



Diachronic approach to practices associated with the use of firewood in Parque Costero del Sur and its surroundings (Buenos Aires Province, Argentina)

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Research

Abstract

Background: The processes of change and continuity in the practices associated with the use of firewood by the inhabitants of the Biosphere Reserve Parque Costero del Sur (PCS-acronym in Spanish) and its surroundings are analysed diachronically.

Methods: Anthracological, ethnobotany historical and ethnobotanical methodology have been used.

Results: In the pre-hispanic period, hunter-gatherer groups used the native species of the talar (**coronillo**, **molle**, **tala** and **sombra de toro**) and the coast (**ceibo** and **willow**), possibly as a source of light, heat, protection, in pottery production and food preparation. Subsequently, the native societies on the frontier continued to use the native species of the talar (**tala**, **molle** and **sombra de toro**) as firewood, with no recorded use of coastal species. Historical documentation reflects the continued use of talar trees as firewood since the colonial period, and even their overexploitation, in addition to the early introduction of exotic species for this purpose. Today, firewood continues to be a key resource in the daily lives of the inhabitants of the PCS for heating and cooking. The use of 28 species was recorded, of which six are native (**tala**, **coronillo**, **molle**, **willow**, **espinillo** and **brusquilla**).

Conclusions: The results presented demonstrate the temporal continuity in the use of some native species as firewood with varying degrees of intensity and the incorporation of exotic species since the colonial period. This reflects the flexibility of the settlers in the face of socio-environmental changes, with innovations and transfers of uses from one plant to another that have enriched local practices.

Keywords: Interdisciplinary, Magdalena, Punta Indio, Local knowledge, Local fuel plants

Background

Fuelwood, which means the cut and chopped woody parts of trees and shrubs used as fuel (Doumecq *et al.* 2020a), has been an essential resource for human societies. The use of fuelwood involves various practices related to the collection and use of these plant resources for different purposes such as heating and food preparation, among other possibilities. In South America, such resources are an essential part of subsistence economies and constitute one of the main sources of energy, especially in rural areas and in areas with harsh climates (Arre *et al.* 2015, Cardoso *et al.* 2015, Doumecq *et al.* 2020a, Doumecq 2023, Hora *et al.* 2021, Jiménez-Escobar 2021, Jiménez-Escobar & Martínez 2019, Morales *et al.* 2018, Ramos *et al.* 2008). Moreover, they play an important role in the domestic sphere, which goes beyond their utilitarian value (Doumecq *et al.* 2023). Numerous transdisciplinary works have described the importance of wood resources for ancient societies (Andreoni & Capparelli 2012, Capparelli & Raffino 1997, Franch Bach *et al.* 2020, García Lerena *et al.* 2018, 2023, Ghiani Echenique *et al.* 2020, Marconetto 1994, 2008, Pérez de Micou 1991). Different issues surrounding the practices associated with the use of firewood have been documented. This activity is often stigmatised as environmentally destructive and also associated with low-income people (Morales *et al.* 2017). For this reason, the issue is generally approached from a conservationist perspective, analysing the negative environmental impact of firewood use on native forests (Contreras-Hinojosa *et al.* 2003, Ramos & Albuquerque 2012, Torres Muro *et al.* 2010). From this perspective, firewood collection is considered an activity incompatible with the conservation of native vegetation in reserve areas (Doumecq 2019). A widespread strategy in different protected areas around the world has been the prohibition of use by local people, and in many cases, communities have even been expelled from their territories (Trentini 2015). The classic conception of protected areas based on the intrinsic separation of humans and nature does not consider the fact that the "natural" environments that are intended to be preserved are in fact the result of human practices over time (Doumecq *et al.* 2020b). For this reason, from the 1960s onwards, claims began to be made in defense of local populations, which were recognised as effective administrators of biodiversity and shapers of the landscape. In this framework, years later, Biosphere Reserves, which contemplated human occupation and promoted sustainable development, emerged (Doumecq *et al.* 2020b, Tuxill & Nabhan 2001).

