaction, preindustrial, resilience, resistance

1 Introduction

Archaeology plays a key role in studying socioenvironmental transformations, allowing us to analyze from a long-term perspective how societies have impacted and responded to changes in their territories, production methods, and power structures over long periods. Through the archaeological record, we can identify how different communities managed their resources, faced crises,

and developed strategies for adaptation and transformation that enabled them to sustain themselves in the medium and long terms (Nelson et al., 2012; Sauer, 2014; Løvschal, 2022). While much of the research has focused on preindustrial contexts, examining how these dynamics were reconfigured in settings affected by colonization and the expansion of industrial systems is essential for understanding our contemporary society. These processes not only transformed ecosystems but also established new forms of territorial organization, economic relations, and structures of domination, thus redefining the subsistence and resistance strategies of local communities.

The Aysén region in western Patagonia is an illustrative case for exploring these processes. Although communities in this area have inhabited the territory for more than 12,000 years (Méndez et al., 2023), the most significant changes in the landscape and ecological dynamics occurred with the onset of peripheral capitalism in the early 20th century. However, this period of industrialization did not completely sever ties with the past; instead, it was built upon preexisting adaptation strategies developed within nonindustrial socioecological systems. Indigenous communities such as the Kawéshkar, Tehuelche, Huilliche, and Mapuche, along with rural creole groups, confronted the expansion of industrial livestock farming, deforestation, and mining through a blend of resistance and adaptation. They integrated new productive practices while preserving traditional knowledge of their territory.

The industrialization of Aysén brought profound cultural and environmental changes closely tied to the forced transformation of indigenous communities within the broader Patagonian region. These shifts not only led to their isolation in new environments but also disrupted their traditional ways of using territory and resources (Goñi, 2000; Nuevo-Delaunay and Goñi, 2004; Nuevo-Delaunay, 2012, 2025, 2016; Reyes and Nuevo-Delaunay, 2022; Nuevo-Delaunay and Letelier Cosmelli, 2024). Examining their resilience through archaeology provides valuable insights into their adaptation, negotiation, and survival strategies in response to colonialism and industrial expansion. These processes triggered significant environmental, political, and cultural changes, forcing all communities to develop mechanisms to cope with territorial dispossession and economic transformation.

By examining the material evidence of these transformations, this study draws on systematic archaeological surveys and site documentation conducted since 2008 in the Andean valleys of central-western Patagonia. By integrating archaeological, historical, and environmental data, it examines how local communities adapted to long-term socioecological changes, particularly during the transition from preindustrial to industrial contexts.

This interdisciplinary approach not only sheds light on the continuity and disruption of preindustrial strategies within landscapes reshaped by modernity but also addresses the methodological challenges of identifying these processes in the archaeological record. The overwhelming impact of industrialization has often obscured traces of earlier adaptations, complicating efforts to recognize indigenous resilience and resistance. Understanding these dynamics is essential for revealing how these communities navigated profound

transformations, asserting their agency despite the pressures of industrial expansion.

1.1 Archaeology and resilience: strategies for adaptation and resistance in subaltern societies

It is essential to recognize that the distinction between social and natural systems is artificial to understanding socioenvironmental challenges (Berkes et al., 2002). Over time, perspectives on this relationship have evolved from a deterministic approach—attributing changes exclusively to natural factors—to a more integrative view that acknowledges their reciprocal influence (Bennett, 2005). The Industrial Revolution marked a turning point in this interaction, radically altering the relationship between society and the environment. This transformation accelerated economic and technological development, and it profoundly restructured ecosystems and social organization (Martin, 2009), contributing to the Anthropocene—an era in which human activity has become a dominant geological force (Steffen et al., 2011).

The consequences of these changes include significant alterations to the biosphere, such as landscape modification, loss of biodiversity, and climate change, all of which are progressing at unprecedented rates. The increasing influence of human activities has widened the gap between environmental challenges and our ability to address them (Berkes et al., 2002). Furthermore, these transformations have historically reshaped social structures and settlement patterns, disproportionately impacting marginalized populations through processes of dispossession, marginalization, and forced displacement.

Under the Enlightenment framework, the notion of the rational, self-interested individual became central to the idea of progress (Ingold, 1986). This perspective reinforced the divide between nature and culture, and it influenced the expansion of industrialization in 19th-century America, particularly within its newly formed nation-states. This mindset fueled colonial expansion, creating racial, economic, and epistemic hierarchies that legitimized the dispossession and forced displacement of indigenous populations (Ferdinand, 2022). The coloniality of power imposed Western knowledge systems, marginalizing indigenous communities and their ways of life while integrating them into exploitative labor structures (Quijano, 1998). Despite these imposed frameworks, indigenous and marginalized communities resisted, maintaining alternative relationships with nature and preserving forms of knowledge and adaptation that challenged colonial domination.

In this context, Ferdinand (2022) suggests that two significant fractures characterize modernity. The first is an environmental fracture driven by a technocratic and capitalist civilization that has devastated both human and nonhuman ecosystems and communities. The second is a colonial fracture initiated by Western and imperialist expansion, which has marginalized and dispossessed indigenous peoples. These two fractures have operated simultaneously, reinforcing a model of progress on the basis of exploitation and exclusion. This colonial-capitalist

model not only has structured global inequalities but also has led to the current crisis of the Anthropocene, accelerating environmental degradation.

In response to various crises, the concept of resilience has emerged as a key framework for understanding how societies navigate environmental and cultural transformations. It has been recognized as a boundary concept that has the potential to bridge scientific disciplines and inform policies, planning, and practices aimed at addressing the social and environmental challenges of modernity (Levin et al., 2022; Løvschal, 2022).

Resilience was originally defined as the ability of a system to return to equilibrium after a disturbance (Folke, 2016). However, it has evolved beyond the idea of merely resisting change. Today, resilience is understood not only as the ability to persist but also as the capacity to adapt and transform within dynamic and uncertain environments. This modern understanding incorporates recovery, flexibility, and innovation (Holling, 1973; Folke, 2016). From this perspective, resilience is not about restoring a previous state but about reimagining systems to create new pathways for survival and continuity (Folke, 2016).

In this context, archaeology offers valuable insights into how past and present societies have developed resilience. By studying historical strategies, we can better understand how communities have adapted to environmental and social disruptions. This understanding provides valuable tools for addressing contemporary global challenges (Nelson et al., 2012; Sauer, 2014). Research on past resilience reveals the various methods that communities have employed to navigate crises, such as reorganization, innovation, and cultural persistence, yielding insights that can inform modern strategies for sustainability and adaptation (Sauer, 2014; Løvschal, 2022).

In archaeology, resilience theory often focuses on climate and paleoenvironments, shedding light on how historical societies responded to environmental changes. This long-term perspective helps identify crucial factors contributing to human resilience and informs strategies for future challenges (Burke et al., 2021; Løvschal, 2022). Recent studies in this field have integrated paleoenvironmental data, Bayesian modeling, and radiocarbon dating to link climate variability with settlement patterns (i.e., Colin et al., 2020; Riris and De Souza, 2021).

Nevertheless, some critiques of resilience theory in archaeology highlight its overreliance on ecological models and its tendency to depict societies as passive recipients of environmental change (Burke et al., 2021; Løvschal, 2022). Scholars emphasize the need for a more integrative approach that considers political economy, inequality, and multispecies interactions to better capture the complexities of human–environment dynamics (Løvschal, 2022).

According to Løvschal (2022), archaeology and philosophy can redefine resilience by examining the long-term histories of landscapes and alternative understandings of time. Rather than interpreting change as a linear or catastrophic process, it is crucial to acknowledge the multiple temporal dynamics that shape societies' responses to environmental transformations. This perspective challenges traditional ecological models by emphasizing that environmental change cannot be analyzed in isolation; it must be understood within the political and cultural frameworks that shape it. This shift aligns with broader

developments in archaeology, where crisis and collapse models are increasingly being called into question for oversimplifying social change and overlooking the complex interplay between environmental, political, and cultural factors (Yoffee, 2010; Middleton, 2017, 2025).

Resilience is not only a reaction to environmental pressures but also a response to historical inequalities that shape a society's capacity to adapt. This statement is particularly relevant in central-western Patagonia, where communities, as in most of the Southern Hemisphere, have long developed resilience and resistance strategies in response to socioenvironmental transformations (Silliman, 2001; Nuevo-Delaunay and Goñi, 2004; Dillehay, 2007; Mitchell and Scheiber, 2010; Nuevo-Delaunay, 2012; Friesen, 2013; Kinahan, 2014; Nuevo-Delaunay, 2025; Sauer, 2014; Nuevo-Delaunay et al., 2014, 2017, 2020; Nuevo-Delaunay and Paterson, 2017).

To fully grasp resilience in this region, it is essential to distinguish it from resistance. Resilience encompasses the ability of a system to absorb disturbances, adapt to challenges, and navigate change through multiple strategies (Adger, 2000; Leslie and McCabe, 2013; Folke, 2016). In contrast, resistance involves deliberate efforts by marginalized groups—particularly indigenous communities—to persist within or outside exclusionary systems (Matthews, 2010).

Although distinct, resilience and resistance share a common objective: survival and continuity. Through adaptation, negotiation, or defiance, these strategies illustrate how communities actively assert agency, challenge imposed constraints, and reshape their social and environmental landscapes (Wilcox, 2009). Survival narratives have been instrumental in highlighting indigenous experiences, moving beyond traditional accounts of loss and cultural assimilation. Recent studies on social resilience further support this perspective, demonstrating how communities have developed adaptive strategies to navigate disruptive changes, such as colonial encounters, thus reinforcing their capacity for long-term continuity (Silliman, 2014; Walder and Yann, 2018).

Building on this framework, indigenous communities in Aysén preserved and adapted key cultural practices while simultaneously reconfiguring their identities amid displacement and marginalization. Archaeological evidence suggests that everyday practices—often overlooked in historical narratives (Scott, 1985)—played a fundamental role in both resilience and resistance. These material expressions of cultural continuity, visible in the archaeological record, were essential not only for maintaining identity but also for actively contesting imposed economic and industrial models, resisting assimilation, and challenging historical erasure.

Therefore, reevaluating Aysén's historical period challenges the long-standing notion that this region was uninhabited at the time that *outsiders* arrived, instead highlighting the strategies of adaptation, resilience and resistance developed by its inhabitants. From a decolonial perspective, this means recognizing that indigenous populations and other marginalized communities were not merely passive recipients of external forces. Rather, they were active agents who confronted colonization and industrialization through distinct and often overlooked forms of resilience and resistance. Acknowledging these histories allows us to question

dominant narratives and make visible these communities' enduring struggles and contributions, many of which remain marginalized in mainstream historical accounts.

1.2 Aysén region in context

The Aysén region is located between the 43° and 50° parallels south and covers a total area of 198,494 km², making it one of Chile's most extensive yet most isolated regions. Two main geographical areas characterize this region. First, the Pacific Ocean slope consists of an archipelagic territory featuring a cold jungle stretching from Chiloé to the Taitao (Reyes et al., 2019; Reyes, 2020). This area is historically associated with indigenous canoeing groups such as the Chonos and Kaweshkar (Cooper, 1946; Emperaire, 1963). Second, moving inland toward the region east of the Andes, the landscape transforms into vast steppes and flat, windy terrains. This region is historically connected to the Nahuelhuapi Lake area and extends to the Atlantic Ocean and Argentine territory (Urbina Carrasco, 2013). It is associated with groups known as Aonikenk or Tehuelches and Mapuche/Huilliche communities.

For the coastal area associated with canoeing groups, there is a significant ethnohistorical record detailing the processes of contact and extermination of local canoeing populations from the colonial period onward. However, there is less documentation regarding the Hispanic presence in this region during the colonial era. This lack of references reflects the limited importance historically attributed to the region, as contemporary attention was largely directed toward central Chiloé and the Strait of Magellan areas perceived as economic and political enclaves (Urbina Carrasco, 2013). While there are some relevant records of early direct contact with local populations, most focus on the Pacific coastal zone (Urbina Carrasco, 2010, 2013, 2014; Urbina Carrasco et al., 2020). These accounts, though valuable, are relatively few and become increasingly scarce south of the Chonos Archipelago (around 50° latitude) and especially toward the interior of the territory.

For inland groups, these have been widely described for the current Argentine territory corresponding to nomadic communities with a hunter-gatherer economy. Discourse was constructed from the colonization processes at the time of the formation of the nation-state during the 19th century. The consequences of this formation included the military practices of the neocolonization of genocide and reduction from the state, such as the so-called pacification of Araucanía in Chile and the Desert Campaign in Argentina, which started in the second half of the 19th century and sought to make the presence of native communities invisible.

Since the mid-19th century, the Aysén region has been the focus of numerous scientific and geographical expeditions in the context of nation-state formation. These expeditions contributed to the perception of the area as unpopulated and marginal within the development of the Chilean nation-state. Beginning in the 1830s, an exploratory initiative led by the Chilean navy aimed not only to describe the territory but also to seek access to the interior of

Patagonia. This approach was intended to establish sovereignty and to facilitate future use and occupation of the region (Sagredo, 2013).

In 1871, the Chilean Ministry of the Navy sent an expedition commanded by Commander Simpson aboard the corvette Chacabuco to the coast of Aysén. The mission was to search for a passage into the interior region (Simpson, 1875). Among the results of the expedition was a survey of the northern area of Ofqui; however, it could not be crossed (Steffen, 2010). After two unsuccessful attempts, Simpson finally reached the Patagonian plateau and discovered the valley named after him (Steffen, 2010).

In the last decade of the 19th century, following the signing of the 1881 Boundary Treaty between Chile and Argentina, there was an increased need to explore and define the region. This state interest led to the expedition of the German geographer Hans Steffen, hired by the Chilean government, which took place from 1893 to 1899. Steffen's explorations provided detailed descriptions of the Aysén Valley, the Cisnes River, and the Baker Basin, highlighting the presence of scattered settler communities and the environmental impact of early settlement activities. With respect to the local indigenous population, Steffen did not report any indigenous presence in Aysén itself. However, he did mention their presence in nearby areas (Steffen, 2010). Archaeological studies in neighboring Santa Cruz Province (Argentina) confirmed the continued presence of Tehuelche and Mapuche communities in areas surrounding Aysén (Nuevo-Delaunay et al., 2020). Within Patagonia, particularly the Aysén region, there is little documentary evidence regarding indigenous occupation. This lack of documentation does not imply that indigenous populations were absent; instead, it suggests that their presence may have been overlooked in historical accounts. This issue is connected to the genocide and territorial reduction processes carried out by national governments from the mid-19th century onward, including the misnamed "Pacification of Araucanía" in Chile and the "Desert Campaign" in Argentina. These military campaigns, along with the spread of exotic diseases, alcoholism, and systematic violence, contributed to facilitating the establishment of the livestock industry (Nuevo-Delaunay, 2012).

The expansion of the state profoundly transformed the mobility dynamics of indigenous peoples. Between 1869 and 1870, British naval officer George Ch. Musters traveled 2,750 kilometers from the Strait of Magellan to the Negro River as part of a caravan led by indigenous cacique Casimiro at a time when Patagonia still retained a degree of autonomy (Musters, 1871; Vezub, 2015). The isolation of the surviving communities limited their economic and social opportunities, reinforcing stereotypes about their supposed lack of industriousness and their relationship with alcohol. In 1876-77, Francisco Perito Moreno described that despite the integration of some indigenous people into industrial society, they were often associated with laziness and alcohol consumption. This perception was used to justify their territorial dispossession and their conversion into labor for ranchers (Moreno, 1897). These ideas also extended to the population that migrated to the Chiloé Archipelago in the Pacific Ocean to Aysén, where they were recognized for their role in the colonization and development of the livestock and ranching sectors (Marín, 2014).

The consolidation of the Argentine and Chilean states further restricted indigenous mobility, forcing many communities into marginal areas with fewer resources, making it difficult to sustain their equestrian lifestyle (Velásquez et al., 2005). At the end of the 19th century, the arrival of European sheep breeders and the implementation of state policies accelerated the transformation of the landscape. Throughout the 20th century, the fragmentation of the territory into ranches further solidified this change. Archaeological evidence shows increased remains associated with livestock activities, such as domestic animals, glass tools, and construction materials such as brass (Nuevo-Delaunay, 2012; Belardi et al., 2013). Research within former indigenous *reserves* provides evidence of their persistence despite significant territorial transformations. Archaeological findings from these sites indicate long-term occupation, as seen in architectural structures and tools (Nuevo-Delaunay et al., 2020). Resilience strategies included technological adaptations, particularly in tool production and resource management. The adoption of horses and the repurposing of materials, such as glass for scraper production, illustrate the use of new resources while maintaining traditional practices (Casamiquela, 1978; Gusinde, 1982; Martinic and Prieto, 1986; Otero, 1987; Jackson, 1991a,b, 1999; Horwitz et al., 1994; Martinic, 1995; Nuevo-Delaunay, 2007; De Angelis and Mansur, 2010).

Although local conflicts between ranchers and indigenous people in Aysén have not been as widely documented as those in Magallanes and Tierra del Fuego, they likely existed. The scarcity of historical records does not mean that these conflicts were absent; instead, they may have been less visible in official sources. Expanding livestock and consolidating ranches in the region could create tensions with indigenous populations, particularly concerning access to resources and land. While evidence of these conflicts is limited, some incidents, such as the murder of three Kawésqar individuals in 1931 by employees of Estancia Posadas, indicate that such conflicts did indeed occur (Osorio, 2012).

2 Materials and methods

This research is based on systematic archaeological surveys and stratigraphic excavations in the Aysén region, particularly in the Andean valleys of central-western Patagonia, carried out for over 20 years, thus generating a comprehensive archaeological and historical database relevant to understanding long-term human occupation and adaptation during historical times.

Sites were classified by material composition, spatial distribution, and periodization, integrating archaeological analysis, historical archive review, and environmental data (See Tables 1, 2). Where applicable, each site was documented on the basis of its surface characteristics, spatial setting, and stratigraphic profile. Subsurface interventions, including core sampling, test pits, and large-scale excavations, provided further insights into site formation processes. Additionally, radiocarbon dating, thermoluminescence, and historical documentation were employed to refine the chronological framework. This methodology allowed for the identification of landscape occupation dynamics and their sociocultural, political, and environmental implications, particularly in relation to colonial and neocolonial

expansion by the Chilean state in the early 20th century and the subsequent establishment of an extractivist model.

Finally, regarding the material and contextual aspects of the sites, a typological proposal is presented. A significant methodological challenge in this study is the issue of archaeological selection bias. Industrial expansion has produced a prominent material record of large-scale infrastructures, which often overshadows evidence of smaller-scale strategies. To address this challenge, we implemented a multiscale landscape approach that considers the spatial relationships among different site types, land-use strategies, and economic activities. This approach enables a more nuanced understanding of Aysén's historical period.

3 Results

The data gathered resulted in a classification based on the spatial distribution, material evidence, and the chronological framework. This typological approach provides a comprehensive understanding of regional occupation dynamics, illustrating how indigenous groups, settlers, and industrial actors engaged with the landscape over time.

By integrating these factors, the classification offers a generalized perspective on landscape use, allowing for the identification of long-term occupation strategies, resilience mechanisms, and transformations in settlement patterns. It highlights continuities and shifts in spatial organization, revealing how communities adapted to environmental pressures, socioeconomic shifts, and industrial expansion. To exemplify each category, we describe the main archaeological sites of the categories.

Regarding the material and contextual aspects of the sites, the following typological proposal is presented, followed by an explanation of each category (see Figure 1).

3.1 Open-air habitation sites of recent indigenous groups

These sites contain lithic, ceramic, and faunal remains, indicating recurrent occupations by indigenous groups before direct contact with colonizers. Among them, Chile Chico 1, located on the coast of Lago General Carrera, contains dispersed surface materials, including lithic debris, ceramic fragments, and grinding stones with starch grains from native plants such as *Mutisia spinosa* and *Solanum tuberosum* (Nuevo-Delaunay et al., 2022). Stratigraphic excavation reveals additional material at depths of up to 10 cm, including lithic flakes, burned and fragmented bones, a carved tool, and a pigment-stained pebble. Radiocarbon dating identifies two occupation phases: 290–440 cal BP and 330–550 cal BP (Nuevo-Delaunay et al., 2022).

These sites likely represent late precontact indigenous occupations, where the presence of ceramics suggests engagement in regional exchange networks and the continuation of traditional subsistence practices. They illustrate how indigenous communities maintained mobility patterns, resource exploitation strategies, and technological traditions while gradually integrating external materials into daily activities.

TABLE 1 Summary of archaeological site typologies in the Aysén region.