The Biosphere Reserve **Parque Costero del Sur** (PCS) was created in 1984 by UNESCO for its valuable biocultural heritage associated with the native forest known as **talar**. Furthermore, it was declared a Wildlife Refuge in 1997 at the provincial level (Ghiani Echenique *et al.* 2018, Stampella *et al.* 2016). In this context, through an interdisciplinary approach, we propose to analyse the practices associated with the use of firewood in the PCS and its surroundings from the human settlement to the present and to establish possible changes and continuities in these practices. Which species are currently used and which in the past? Which uses and/or practices are maintained, and which are not? Why? How did they influence the shaping of the current landscape? How did the creation of the PCS affect the firewood activity? Although some partial results have been published (Doumecq 2019, 2023, Doumecq *et al.* 2020a, 2023, García Lerena *et al.* 2018, 2023, Ghiani Echenique *et al.* 2020, 2023, Jiménez-Escobar *et al.* 2021, Stampella *et al.* 2016), this work constitutes an original integration, tending towards a diachronic approach to the subject.

Materials and Methods

The Study Area

The PCS is located in the southern sector of the shore of the Río de la Plata (Buenos Aires, Argentina), which includes the coastal sector of the districts of Magdalena and Punta Indio (Fig. 1). Recently, the PCS was extended because of the initiative of the reserve's Management Committee, in which the municipalities involved participate, through a report approved by UNESCO in 2019. As a result of this extension, new localities were included in the PCS. This territory is predominantly rural, with some population centres, the city of Magdalena being the largest (26,734 inhabitants, INDEC 2022). The main economic activity is agriculture and livestock farming, and to a lesser extent the substratum shell exploitation and tourism.

From a phytogeographical point of view, the area is located on the eastern edge of the Pampean Province (Cabrera 1971), which is characterised by the preponderance of grasslands or grassy steppes whose climax community is the **flechillar**, which extends over high fields with humid and slightly acidic sandy-clay soils (Abba *et al.* 2009). The coastal sector is occupied by the **talar**, a native forest with floristic elements related to the Espinal Phytogeographic Province (Burkart *et al.* 1999, Cabrera 1971, among others), which develops on the shell ridges resulting from the Holocene marine ingression (Cavallotto 2002, among others). In this sector of the Río de la Plata littoral, the **talar** is formed by **tala** (*Celtis tala* Gillies ex Planch.), **coronillo** (*Scutia buxifolia* Reissek), **sombra de toro** [*Jodina rhombifolia* (Hook. & Arn.) Reissek], **molle** [*Schinus longifolius* (Lindl.) Speg.], and to a lesser extent **espinillo** [*Vachellia caven* (Molina) Seigler & Ebinger], **sauco** (*Sambucus australis* Cham. and Schlttdl.), **curupí** (*Sapium haematospermum* Müll. Arg.), **ombú** (*Phytolacca dioica* L.) and **brusquilla** (*Colletia spinosissima* J.

F. Gmelin), in association with grasses, climbing plants and creepers. The **talar** alternates with grassland in higher areas and with hydrophilous vegetation in lower areas. Towards the shoreline, **juncuales**, **pajonales** and riparian forests develop, with representation of **ceibo** (*Erythrina crista-galli* L.) and **willow** (*Salix humboldtiana* Willd.), the last one together with other exotic species of the genus and hybrids that have been planted to combat coastal erosion (Fig. 2). In addition, the presence of numerous introduced exotic tree species can be observed in the PCS, many of them intentionally introduced to accompany the conformation of the different **estancias** in the area from the 17th century onwards (García Lerena *et al.* 2018). For example, species such as **mora** (*Morus alba* L.), **black acacia** (*Gleditsia triacanthos* L.) and **ligustrum** (*Ligustrum lucidum* Ait. F.) became naturalised and have a high degree of aggressiveness in the **talares**, becoming dominant in some communities (Delucchi & Torres Robles 2006).

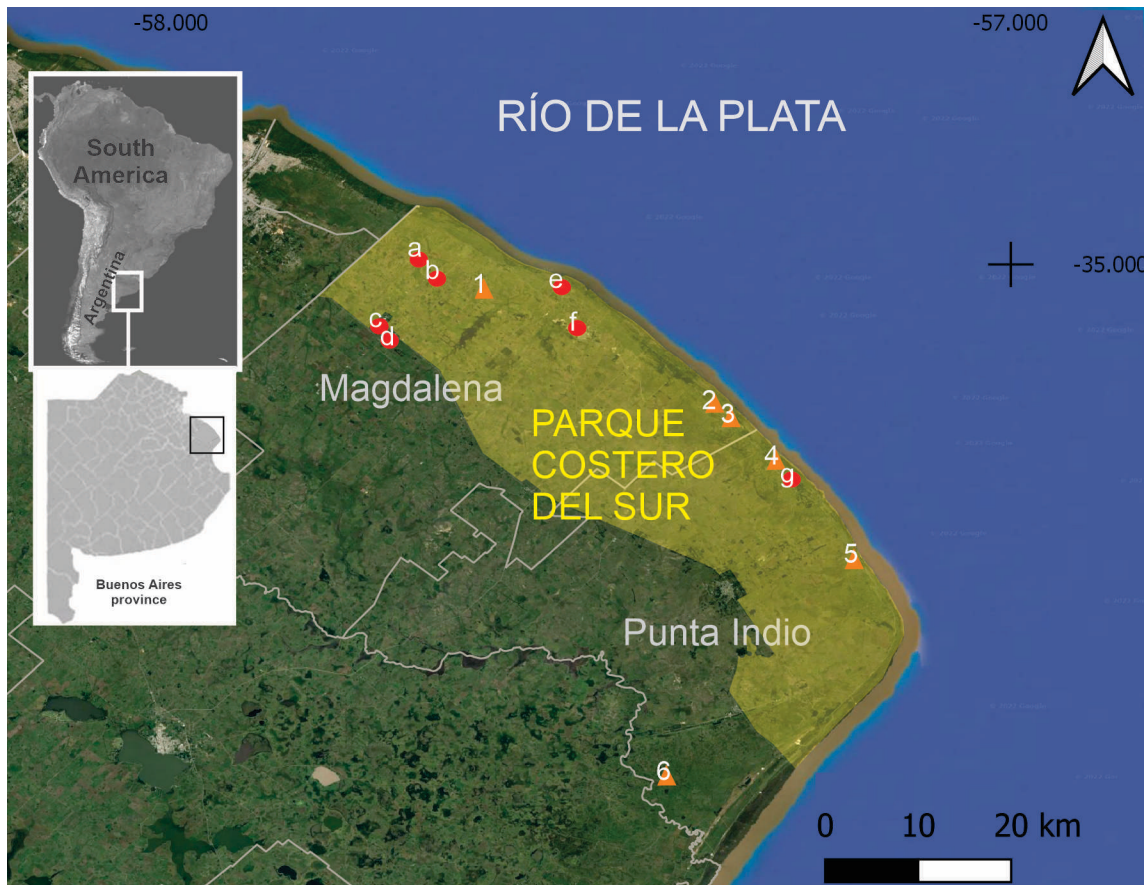


Figure 1. Map of the study area. The districts of Magdalena and Punta Indio, the Parque Costero del Sur, the archaeological sites mentioned in the text (1- Estancia Bertón, 2- El Santuario I, 3- Las Marías, 4- Barrio San Clemente, 5- Los Tres Ombúes, 6- El Puesto) and the localities where the ethnobotanical fieldwork was made (a- Los Naranjos, b- El Pino, c- Bavio, d- La Capilla, e- Atalaya, f- Magdalena, g- Punta del Indio).

Nowadays, there are municipal ordinances and decrees in the PCS that regulate activities related to the use of firewood. For example, Ordinance N°294/1998 of Punta Indio details that the species to be conserved are **tala**, **molle**, **coronillo**, **sombra de toro**, **espinillo** and **ombú**. In this sense, it prohibits the cutting, pruning, root extraction, burning, fumigation of these species within the PCS, as well as the total or partial transport of leaves, branches, trunks, bark, roots and/or products derived from these species. Non-compliance will result in the possibility of a penalty. On the other hand, the municipality of Magdalena promotes conservation through tax benefits for those who preserve native vegetation on their property through Decree N°761/2014 (Ghiani Echenique *et al.* 2018).



Figure 2. Vegetation of the Parque Costero del Sur: **talar** and grassland (left), **juncal**, **pajonal** and riparian forest on the coast of the Río de la Plata (right).