Site type	Example site(s)	Key features	Chronological range
1. Open-air habitation sites (Indigenous)	Chile Chico 1 (RJ80)	Lithics, ceramics, faunal remains, grinding stones	290–440 cal BP, 30–500 cal BP
2. Open-air habitation sites (indigenous + historical)	Appeleg 1 (CIS009)	Lithics, ceramics, faunal, glass, metal	330–500 cal BP, 730–800 cal BP, post-1880
3. Isolated finds/discrete events	Sitio El Deshielo Histórico (CIS082)	Low-density remains, hearths	20th century
4. Cave sites with recent use	Cueva de La Vieja (BN15), El Chueco 1 (CIS042), Cueva de las Manos del Río Pedregoso (RJ95)	Manure, ash, burning evidence	19th–20th century
5. Ranch headers (main estates)	Antigua Estancia (CIS103), Estancia Alto Río Cisnes, SIA (Coyhaique), Lucas Bridges House	Wood/metal/masonry structures, industrial buildings. Indigenous-type technologies linked to the presence of foreign raw materials such as glass	1903–1930s
6. Satellite sites (permanent)	Puesto El Deshielo (CIS084), Avilés River Valley	Worker housing, minimal structures	20th century
7. Satellite sites (lightweight)	CIS101, CIS095, CIS096	Temporary shelters	20th century
8. Independent actor installations	Casa Richards (Ñ2), Arroyo Cardenio 2 (RJ111)	Wooden houses, domestic artifacts.	1898–early 20th century
9. Documented historical landmarks	Guerra de Chile Chico site (Laguna Verde), Isla de los Muertos	Burials, architectural remains	1905–1917
10. Historical fire features	La Veranada (COY007)	Stratified ash/fire layers	Colonial to 20th century
11. Industrial mining sites	Puerto Cristal, Puerto Sánchez, Las Chivas, La Escondida	Mining processing plants, worker housing	1936–1990s

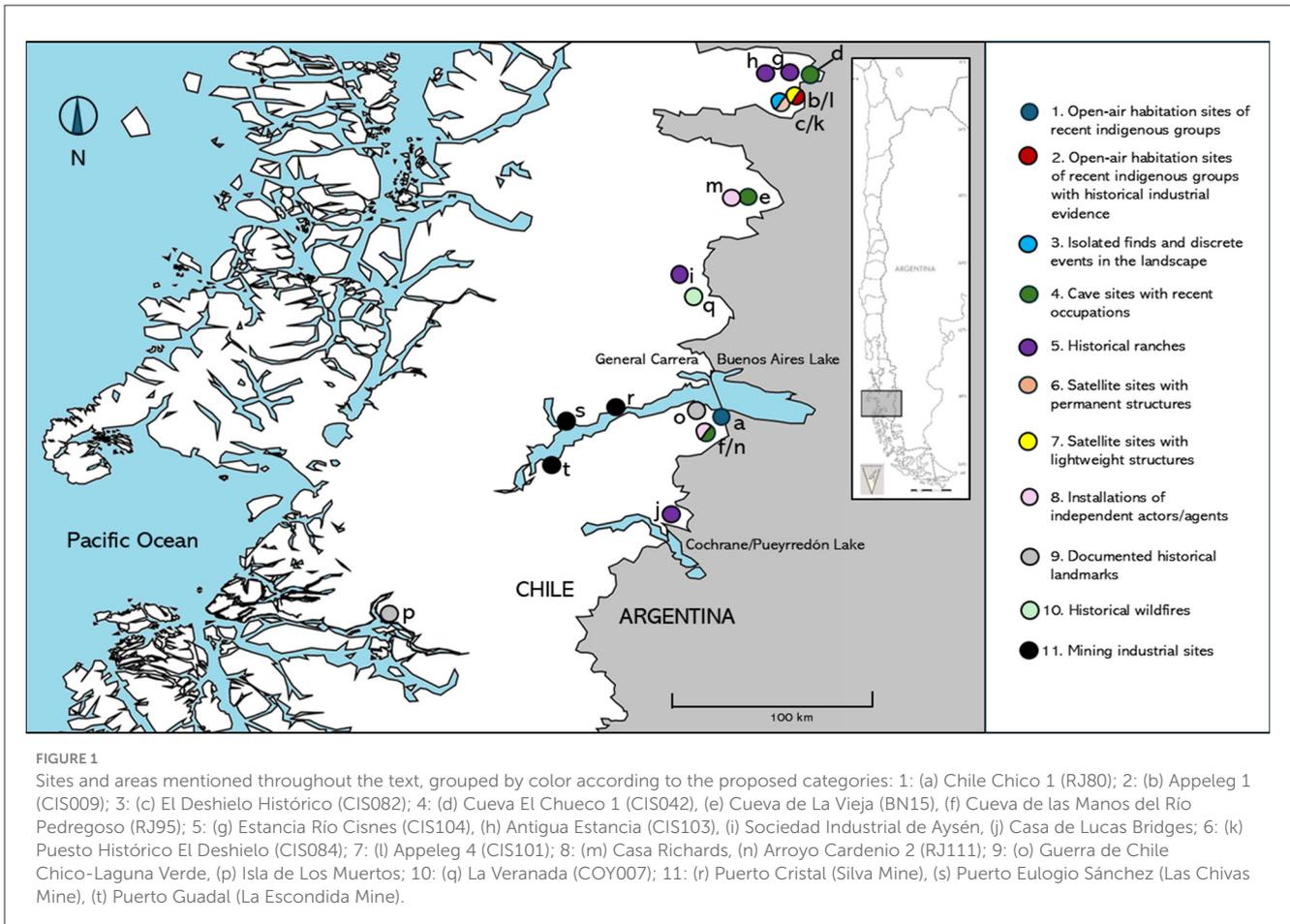
TABLE 2 Comparative summary of environmental changes and cultural responses over time.

Period	Environmental changes	Cultural responses	Supporting data types
Preindustrial (before 1900)	Early Holocene fire peak likely caused by lightning, predating human presence. After ~11,000 cal yr BP, increased moisture drove <i>Nothofagus</i> expansion. Forest–steppe dynamics were shaped by climate and low-intensity Indigenous burning. Mid-Holocene CHAR rose slightly but remained low compared to industrial-era levels.	Territorial mobility; seasonal use of resources; Indigenous fire management practiced at fine ecological scales.	Paleoecology (pollen, charcoal) from Lake Shaman and El Embudo Mallín (de Porras et al., 2012, 2014); archaeology (Méndez et al., 2016); paleofire synthesis (Holz and Veblen, 2009; Holz et al., 2012).
Early industrial expansion (1900–1950)	Onset of large-scale deforestation and fire-driven pasture expansion due to settler colonization and industrial livestock. CHAR values rise dramatically, peaking at 176 particles/cm ³ /yr around 2.8 ka.	Indigenous displacement; restructuring of land and livelihoods; adoption of hybrid tools (e.g., lithic-glass); incorporation into wage labor.	Historical documents; sediment charcoal data (de Porras et al., 2012, 2014); colonial fire records (Holz and Veblen, 2009); archaeological surveys.
Late industrial phase (1950–1990)	Land-use intensification continues. Pollen and charcoal data reflect ecological degradation and regressive succession. Fire activity declines due to vegetation shifts and suppression policies.	Rural depopulation; weakening of traditional knowledge systems; structural reliance on export-based livestock production.	Pollen and vegetation analyses; paleoecological studies (de Porras et al., 2012, 2014; Martinic, 2005).
Contemporary (1990–present)	Fire control and conservation policies introduced. Increase in protected areas, including national parks and private reserves. Landscape fragmentation increases due to privatization and competing land uses.	Livestock economy persists; rise of salmon farming and ecotourism; increased local participation in conservation and cultural heritage.	GIS and conservation databases; environmental policy reviews; fire monitoring; land-use data.

3.2 Open-air habitation sites of recent indigenous groups with historical industrial evidence

A variation on open-air habitation sites, these sites exhibit characteristics similar to those of the previously described category but include historical materials such as glass and metal, indicating repeated visits and reoccupations (Nuevo-Delaunay et al., 2022). One notable example is Appeleg 1, which is located in the Cisnes River Valley (Velásquez et al., 2007; Méndez and Nuevo-Delaunay, 2019).

Appeleg 1 consists of multiple concentrations of dispersed materials across an extensive 14,500 m² area situated in deflation hollows on dunes (Reyes et al., 2006; Velásquez et al., 2007; Méndez and Nuevo-Delaunay, 2019). The site contains lithic and ceramic artifacts, faunal remains, stone arrangements, combustion areas, and historical materials such as metal and glass (Figure 2). Radiocarbon dating reveals multiple occupation phases, ranging from 330–500 cal BP and 730–800 cal BP (Méndez et al., 2016). Additionally, thermoluminescence dating revealed earlier occupations at 1,290 ± 130 and 740 ± 80 BP (Velásquez et al., 2007; Méndez and Nuevo-Delaunay, 2019).



Historical materials provide further chronological markers. Glass fragments display mold seams and hand-finished lips, suggesting that some bottles date to at least 1880. Additionally, soldered tin cans indicate occupation before 1920, whereas industrially manufactured bottles date to after 1930 (Méndez and Nuevo-Delaunay, 2019). The site has undergone significant post-occupational disturbances, primarily due to intensive sheep ranching since the early 20th century, associated with Estancia Río Cisnes (Velásquez et al., 2007).

Beyond the material evidence, the site contains stone accumulations, which are features often linked to funerary practices such as chenques, a tradition associated with steppe hunter-gatherers over the past millennium. However, no human remains have been identified at this location, suggesting alternative interpretations. Some researchers propose that these mounds served as landscape markers, whereas others suggest the possible presence of “false chenques” (Reyes et al., 2006).

3.3 Isolated finds and discrete events in the landscape

These sites correspond to locations with very low-density material remains or single-use hearth features without subsequent reoccupation. These have been identified across all surveyed valleys

in the region. These occupations predate industrial expansion and include radiocarbon-dated contexts ranging from pre-Hispanic to early colonial periods notably exemplified by the site El Deshielo Histórico. The presence of such features suggests indirect contact with external influences, as indicated by shifts in mobility patterns, which were likely influenced by the introduction of horses. However, despite these changes, traditional movement strategies appear to have persisted. These sites represent ephemeral occupations primarily associated with transient activities, with hearths serving as key indicators of short-term habitation.

3.4 Cave sites with recent occupations

These sites correspond to ephemeral activities that have been recognized or excavated within the upper layers of the depositional sequences. A notable example is the Cueva de La Vieja in the Ñirehuao Valley, which shows evidence of initial occupation in the region. At the base of its upper stratum, sheep manure remains have been dated to approximately 130 ± 30 years BP, indicating the initial stage of livestock farming at the start of the XX century (Méndez et al., 2018). Another important site is El Chueco 1 cave in the Cisnes River Valley, where the upper stratum containing manure associated with occupation in a ranching context (Méndez et al., 2011).



Historical occupations occur in these top stratigraphical units as indicated by recent age archaeological material within these dung strata. A comparative micromorphological analysis carried out in analogous sections of Cueva de la Vieja and Baño Nuevo 1 sites showed that sedimentary changes of the XX century were as profound as those of the Pleistocene-Holocene transition (ca. 11,500 cal BP) indicating major transformations in the environment surrounding these two sites (Ozán et al., 2019). Additionally, the Cueva de las Manos del Río Pedregoso site in the Jeinemeni Valley reveals a distinct layer beneath the upper layer of Hudson River ash. This layer shows traces of manure and evidence of burning events associated exclusively with sheep bone material (Nuevo-Delaunay et al., 2022). These sites likely reflect the presence of industries related to sheep herding, as well as evidence of continuous occupations since ancient times in Patagonia.

3.5 Historical ranches

These sites correspond to concentrations of multiple hierarchically arranged architectural evidence with different functions in various states of preservation. Among them is the Antigua Estancia site on the Cisnes River, corresponding to one of the earliest settlements associated with ranching development in the area. It features 7 architectural structures, predominantly made of wood and metal sheeting. Additionally, the Estancia Río Cisnes, built in 1932, stands out as the main settlement of this valley (Ivanoff, 1997; Consejo de Monumentos Nacionales, 2009), built by the livestock company Anglo-Chilean Pastoral Co. The foundational house (Figure 3) includes other associated facilities, such as a shearing shed and a school. These ranches likely shifted the location of their facilities throughout its occupational history (Figure 4).

Also included are the facilities of the Aysén Industrial Society (SIA), the current location of the Regional Museum of Aysén in Coyhaique, established in the valley of the Coyhaique River between 1903 and 1906. Its central facilities were used by the company until 1848, highlighting the presence of an industrial-style city where, in addition to the facilities related to ranching, such as shearing sheds, workers' houses, sheep baths, and pens, a warehouse, a bakery, and the doctor's residence were present, along with the police station (Osorio, 2021). Notably, the Foundation House has incorporated building materials over time, predominantly wood and metal but also masonry and concrete, as in the case of the SIA in the 1930s.

Finally, the house of Lucas Bridges in the Chacabuco Valley is noteworthy. It was linked to the Posadas Estate Society of Hobbs and Co. in 1916, which in turn began to be managed by Lucas Bridges in 1921. The house is made of wood with a rectangular floor plan, features a gabled metal roof, an exterior covered corridor, and a tongue-and-groove floor, and was reconstructed in 2018, becoming a museum. Additionally, fragments of chipped glass bottle bottoms were found outside the house in the early 2000s. Six pieces resemble what could be associated with scraping activities, suggesting likely indigenous-type technologies linked to the presence of foreign raw materials such as glass. This evidence illustrates the transformation of traditional lifestyles of local populations in the context of the development of the ranching economy.

3.6 Satellite sites with permanent structures

These sites are designated for the accommodation of workers engaged in specific seasonal livestock management tasks in remote areas of the ranches. They feature a limited number of structures and offer less functional diversity than head ranches do. Notably,



FIGURE 3
Drawing of the current manor house of the National Monument Estancia Río Cisnes (CIS104).

these sites have been identified primarily along the Cisnes River, such as the Puesto Histórico El Deshielo site (Figures 5, 6), and in the Avilés River valley (Patagonia National Park).

3.7 Satellite sites with lightweight structures

These sites are designated for occasional overnight stays in remote areas. They feature simple, expedient structures that require minimal investment and are utilized primarily for tasks related to grazing, particularly around the main ranches and especially in the upper Cisnes River basin (CIS101, CIS095, CIS096) (Figure 7).

3.8 Installations of independent actors/agents

These installations represent sites of often spontaneous settlement processes that took place both before and after the implementation of state-led population strategies. Unlike officially planned settlements, these locations were established by nonindigenous independent individuals or groups who occupied and utilized the land on the basis of economic opportunities.

One of the earliest is the settlement of the Richard brothers in Ñirehuao. Their arrival was documented to have occurred in 1898, prior to the border agreement with Argentina. Although no architectural remains have been identified in the studied area and no conclusive evidence confirms this site as their settlement, the findings indicate a historical occupation associated with livestock

farming, particularly cattle and horses. This is supported by the presence of animal bone remains, along with various metal artifacts, such as nails, wires, and glass fragments.

Another significant site is Arroyo Cardenio 2 (Figure 8), which is located in the Meseta de Chile Chico, a currently uninhabited area. The site features a wooden structure with a foundation made of flagstone, including a chimney of the same material. The upper part and the roof are covered with zinc sheets, and the structure has windows, although their glass panes are broken. While the ownership of this house remains unclear, local accounts suggest that it may have once belonged to outlaws.

3.9 Documented historical landmarks

These sites are part of extensively documented historical events. Among them, significant information exists regarding the key locations of the “Guerra de Chile Chico” in 1917 (Niemeyer, 1969; Ivanoff, 1997), which include architectural remains (Figure 9) and burial structures. This site is crucial for understanding the cultural dynamics and early conflicts between estancia and independent settlers and, consequently, the confrontation between the Chilean state and rural colonists.

Another significant site is the Isla de los Muertos, located in the Baker River delta, which served as a cemetery for 34 workers from the Sociedad Explotadora del Baker, a company dedicated to forestry and livestock exploitation in the region. The workers arrived in December 1905 and were supposed to be retrieved by mid-1906. However, this never happened, resulting in the tragic death of 59 laborers, leading to the establishment of the cemetery

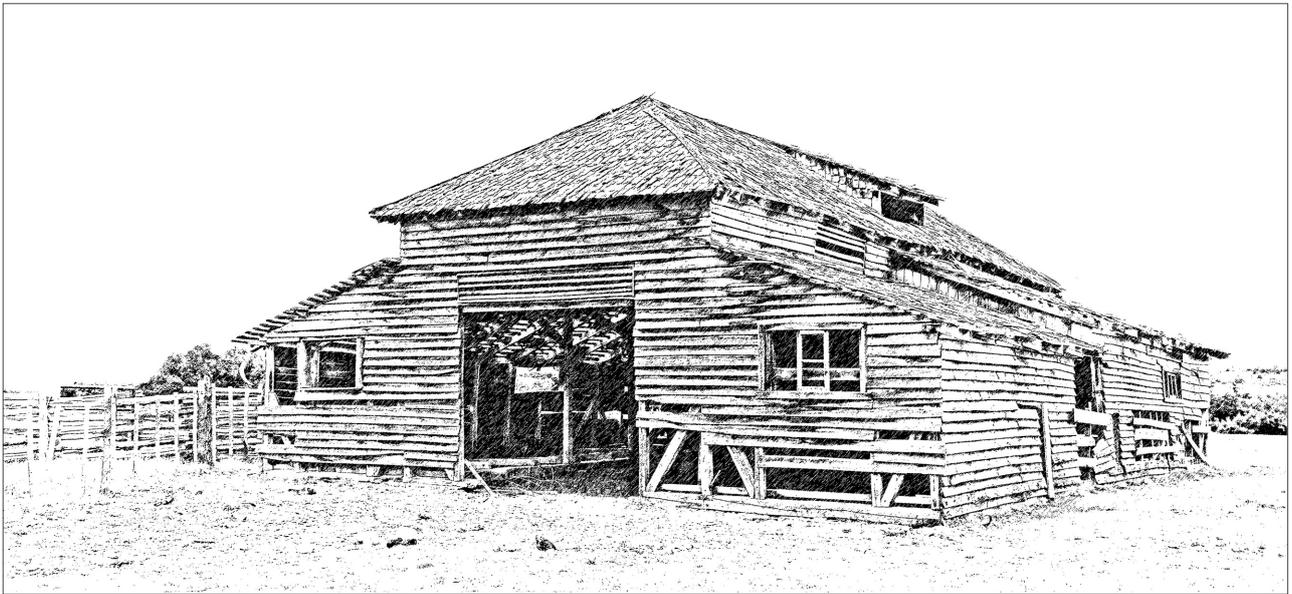


FIGURE 4
Drawing of the current view of a shed-type structure at the Antigua Estancia site (CIS103).

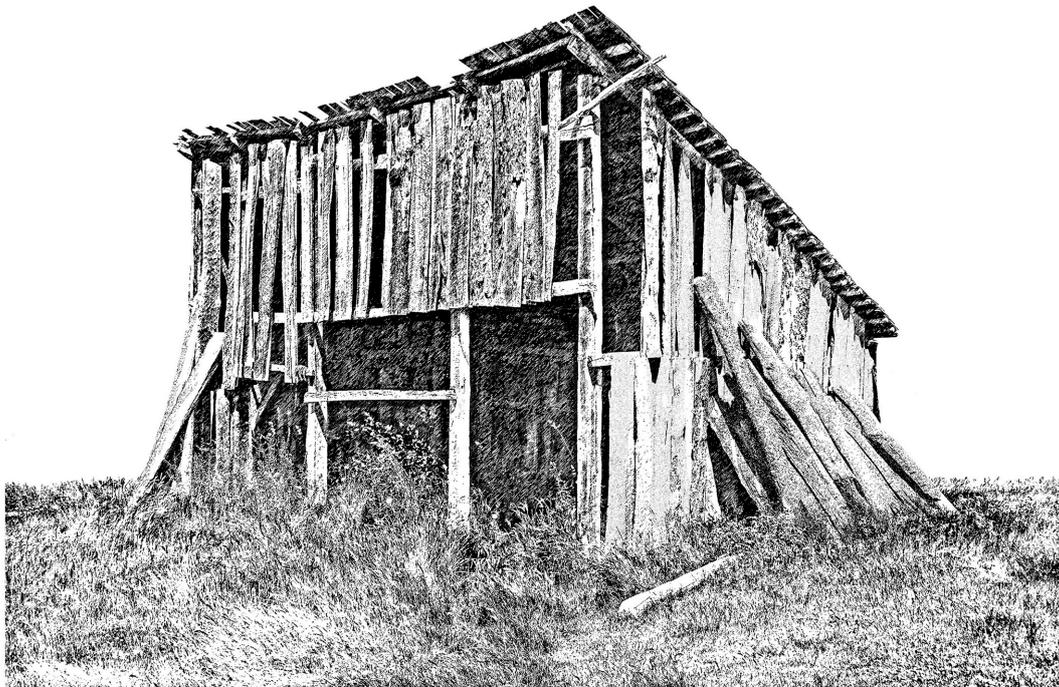


FIGURE 5
Drawing of the current view of a stable at the Puesto Histórico El Deshielo (CIS084) site.



(Ivanoff, 2000; Mena and Velásquez, 2000; Martinic, 2005; Osorio, 2016; Reyes et al., 2004).

3.10 Historical wildfires

Across much of the region, evidence of historical fire events is embedded within the stratigraphic record, tracing back to the arrival and establishment of settler communities (Martinic, 2005). These fire features, which were often associated with land clearing, provide crucial chronological markers for reconstructing past human–environment interactions. The Simpson River Basin offers well-documented cases, particularly at La Veranada site, where stratigraphic sequences reveal multiple fire episodes linked to occupation and landscape modification (Méndez et al., 2013). These findings highlight the role of fire as both a transformative environmental force and an indicator of historical land-use patterns.