Historical overview of the study area

Archaeological research in the area indicates that during the late Holocene, from at least 1800 years ago until after the Spanish-Indian contact, the **talares** of the PCS were inhabited by human groups that practiced hunting, gathering, fishing and pottery production. In the researched sites, the archaeological materials were located in the current soil, predominantly in the A horizon. The record consists mainly of pottery fragments and faunal bone remains, and lesser extent of lithic materials, small charcoal, among others. Studies indicate that the groups inhabited these sites on a prolonged or recurrent basis, made intensive use of local resources and participated in regional exchange and interaction networks through which they obtained allochthonous resources, such as lithic materials, among others (Balesta *et al.* 1997, Day Pilaría 2018, Ghiani Echenique 2021, Ghiani Echenique & Paleo 2018, Paleo & Pérez Meroni 2004, 2007, among others). These studies mention that palynological records from the archaeological locality Barrio San Clemente, located in the PCS, point to the development of the forest coinciding with the first records of human occupation (Paleo *et al.* 2002). The archaeobotanical investigations carried out at the Las Marías site, based on the identification of micro-rests in ceramic fragments and grinding elements corresponding to the early occupations, made it possible to identify the use of plant resources typical of the **talar** (Auge *et al.* 2021; Pérez Meroni *et al.* 2010), as well as the introduction of cultivated plant species such as **maize** (*Zea mays* L.) and possibly **manioc** (*Manihot esculenta* Crantz), which could have been produced locally or obtained by exchange (Auge *et al.* 2021). For this period, with a date of 1110 ± 19 BP, the Los Tres Ombúes site, on the shell ridges covered with **talar**, presents an interesting record corresponding to hunter-gatherer and ceramic groups (Ghiani Echenique 2021, Ghiani Echenique & Paleo 2018).

Since the arrival of the Europeans to the area, in the 16th century, the Magdalena district began to take shape in the southernmost region of the Hispanic dominions. It included the territory of the current district of the same name, although it originally occupied a larger territorial extension, from the Riachuelo to the vicinity of the Samborombón river first, and then the Salado river, the latter being considered the southern border with the indigenous populations for a long time (Paleo *et al.* 2016). At this time, the lower density of finds and differences in the material record of the sites assigned to native populations would indicate settlement strategies of shorter duration and greater residential mobility (Paleo & Pérez Meroni 2004). The presence of these groups in the area would have extended until the end of the 18th century, with the incorporation of the territory to Hispanic dominion (García 2014, Ghiani Echenique *et al.* 2023, Sempé *et al.* 1999). El Puesto archaeological site, located on the shore of a small lagoon associated with the Samborombón River, corresponds to the occupation of late hunter-gatherer and potter groups, as indicated by the radiocarbon dating of 240 ± 24 BP (Ghiani Echenique 2021, Ghiani Echenique *et al.* 2023).

Towards the end of the 18th century and the 19th century, the establishment of the **estancias** was an important part of the settlement process in the region. The term **estancia**, in the Pampean region, generally refers to rural productive establishments, which varied from the primitive cattle ranch dedicated to leather production to companies producing cereals and refined livestock (Brittez 2006). The introduction of animal and plant species to the **estancias** is central to understanding how their development and history have transformed the landscape to give rise to its current appearance (García Lerena *et al.* 2018). Linked to these **estancias** is El Santuario I archaeological site, located in a cattle ranch, on a shell ridge covered with **talar**. Different activities related to food practices around a bonfire located in the second half of the 19th century were interpreted from its analysis, such as the consumption of beverages, food, **mate** and smoking. Due to the characteristics of the context, the materials and their spatial disposition, the possible generators of the site are the rural workers, **puesteros**

and laborers (García 2014). On the other hand, the Estancia Bertón site, chronologically located in the same period, corresponds to a cattle ranch where a rural trade operated by the end of the 19th century (García 2014).

Theoretical-methodological framework

To investigate the ways in which human societies engage with the plant environment for fuelwood use, we believe that an interdisciplinary perspective and methodology is crucial. Environmental knowledge is in itself a complex process made up of several biocultural factors. Considering its socio-historical depth requires analysis from the perspectives of archaeology and current and historical ethnobotany, together with the valuations of local social actors. Most of the methods and techniques implemented are shared by the different disciplines that converge in this work. There is a methodological transversality that makes it possible to establish interdisciplinary relationships. This approach integrates different types of evidence that are put into dialogue in a fluid and continuous manner to achieve an analysis of the results in a diachronic perspective. This work is organised along a temporal line, focusing on pre-hispanic, colonial, post-independence and present times. Different methodologies related to anthracology, historical ethnobotany and ethnobotany are used. Also, our perspective contemplates the integration of different ways of analysis. In this sense, the study of documentary sources, the archaeological record and the ethnobotanical data, as different sources of information, were integrated and articulated to arrive at the presented interpretations.