3.11 Industrial mining sites

These sites represent large-scale mining settlements associated with the extraction of lead, molybdenum, and silver, particularly

around General Carrera Lake. The Silva Mine, identified in 1936, initially operated on an artisanal scale before consolidating with the establishment of Empresa Minera de Aysén (EMA) in 1948. EMA later developed Puerto Cristal, a mining camp that housed 900 inhabitants by 1953 (Pérez-Bustamante et al., 2010). The site retains extensive industrial remains, including processing plants, transportation systems, and worker housing, offering significant archaeological evidence of mid-20th-century extractive industries.

At the same time, significant copper deposits were discovered in Las Chivas near Puerto Eulogio Sánchez town, leading to mining operations starting in 1950 under the Compañía Minera Las Chivas. This discovery was soon followed by the establishment of the La Escondida copper mine in Puerto Guadal, which further intensified industrial activity and migration to the region (Pérez-Bustamante et al., 2010).

Another important settlement, discovered in 1948, was Puerto Eulogio Sánchez (Figure 10), which was developed in connection with the Las Chivas Mine on the northern shore of General Carrera Lake. Mining operations at this site began around 1950, and 150 workers were employed (Pérez-Bustamante et al., 2010). Between 1960 and 1990, the site was operated by three different companies, beginning with Compañía Minera Tamayo S.A. until 1963, followed by Compañía Minera Las Chivas (Lahsen and Oyarzún, 1966). Mining activities ceased in the early 1990s, leaving behind extensive



FIGURE 7
Lightweight wooden structure at Appeleg 4 (CIS101) site in the Río Cisnes area.

structural remains such as ore-processing facilities, slag heaps, and residential areas.

The decline in mining activity led to the gradual depopulation of these settlements. However, their material remains provide a critical archaeological record of industrial adaptation, technological processes, and the social dynamics of mining labor in Patagonia. The remnants of mining infrastructure, abandoned settlements, and associated artifacts serve as tangible evidence of the region's extractive past, offering valuable insights into the industrial transformations and workforce mobilization that characterized this period (Letelier-Cosmelli et al., 2025).

4 Discussion

The archaeological record of Aysén in central-western Patagonia sheds light on how indigenous and local communities navigated profound social, political, cultural, environmental, and economic transformations during neocolonialization and industrialization. In response, they developed resilience strategies beyond survival, actively shaping change by negotiating challenges,

adapting traditions, and resisting imposed systems when necessary (Holling, 1973; Folke, 2016). This resistance often took the form of everyday acts—subtle yet powerful—which archaeology helps uncover. Material traces of daily life, such as tool use, settlement patterns, and resource management, reveal how communities asserted agency, not only enduring disruption but also reclaiming their identity and reshaping their landscapes amid external pressures.

At a regional scale, the processes related to industrialization must be understood within broader environmental, social, and political transformations. These changes were not limited to the adoption of new technologies; they also involved shifts in social dynamics, cultural practices, and power structures. The expansion of Spanish-controlled regions in the north, driven by conquest and territorial control, led to displacement, forced adaptation, and the restructuring of indigenous territoriality and mobility. Within this context, the introduction—and eventual dominance—of horses from the 17th century onward played a crucial role in redefining movement patterns, resource exploitation, subsistence strategies, and territorial organization (Taylor et al., 2023; Rindel et al., 2024). Equestrian practices



FIGURE 8
Drawing of habitation structures associated with outlanders at Arroyo Cardenio 2 site (RJ111).



FIGURE 9
Adobe and stone residential structure, Estancia Lago Verde, corresponding to one of the conflict areas during the "Guerra de Chile Chico."

extended mobility ranges, facilitated new hunting and trade strategies, and contributed to the emergence of hybrid socioeconomic systems that blended indigenous traditions with colonial influences.

In central-western Aysén, these transformations became particularly evident from the 18th century onward. However, the most profound social and material changes occurred in the mid-19th century, when military campaigns in Argentina and Chile



FIGURE 10
Mineral processing plant in Puerto Eulogio Sánchez in the basin of General Carrera Lake.

disrupted settlement patterns and forced indigenous groups into marginal areas (Goñi, 2000). These pressures escalated with the consolidation of national borders and the expansion of the estancia economy in the early 20th century. This process, described as “extensification,” led to reduced mobility and the establishment of more permanent settlements, intensifying land use and ultimately contributing to the collapse of traditional subsistence systems (Goñi, 2000; Bandieri, 2005).

This process can be observed through key archaeological sites, such as Chile Chico 1 in the General Carrera Basin and Appeleg 1 in the upper Cisnes River Basin, which provide insights into the transition of indigenous communities from traditional ways of life to the gradual incorporation of foreign elements introduced through colonial dynamics. Appeleg 1 suggests continuity of occupation before industrial transformations, extending into the 18th century but becoming more evident through material remains dating to the late 19th and early 20th centuries in spatial coexistence with earlier material (Reyes et al., 2006; Velásquez et al., 2007; Méndez and Nuevo-Delaunay, 2019). This period also coincides with significant disturbances, primarily due to intensive sheep ranching since the early 20th century, particularly linked to Estancia Río Cisnes (Velásquez et al., 2007).

Despite these transformations, the findings at the house of Lucas Bridges in the Chacabuco Valley reveal the integration of

glass as raw material into traditional indigenous practices typical of lithic material in leather and wood processing. This change suggests the adoption of new raw materials while maintaining traditional techniques. This technological transition suggests continuity in craft production and dynamic engagement in exchange networks with nonindigenous populations as well as active agency in the face of external pressures.

The early stages of industrial expansion in Aysén are reflected in sites associated with informal settlement processes that preceded the establishment of national borders. Early cases such as Casa de Richards illustrate how settler communities expanded independently before official state intervention. While the archaeological record of interactions between these early industrial initiatives and local indigenous populations is scarce, it is not entirely absent. Further research is needed to better understand these early dynamics, particularly how indigenous and outsider communities engaged with, resisted, or adapted to these initial waves of industrial expansion.

However, the most significant social and material transformations occurred in the late 19th century, driven by the expansion of the livestock industry and the arrival of European settlers who established themselves in the region. These changes intensified in the early 20th century with the formalization of national borders, which accelerated the growth of the estancia

economy, closely tied to large-scale land use and resource exploitation. The Chilean state actively promoted this model to assert sovereignty in frontier regions, implementing territorial control through land leases to large companies (Harambour, 2019). This model marked a shift toward state-facilitated territorial appropriation, displacing preexisting indigenous and local actors and legitimizing their exclusion by framing them as nonexistent. In this context, entrepreneurs and foreign investors were entrusted with exercising sovereignty on the state's behalf (Harambour, 2019).

The estancia economy reshaped land ownership and transformed the region's infrastructure. Roads and law enforcement posts, often subsidized by the same companies that controlled the land, reinforced state presence. Large administrative centers emerged, such as Estancia Río Cisnes, Antigua Estancia, and the house of Lucas Bridges. These sites functioned as urban hubs, integrating sheep farming with essential services for settlements and surrounding areas. Beyond these main estancias, a network of satellite sites played a crucial role in the region's economic and social organization. These included permanent outposts, such as Puesto El Deshielo, and temporary overnight shelters, such as Appeleg 4 and several lightweight structures in the Barrancas del Cisnes area (CIS095, CIS096). Additionally, some preexisting indigenous occupation sites, particularly caves, were repurposed for estancia-related activities. Notable examples include Cueva de La Vieja in the Ñirehuao Valley (Méndez et al., 2018), Cueva El Chueco 1 in the Cisnes River valley (Méndez et al., 2011), and Cueva de las Manos del Río Pedregoso in the Jeinemeni valley (Nuevo-Delaunay et al., 2022). These sites illustrate the extensive land-use strategies of estancia economies, which depended on worker mobility and deep territorial knowledge. Economical, administrative and population changes were significant enough to produce modifications in local hydrology and land use as revealed by fine-grained sedimentary studies in cave sites in the Ñirehuao valley which precisely date to the late 19th to early 20th century transition (Ozán et al., 2019).

Parallel to the state-driven expansion of industrial livestock farming, a wave of unplanned migration took place as Chilean creole populations moved southward in search of new opportunities. Many had already experienced displacement from northern and central regions of Chile, and their arrival led to increasing land conflicts, most notably the "Guerra de Chile Chico"—a series of violent clashes between rural settlers (both indigenous and creole) and large *estancieros*, where state forces ultimately sided with the latter.

This broader conflict was not limited to disputes over land ownership; it also extended to the conditions of labor exploitation. Isla de Los Muertos serves as a stark reminder that systemic abuses were inflicted not only upon indigenous communities but also upon creole workers, who endured extreme labor conditions under exploitative regimes. Many of these workers, drawn into the expanding forestry and livestock industries, faced unsafe working environments, harsh treatment, and a lack of state protection. The tragic events at Isla de Los Muertos, where dozens of workers perished under extreme conditions, underscore how industrial expansion and territorial control were deeply intertwined with labor exploitation, reinforcing social

hierarchies and widening inequalities (Ivanoff, 2000; Mena and Velásquez, 2000; Martinic, 2005; Osorio, 2016; Reyes et al., 2004).

These migrant workers, particularly those who settled outside the estancias, significantly reshaped the landscape. Unable to access the best pasturelands, they established themselves in marginal forested areas, where fire became a key tool for land clearing. While indigenous communities had long used controlled burning for land management, the arrival of migrant settlers and the expansion of estancias intensified deforestation on an unprecedented scale (Holz et al., 2016). The stratigraphic record confirms widespread fire use, with dispersed charcoal deposits aligning with historical accounts of large-scale burns (Holz et al., 2016). Whether intentional or resulting from unsustainable land-use practices, these fires drastically altered the environment, particularly in areas converted into pastures (Martinic, 2005). The La Veranada site in the Simpson River Basin provides clear sedimentary evidence of these fire-induced transformations (Méndez et al., 2013), illustrating the long-term ecological impact of human intervention in Aysén's landscapes.

Migrant workers played a significant role in reshaping the landscape. Lacking access to prime pasturelands, they cleared marginal forested areas using fire. While Indigenous communities had long practiced controlled burning as part of their land management, the arrival of settlers and the expansion of estancias intensified deforestation on an unprecedented scale (Holz et al., 2016). Stratigraphic evidence, including widespread charcoal deposits, supports historical accounts of large-scale burns, particularly in areas converted to pasture (Martinic, 2005; Méndez et al., 2013).

At a regional scale, fire activity in Patagonia is influenced by both climatic variability and human impact. The most significant peak in fire activity occurred shortly after the arrival of humans, suggesting that climate alone cannot account for this pattern (Holz et al., 2016). Climate systems like the Southern Annular Mode, which alters westerly wind patterns, and the El Niño–Southern Oscillation, which affects rainfall and temperature, have shaped environmental conditions. However, archaeological, historical, and oral sources emphasize the crucial role of human-set fires in driving ecological change, particularly during the late Holocene (de Porras et al., 2014; Holz et al., 2012; Méndez et al., 2016; Moreno et al., 2023).

Vegetation studies support this interpretation, showing clear patterns of change following fire (de Porras et al., 2014; Kitzberger et al., 2005). These processes have contributed to transforming native forests and grasslands into fire-prone shrublands, reinforcing recurrent disturbance cycles (Veblen et al., 2008; de Porras et al., 2012, 2014). Fire effects include direct impacts like biomass loss, soil organic matter combustion, and cambium damage from heat. Indirect effects involve changes in soil properties, microclimate (radiation, temperature, moisture), and altered herbivore habitats that can influence plant communities (Kitzberger et al., 2005).

Vegetation studies support this interpretation, showing clear patterns of change following wildfire occurrence (de Porras et al., 2014; Kitzberger et al., 2005). These processes have

contributed to transforming native forests and grasslands into fire-prone shrublands, reinforcing recurrent disturbance cycles (Veblen et al., 2008). Overgrazing by sheep further accelerates these transformations (Kitzberger et al., 2005).

In addition to livestock farming, mining emerged as another major driver of industrial expansion in Aysén. The discovery of lead, copper, zinc, and molybdenum deposits in the basin of General Carrera Lake led to the rise of artisanal mining in the 1940s, followed by industrial-scale operations in the 1950s. These mineral discoveries gave rise to significant mining settlements such as Puerto Cristal and Puerto Sánchez, where community life was deeply shaped by extractive activities. Today, the remnants of these once-thriving settlements and their abandoned infrastructure stand as poignant testaments to this extractive past. While there are increasing efforts to preserve and promote these sites as part of the region's cultural and tourism heritage, the environmental legacy of mining remains unresolved. In particular, contamination from heavy metals continues to affect the waters of General Carrera Lake and surrounding ecosystems, posing ongoing risks to biodiversity and public health.

5 Conclusion

In Aysén, the expansion of industrial livestock farming and mining profoundly reshaped ecosystems and local social structures. These transformations, evident in archaeological, ecological, and historical records, fundamentally altered the forest-steppe ecotone and disrupted long-standing Indigenous land-use systems. The imposition of extractive and export-oriented production models displaced traditional livelihoods and fragmented territories. Despite these pressures, indigenous and local communities demonstrated remarkable resilience, adapting to new realities while preserving key elements of cultural identity, ecological knowledge, and social cohesion.

The archaeological record of Aysén is central to revealing these historical dynamics. It documents long-term land-use strategies grounded in deep environmental understanding and complex forms of collective organization, knowledge systems often overlooked or erased in written histories. This historical lens is particularly relevant today, as contemporary crises such as climate change, land grabbing, and renewed extractive pressures continue to impact marginalized populations disproportionately. Engaging with these layered pasts allows us to understand ongoing injustices better and imagine more equitable and sustainable futures informed by historical memory and community-based resilience.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

Author contributions

JL: Resources, Writing – original draft, Investigation, Funding acquisition, Visualization, Data curation, Project administration, Conceptualization, Formal analysis, Writing – review & editing, Methodology. AN-D: Methodology, Writing – original draft, Conceptualization, Validation, Data curation, Investigation, Visualization, Supervision, Funding acquisition, Formal analysis, Writing – review & editing, Project administration, Resources. CM: Validation, Formal analysis, Writing – review & editing, Project administration, Supervision, Data curation, Methodology, Investigation, Writing – original draft, Conceptualization, Resources, Funding acquisition. OR: Project administration, Methodology, Data curation, Writing – review & editing, Investigation, Conceptualization, Funding acquisition.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. BIP 40047179-0 GORE Aysén Paisaje Arqueológico Rural de Aysén entre los siglos XVIII y XX, ANID REGIONAL R20F0002 (PATSER), ANID FONDECYT 1210042, ANID FONDECYT 1210045, Semilla CIEP-PATSER “Desarrollo industrial y minería en el lago General Carrera, transformación social desde una perspectiva de la Arqueología Industrial (1930-1990)”, ANID/Basal FB210018, ANID/Beca Chile postdoctorado 74250021.

Acknowledgments

We would like to express our sincere gratitude to the institutions that have provided essential support throughout this research process in Aysén: the Museo Regional de Aysén, CONAF, PAR Explora Aysén, Carabineros de Chile, the Chilean Navy, the Entrada Baker military detachment, the municipalities of Lago Verde, Puerto Ingeniero Ibáñez, and Chile Chico, the Governor's Office of General Carrera, Thompkins Conservation, Estancia Ñirehuao, Estancia Cisnes, and Estancia Baño Nuevo. Their collaboration, logistical support, and access authorization have been key to the development of our work. Likewise, we extend our heartfelt thanks to all the individuals who, over the years, have made this research possible through their generosity, knowledge, permissions, and ongoing support. To all of them, we offer our deepest appreciation and recognition: Paulina Chávez, Stephanie Bouckaert, Eduardo Batarce, Pablo Rati, Marisol Delgado, Andrés Hernández, Berndt Von Malapert, Horacio Croxatto, Marco Peede, María José Montequín, Claudio Bariggi, Robinson Palma, Freddy Boldt, Eloy Ribera, Andrés Schwencke, Juan Carrasco, Pablo Galilea, Alejandro Galilea, Cirilo Peede, Nibaldo Calderón, Sergio Haro, Ceferino and Ignacio Márquez, Washington Fica, Ana María Muñoz, Niquete Raty, Mauricio Quercia, Vicente Sandoval, Cristian Saucedo, Dagoberto Guzmán, Benjamín Saavedra, Adolfo Rojo, the Suazo family, the Nahuelquín Delgado family, and the Piedmont family.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

- Adger, W. N. (2000). Social and ecological resilience: are they related?. *Prog. Hum. Geogr.* 24, 347–364. doi: 10.1191/030913200701540465
- Bandieri, S. (2005). *Historia de la Patagonia*. Buenos Aires: Sudamericana. Spanish.
- Belardi, J. B., Marina, F. C., Nuevo-Delaunay, A., and De Angelis, H. (2013). Raspadores de vidrio y gres cerámico en la reserva tehuelche (Aonikenk) de Camusu Aike: aportes al conocimiento de poblaciones indígenas de los siglos XIX y XX en el territorio de Santa Cruz. *Relaciones* 38, 37–57. Spanish.
- Bennett, J. W. (2005). *The Ecological Transition: Cultural Anthropology and Human Adaptation*. London: Routledge.
- Berkes, F., Colding, J., and Folke, C. (2002). "Introduction," in *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*, eds. F. Berkes, J. Colding, and C. Folke (Cambridge: Cambridge University Press), 1–30.
- Burke, A., Peros, M. C., Wren, C. D., Pausata, F. S. R., Riel-Salvatore, J., Moine, O., et al. (2021). The archaeology of climate change: the case for cultural diversity. *Proc. Natl. Acad. Sci. U.S.A.* 118:e2108537118. doi: 10.1073/pnas.2108537118
- Casamiquela, R. M. (1978). Temas patagónicos de interés arqueológico. III: la técnica de la talla del vidrio. *Relaciones* 12, 213–223. Spanish.
- Colin, F., Quiles, A., Schuster, M., Schwartz, D., Duvette, C., Marchand, S., et al. (2020). The end of the "green oasis": chronological Bayesian modeling of human and environmental dynamics in the Bahariya area (Egyptian Sahara) from pharaonic third intermediate period to medieval times. *Radiocarbon* 62, 25–49. doi: 10.1017/RDC.2019.106
- Consejo de Monumentos Nacionales (2009). *Decreto Supremo N.º 413, declara Monumento Histórico el Cementerio de Isla de los Muertos, Comuna de Tortel, Región de Aysén [Decreto]*. Ministerio de Educación, Gobierno de Chile. Available online at: https://www.monumentos.gob.cl/sites/default/files/decretos/MH_01178_2009_D00413.PDF
- Cooper, J. (1946). "The Chono," in *Handbook of South American Indians*, Vol. 1 (Washington, D.C.: Bureau of American Ethnology Bulletin 143), 47–54.
- De Angelis, H. N., and Mansur, M. A. E. (2010). Artefactos de vidrio en contextos cazadores recolectores. *Rev. Atl. Mediterr. Prehist. Arqueol. Soc.* 12, 59–73. Spanish. doi: 10.25267/Rev_atl-mediterr_prehist_arqueol_soc.2010.v12.05
- de Porras, M. E., Maldonado, A., Quintana, F. A., Martel-Cea, A., Reyes, O., and Méndez, C. (2012). Postglacial vegetation, fire and climate dynamics at Central Chilean Patagonia (Lake Shaman, 44°S). *Quat. Sci. Rev.* 50, 71–85. doi: 10.1016/j.quascirev.2012.06.015
- de Porras, M. E., Maldonado, A., Quintana, F. A., Martel-Cea, A., Reyes, O., and Méndez, C. (2014). Environmental and climatic changes in central Chilean Patagonia since the Late Glacial (Mallín El Embudo, 44°S). *Clim. Past* 10, 1063–1078. doi: 10.5194/cp-10-1063-2014
- Dillehay, T. D. (2007). *Monuments, Empires, and Resistance: The Araucanian Polity and Ritual Narratives*. Cambridge: Cambridge University Press.
- Emperaire, J. (1963). *Los nómades del mar*. Santiago: Ediciones de la Universidad de Chile. Spanish.
- Ferdinand, M. (2022). *Decolonial Ecology: Thinking from the Caribbean World*. New York, NY: Polity Press.
- Folke, C. (2016). Resilience (republished). *Ecol. Soc.* 21:30. doi: 10.5751/ES-09088-210444
- Friesen, T. M. (2013). When Worlds Collide: Hunter-Gatherer World-System Change in the 19th Century Canadian Arctic. *The Archaeology of Colonialism in Native North America*. Tucson: University of Arizona Press.
- Goñi, R. A. (2000). "Arqueología de momentos históricos fuera de los centros de conquista y colonización: un análisis de caso en el sur de la Patagonia," in *Desde el País de los Gigantes, Actas de las IV Jornadas de Arqueología de la Patagonia*, eds. J. Belardi, F. Carballo, and S. Espinosa (Río Gallegos: UNPA), 283–296. Spanish.
- Gusinde, M. (1982). *Los Indios de Tierra del Fuego. I. (1 y 2). Los Selk'nam*. Buenos Aires: Centro Argentino de Etnología Americana. Spanish.
- Harambour, A. (2019). *Soberanías Fronterizas: Estados y Capital en la Colonización de Patagonia (Argentina y Chile, 1830-1922)*. Valdivia: Universidad Austral de Chile. Spanish.
- Holling, C. S. (1973). Resilience and stability of ecological systems. *Annu. Rev. Ecol. Syst.* 4, 1–23. doi: 10.1146/annurev.es.04.110173.000245
- Holz, A., Méndez, C., Borrero, L., Prieto, A., Torrejón, F., and Maldonado, A. (2016). Fires: the main human impact on past environments in Patagonia? *Past Glob. Change Mag.* 24, 72–73. doi: 10.22498/pages.24.2.72
- Holz, A., and Veblen, T. (2012). Wildfire activity in rainforests in western Patagonia linked to the Southern Annular Mode. *Int. J. Wildland Fire* 21, 114–126. doi: 10.1071/WF10121
- Holz, A., and Veblen, T. T. (2009). Wildfire activity in rainforests in western Patagonia linked to the Southern Annular Mode. *Int. J. Wildland Fire* 21, 114–126. doi: 10.1071/WF10121
- Horwitz, V. D., Borrero, L. A., and Casiraghi, M. (1994). Estudios arqueológicos en San Julio 2 (Tierra del Fuego). *Relac. Soc. Argent. Antropol.* 19, 319–415. Spanish.
- Ingold, T. (1986). "The optimal forager and economic man," in *The Appropriation of Nature: Essays on Human Ecology and Social Relations*, ed. T. Ingold (Manchester: Manchester University Press), 27–44.
- Ivanoff, D. (1997). *La Guerra de Chile Chico, O Los Sucesos del Lago Buenos Aires*. Valdivia. Spanish.
- Ivanoff, D. (2000). *Caleta Tortel y su Isla de los Muertos*. Región de Aysén: Municipalidad de Caleta Tortel. Spanish.
- Jackson, D. (1991a). Los instrumentos de vidrio de Cuarto Chorrillo, costa de Bahía Santiago, Estrecho de Magallanes. *An. Inst. Patagon.* 20, 69–74. Spanish.
- Jackson, D. (1991b). Raspadores de vidrio en Dinamarquero: reflejo de una encrucijada cultural. *An. Inst. Patagon.* 20, 57–68. Spanish.
- Jackson, D. (1999). Raspadores de vidrio en un asentamiento Aonikenk en el valle del Zurdo, zona central de Magallanes. *An. Inst. Patagon.* 27, 175–181. Spanish.
- Kinahan, J. (2014). Cattle paths and the choreography of late pre-colonial contact and trade on the Namib Desert coast. *S. Afr. Archaeol. Bull.* 69, 96–102.
- Kitzberger, T., Raffaele, E., and Veblen, T. (2005). Variable community responses to herbivory in fire-altered landscapes of northern Patagonia, Argentina. *Afr. J. Range Forage Sci.* 22, 85–91. doi: 10.2989/10220110509485865

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fearc.2025.1605519/full#supplementary-material>

- Lahsen, A., and Oyarzún, J. (1966). *Informe N° 11, La Minería en Aisén*. Instituto de Investigación de Recursos Naturales. Spanish.
- Leslie, P., and McCabe, J. T. (2013). Response diversity and resilience in social-ecological systems. *Curr. Anthropol.* 54, 114–143. doi: 10.1086/669563
- Letelier-Cosmelli, J., Nuevo-Delaunay, A., and Goldschmidt, D. (2025). *Cuaderno de Campo: Arqueología Industrial. La Minerías del Lago General Carrera*. Coyhaique: Fichero Austral. Spanish.
- Levin, S. A., Anderies, J. M., Adger, N., Barrett, S., Bennett, E. M., Cardenas, J. C., et al. (2022). Governance in the face of extreme events: lessons from evolutionary processes for structuring interventions, and the need to go beyond. *Ecosystems* 25, 697–711. doi: 10.1007/s10021-021-00680-2
- Lövschal, M. (2022). Retranslating resilience theory in archaeology. *Annu. Rev. Anthropol.* 51, 195–211. doi: 10.1146/annurev-anthro-041320-011705
- Marín, A. (2014). Palena, Quitrulco y Melimoyu: intentos fallidos de colonización en el litoral de la Región de Aysén (1889–1983). *Rev. Austral Cienc. Soc.* 27, 137–156. Spanish. doi: 10.4206/rev.austral.cienc.soc.2014.n27-06
- Martin, P. (2009). “Industrial archaeology,” in *International Handbook of Historical Archaeology*, eds. T. Majewski and D. Gaimster (New York, NY: Springer), 285–297.
- Martinić, M. (1995). *Los Aónikenk, historia y cultura*. Punta Arenas: Universidad de Magallanes. Spanish.
- Martinić, M. (2005). *De la Trapananda al Aysén*. Santiago: Pehuén Editores. Spanish.
- Martinić, M., and Prieto, A. (1986). Dinamarquero, encrucijada de rutas indígenas. *An. Inst. Patagon.* 16, 53–83. Spanish.
- Matthews, C. N. (2010). *The Archaeology of American Capitalism*. Florida: University Press of Florida.
- Mena, F., and Velásquez, H. (2000). Isla de los Muertos: mito y realidad. *An. Inst. Patagon.* 28, 53–72. Spanish.
- Méndez, C., de Porras, M. E., Maldonado, A., Reyes, O., Nuevo Delaunay, A., and García, J.-L. (2016). Human effects in Holocene fire dynamics in Central Western Patagonia (~44° S, Chile). *Front. Ecol. Evol.* 4:100. doi: 10.3389/fevo.2016.00100
- Méndez, C., and Nuevo-Delaunay, A. (2019). Evidencias a cielo abierto para discutir superficies potenciales de actividad temprana en Patagonia centro occidental (44–45° s). *Magallania* 47, 105–116. Spanish. doi: 10.4067/S0718-22442019000100105
- Méndez, C., Nuevo-Delaunay, A., and Reyes, O. (2023). *Una Cueva con 16 000 Años de Historia en Patagonia Central: La Colección Baño Nuevo 1 en el Museo Regional de Aysén*. Bajo la Lupa, Subdirección de Investigación, Servicio Nacional del Patrimonio Cultural. Spanish.
- Méndez, C., Nuevo-Delaunay, A., Reyes, O., Ozán, I. L., Belmar, C., and López, P. (2018). The initial peopling of Central Western Patagonia (Southernmost South America): late pleistocene through Holocene site context and archaeological assemblages from Cueva de la Vieja site. *Quat. Int.* 473, 261–277. doi: 10.1016/j.quaint.2017.07.014
- Méndez, C., Reyes, O., Trejo, V., and Nuevo-Delaunay, A. (2013). “Ocupación humana de alto río Simpson, Aisén (margen occidental de la estepa de Patagonia Central) como caso para medir la intensidad de uso de espacios,” in *Tendencias Teórico-Metodológicas y Casos de Estudio en la Arqueología de la Patagonia*, eds. A. F. Zangrando and R. Barberena (San Rafael: Museo de Historia Natural de San Rafael), 193–201. Spanish.
- Méndez, C. M., Reyes, O. B., Delaunay, A. N., Trejo, V. V., Barberena, R., and Velásquez, H. M. (2011). Ocupaciones humanas en la margen occidental de Patagonia Central: eventos de poblamiento en alto río Cisnes. *Magallania* 39, 223–242. Spanish. doi: 10.4067/S0718-22442011000200016
- Middleton, G. D. (2017). The show must go on: collapse, resilience, and transformation in 21st-century archaeology. *Rev. Anthropol.* 46, 78–105. doi: 10.1080/00938157.2017.1343025
- Middleton, G. D. (2025). Collapse studies in archaeology from 2012 to 2023. *J. Archaeol. Res.* 33, 57–115. doi: 10.1007/s10814-024-09196-4
- Mitchell, M. D., and Scheiber, L. L. (2010). *Across a Great Divide: Continuity and Change in Native North American Societies, 1400–1900* (1st ed.). Tucson: University of Arizona Press.
- Moreno, F. (1897). *Reconocimiento de la Región Andina: Apuntes Preliminares Sobre una Excursión a los Territorios de Neuquén, Río Negro, Chubut y Santa Cruz*. Buenos Aires: Talleres del Publicación del Museo. Spanish.
- Moreno, P. I., Méndez, C., Henríquez, C. A., Fercovic, E. I., Videla, J., Reyes, O., et al. (2023). Fires and rates of change in the temperate rainforests of northwestern Patagonia since ~18 ka. *Quat. Sci. Rev.* 300:107899. doi: 10.1016/j.quascirev.2022.107899
- Musters, G. C. (1871). *At Home with the Patagonians: A Year's Wanderings over Untrodden Ground from the Straits of Magellan to the Rio Negro*. London: John Murray.
- Nelson, M. C., Hegmon, M., Kintigh, K. W., Kinzig, A. P., Nelson, B. A., Anderies, J. M., et al. (2012). “Long-term vulnerability and resilience: three examples from archaeological study in the Southwestern United States and Northern Mexico,” in *Surviving Sudden Environmental Change: Answers from Archaeology*, eds. J. Cooper and P. Sheets (Colorado: University Press of Colorado), 197–222.
- Niemeyer, H. (1969). Un episodio del poblamiento de la Patagonia chilena: la guerra de Chile Chico. *Bol. Univ. Chile* 91, 32–36. Spanish.
- Nuevo Delaunay, A. (2016). *Transformación del paisaje arqueológico rural en el centro-oeste de la provincia de Santa Cruz, siglo XX*. Doctoral dissertation, Facultad de Filosofía y Letras, Universidad de Buenos Aires, Argentina. Spanish.
- Nuevo-Delaunay, A. (2007). “Tecnología vitrea en el siglo XX, Lago Strobel (Santa Cruz, Argentina),” in *Arqueología de Fuego-Patagonia. Levantando Piedras, Desenterrando Huesos... y Develando Arcanos*, eds. F. Morello, M. Martinić, A. Prieto, and G. Bahamonde (Punta Arenas: Ediciones CEQUA), 853–859. Spanish.
- Nuevo-Delaunay, A. (2012). Disarticulation of Aónikenk hunter-gatherer lifeways during the late nineteenth and early twentieth centuries: two case studies from Argentinean Patagonia. *Hist. Archaeol.* 46, 149–164. doi: 10.1007/BF03376875
- Nuevo-Delaunay, A. (2025). *Transformaciones del paisaje arqueológico rural en Patagonia durante el siglo XX*. Ediciones Universidad de Magallanes. (Colección Poblamiento Humano de Fuego-Patagonia).
- Nuevo-Delaunay, A., Belardi, J. B., and Marina, F. C. (2020). Nuevas evidencias de sitios arqueológicos Tehuelche/Aonikenk-Mapuche (siglo XX) en Santa Cruz, Patagonia (Argentina). *Magallania* 48, 161–172. Spanish. doi: 10.4067/S0718-22442020000100161
- Nuevo-Delaunay, A., Belardi, J. B., Marina, F. C., Saletta, M. J., and De Angelis, H. (2017). Glass and stoneware knapped tools among hunter-gatherers in Southern Patagonia and Tierra del Fuego. *Antiquity* 91, 1330–1343. doi: 10.15184/aaq.2017.125
- Nuevo-Delaunay, A., and Goñi, R. A. (2004). —Desarticulación del modo de vida cazador-recolector Tehuelche: dos casos de estudio en la Meseta Central de la Pcia. || in XV CNA (De Santa Cruz: UNRC), 367. Spanish.
- Nuevo-Delaunay, A., Goñi, R. A., Jiménez, N., and Ceçuk, L. (2014). “Marginalidad y adecuación en el siglo XX: dos casos de estudio en la cuenca del lago Strobel,” in *Arqueología de las Cuencas de los Lagos Cardiel y Strobel: Poblamiento Humano y Paleoaambientes en Patagonia* (Buenos Aires: Editorial Aspha), 187–198. Spanish.
- Nuevo-Delaunay, A., and Letelier Cosmelli, J. (2024). “Americas, South: historical archaeology,” in *Encyclopedia of Archaeology* (3rd ed.), eds. T. Rehren and E. Nikita (London: Elsevier), 641–648.
- Nuevo-Delaunay, A., Méndez, C., Reyes, O., Seelenfreund, A., and Belmar, C. (2022). La ocupación humana antigua se los callejones sin salida de Los Andes de Patagonia: midiendo la intensidad de uso del espacio en los márgenes del Campo de Hielo Norte (Aisén, Chile). *Chungará* 54, 481–500. Spanish. doi: 10.4067/S0717-73562022005000203
- Nuevo-Delaunay, A., and Paterson, A. (2017). Introduction: southern deserts historical archaeology. *Int. J. Hist. Archaeol.* 21, 277–279. doi: 10.1007/s10761-017-0410-9
- Osorio, M. (2012). Un episodio de violencia en el Baker: la muerte de tres Kawéšqar en Bajo Pisagua (47°46'S/73°35'), 1931. *Magallania* 40, 41–60. Spanish. doi: 10.4067/S0718-22442012000200003
- Osorio, M. (2016). *Tragedia obrera de Bajo Pisagua. Río Baker, 1906: Origen del cementerio Isla de los Muertos, comuna de Tortel, Patagonia Occidental (2ª ed.)*. Ediciones Nire Negro. Spanish. Available online at: <https://www.investigacion.patrimoniocultural.gob.cl/publicaciones/la-ocupacion-del-sector-coyhaique-bajo-desde-la-estanciacoyhaique-al-museo-regional>
- Osorio, M. (2021). *La Ocupación del Sector “Coyhaique Bajo”: Desde la Estancia Coyhaique al Museo Regional de Aysén*. Proyecto Bajo la Lupa, Subdirección de Investigación, Servicio Nacional del Patrimonio Cultural. Spanish.
- Otero, J. G. (1987). Un raspador en vidrio confeccionado por una tehuelche meridional. *Mundo Ameghiniano* 7, 1–3. Spanish.
- Ozán, I. L., Méndez, C., Oriolo, S., Orgeira, M. J., Tripaldi, A., and Vásquez, C. A. (2019). Depositional and post-depositional processes in human-modified cave contexts of west-central Patagonia (Southernmost South America). *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 532:109268. doi: 10.1016/j.palaeo.2019.109268
- Pérez-Bustamante, L., Muñoz, M. D., and Contreras, R. S. (2010). Poblados mineros patagónicos: paisajes culturales y estructura territorial. *Patrim. Territ.* 7, 49–61. Spanish. Available online at: <https://revistasfaud.mdp.edu.ar/registros/article/view/147>
- Quijano, A. (1998). “Colonialidad del poder, cultura y conocimiento en América Latina,” in *Ecuador Debate* (Quito: CAAP), 227–238. Spanish.
- Reyes, O. (2020). *The Settlement of the Chonos Archipelago, Western Patagonia, Chile*. The Latin American Studies Book Series. Cham: Springer International Publishing.
- Reyes, O., Mena, F., Velásquez, H., and Trejo, V. (2004). Arqueología del siglo XX: el caso de Isla de los Muertos, Patagonia Occidental, Aisén. *Chungara* 36, 131–139. Spanish. doi: 10.4067/S0717-73562004000300016
- Reyes, O., Méndez, C., and San Román, M. (2019). Cronología de la ocupación humana en los canales septentrionales de Patagonia occidental, Chile. *InterSecc. Antropol.* 20, 195–200. Spanish. doi: 10.37176/iea.20.2.2019.449
- Reyes, O., Méndez, C., Velásquez, H., and Trejo, V. (2006). Distribuciones espaciales y contextos arqueológicos de cazadores-recolectores esteparios

- en Alto Río Cisnes (XI Región de Aisén). *Magallania* 34, 75–90. Spanish. doi: 10.4067/S0718-22442006000200008
- Reyes, O., and Nuevo-Delaunay, A. (2022). Becoming cholgueros: an archaeology of the 18th–20th centuries in the Chonos Archipelago of Western Patagonia (Chile). *Shima* 16, 325–338. doi: 10.21463/shima.148
- Rindel, D. D., Zorzoli, C., and Gordón, F. (2024). La introducción del caballo en las poblaciones indígenas de Patagonia: vías de entrada, contexto ecológico y cambios en los patrones de movilidad y subsistencia en momentos históricos. *Rev. del Mus. La Plata* 9, 1–28. Spanish. doi: 10.24215/25456377e190
- Riris, P., and De Souza, J. G. (2021). Formal tests for resistance-resilience in archaeological time series. *Front. Ecol. Evol.* 9:740629. doi: 10.3389/fevo.2021.740629
- Sagredo, R. (2013). De la hidrografía imperial a la hidrografía nacional. Reconocimientos del Pacífico sur. Siglos XVIII y XIX. *Anu. Estud. Am.* 70, 509–556. Spanish. doi: 10.3989/aeamer.2013.2.05
- Sauer, J. J. (2014). *The Archaeology and Ethnohistory of Araucanian Resilience*. New York, NY: Springer.
- Scott, J. C. (1985). *Weapons of the Weak: Everyday Forms of Peasant Resistance*. New Haven, CT: Yale University Press.
- Silliman, S. (2001). Agency, practical politics and the archaeology of culture contact. *J. Soc. Archaeol.* 1, 190–209. doi: 10.1177/146960530100100203
- Silliman, S. (2014). “Archaeologies of survivance and residence: reflections on the historical archaeology of indigenous people,” in *Rethinking Colonial Past Through Archaeology*, eds. N. Ferris, R. Harrison, and M. V. Wilcox (Oxford: Oxford University Press), 57–75.
- Simpson, E. (1875). *Esploraciones hechas por la Corbeta Chacabuco al mando del Capitán de Fragata don Enrique Simpson, en los archipiélagos de Guaitecas, Chonos y Taitao*. Anuario Hidrográfico de la Marina de Chile, Vol. I, 3–166. Santiago: Imprenta Nacional. Spanish.
- Steffen, H. (2010). “Viajes de exploración y estudio en la Patagonia Occidental, 1892–1902,” in *Biblioteca Fundamentos de la Construcción de Chile* (Vols. 1–2), ed. B. R. Sagredo (Santiago de Chile: Cámara Chilena de la Construcción/Pontificia Universidad Católica de Chile/Dirección de Bibliotecas, Archivos y Museos). Spanish.
- Steffen, W., Grinevald, J., Crutzen, P., and McNeill, J. (2011). The anthropocene: conceptual and historical perspectives. *Philos. Trans. R. Soc. A* 369, 842–867. doi: 10.1098/rsta.2010.0327
- Taylor, W. T. T., Belardi, J. B., Barberena, R., Coltrain, J. B., Marina, F. C., Borrero, L. A., et al. (2023). Interdisciplinary evidence for early domestic horse exploitation in southern Patagonia. *Sci. Adv.* 9:eadk5201. doi: 10.1126/sciadv.adk5201
- Urbina Carrasco, X. (2010). La navegación por los canales australes en la Patagonia Occidental insular en los siglos coloniales: la ruta del istmo de Ofqui. *Magallania* 38, 41–67. Spanish. doi: 10.4067/S0718-22442010000200003
- Urbina Carrasco, X. (2013). Expediciones a las costas de la Patagonia occidental en el período colonial. *Magallania* 41, 51–84. Spanish. doi: 10.4067/S0718-22442013000200002
- Urbina Carrasco, X. (2014). *Fuentes para la Historia de la Patagonia Occidental en el período colonial. Primera parte: siglos xvi y xvii*. Valparaíso: Ediciones Universitarias de Valparaíso, Pontificia Universidad Católica de Valparaíso. Spanish.
- Urbina Carrasco, X., Reyes, O., and Belmar, C. (2020). Canoeros en Chiloé: de facilitadores de las navegaciones españolas en los archipiélagos de los Chonos y de Guayaneco, a productores y comerciantes. *Chungara* 52, 335–346. Spanish. doi: 10.4067/S0717-73562020005000702
- Veblen, T. T., Kitzberger, T., Raffaele, E., Mermoz, M., Gonzalez, M. E., Sibold, J. S., and Holz, A. (2008). The historical range of variability of fires in the Andean-Patagonian *Nothofagus* forest region. *Int. J. Wildland Fire* 17, 724–741. doi: 10.1071/WF07152
- Velásquez, H., Méndez, C., Reyes, O., Trejo, V., Sanhueza, L., Quiroz, D., et al. (2007). Campamentos residenciales tardíos a cielo abierto en Alto Río Cisnes (Región de Aisén). *Magallania* 35, 121–132. Spanish. doi: 10.4067/S0718-22442007000100008
- Velásquez, H., Mena, F., Trejo, V., and Reyes, O. (2005). Un panorama histórico y arqueológico en la cordillera Aisenina: transición siglo XIX-XX. *Werken* 7, 5–20. Spanish.
- Vezub, J. E. (2015). La caravana de Mustres y Casimiro: la “cuestión tehuelche” revisitada por el análisis de redes. Punta Arenas-Carmen de Patagones, 1869-70. *Magallania* 43, 15–35. Spanish. doi: 10.4067/S0718-22442015000100002
- Walder, H., and Yann, J. (2018). “Resilience and survivance: frameworks for discussing intercultural interactions,” in *Encounters, Exchange, Entanglements: Current Perspectives on Intercultural Interactions Throughout the Western Great Lakes*, eds. H. Walder and J. Yann (Milwaukee, WI: Midwest Archaeological Conference), 1–18.
- Wilcox, M. (2009). *The Pueblo Revolt and the Mythology of Conquest: An Indigenous Archaeology of Contact*. Oakland, CA: University of California Press.
- Yoffee, N. (2010). “Collapse in ancient Mesopotamia: what happened, what didn’t,” in *Questioning Collapse: Human Resilience, Ecological Vulnerability, and the Aftermath of Empire*, eds. P. A. McAnany and N. Yoffee (Cambridge: Cambridge University Press), 176–206.