Anthracology: The analysis of the charred wood fragments was carried out based on the methodology developed for the analysis of the set recovered at the Los Tres Ombúes site (Ghiani Echenique *et al.* 2020), which was also applied to the small charcoals from El Puesto site (Ghiani Echenique *et al.* 2023). The first is located in a **talar** adjacent to the coast, with **coronillo**, **molle**, **sombra de toro** and **tala** trees. To date, two grids have been excavated to a depth of 0.65 m, where a total of 100 carbonised wood remains were found scattered, without association with combustion structures. They are between 6 and 24 mm long (9.2 mm average) and 3 to 11 mm wide (5.5 mm average). On the other hand, El Puesto site is associated with a predominantly **tala** forest. The anthracological assemblage recovered in the two excavated grids is made up of 23 elements scattered at a depth of 0.10-0.25 m, which are between 4 and 12 mm long (7.8 mm average) and 2 to 10 mm wide (6 mm average). The possibility of identifying charcoal is largely conditioned by the size of the fragment; according to Piqué (1999) it is feasible from 2-3 mm, while larger dimensions facilitate manipulation and the obtaining of larger surfaces. However, different alterations can hinder the analysis (Andreoni 2014, Piqué 1999).

The analysis was carried out following the guidelines proposed by Piqué (1999), Pearsall (2000), Marconetto (2008) and Andreoni (2014). Firstly, a reference collection of woods corresponding to tree species from the study area was constituted: **tala**, **coronillo**, **molle**, **sombra de toro**, **ombú**, **willow** and **ceibo**, which were experimentally carbonised. This collection is deposited in the Laboratorio de Análisis Cerámico of the Facultad de Ciencias Naturales y Museo (FCNyM), Universidad Nacional de La Plata (UNLP). The archaeological charcoals and reference samples were manually fractured for microscopic observations aimed at the anatomical characterisation of the woody tissues of each species (porosity, growth rings, vessels, fibres, etc.), taking into account the transverse, longitudinal and radial longitudinal sections (IAWA 1989). This procedure is feasible for taxonomic identification because, even though the charring process modifies certain quantitative morphological characteristics, the qualitative features that allow the identification of charred samples remain (Solari 2000). It is worth mentioning that identifications usually reach the genus level, whereas in this case the affinity of the archaeological samples with species growing in the region is considered (Marconetto & Gordillo 2008), which correspond to different genus. Consequently, different anatomical characters observed in each of the archaeological fragments were compared with the reference collection for taxonomic identification. Subsequently, the size of the firewood to which each sample corresponds was evaluated. For this purpose, the methodology cited by Marguerie & Hunt (2007), Mafferra *et al.* (2015) and Marconetto (2007) was used by observing the direction of the radius in cross-section. If the rays are convergent towards the medulla, they are identified as fine wood, while if the rays are parallel, they correspond to thick wood (>3 cm). The curvature of the growth rings (strongly curved, moderately curved and weakly curved) was also observed.

Historical ethnobotany: Documentary sources are conceived in a broad sense, including bibliographic, documentary, iconographic, cartographic, land register, chronicles, and photographic sources, whether published or unpublished. Written sources and material culture are complementary (Montón Subías 2015) and are products of past societies as a whole, as a totality. They were part of the social life participating in daily social interaction and functioning as resources for the control and negotiation of social positions (Bianchi Vilelli & Senatore 2015). The sources selection was made considering its correspondence with the study area and the period of interest. Edited sources were consulted, such as travelers' diaries, naturalists, chroniclers, and ranchers' manuals covering the period from the first chronicles of the sixteenth century to the twentieth century, present in different libraries (UNLP Library, the Facultad de Humanidades y Ciencias de la Educación Library and the FCNyM Library). In addition, unpublished sources, in particular inventories of successions and duplicates of

measurements, present in the Archivo General de La Nación, the Archivo Histórico ARBA and Archivo Histórico of the Museo de La Plata, were surveyed. These documents were analysed considering aspects such as the author of the source, the context of production and circulation, first or second-hand information, and the geographical location referred to. It should be noted that each documentary source has a bias related to the implicit interests of the writer of the work (to whom it is addressed, why he writes it, how he writes it, what information he decides to make explicit and what he omits), aspects that can be analysed according to the ethnobotanical critique of historical documents (Medeiros 2010). Each document was cataloged (Annex 1) considering the criteria named above, and if there were mentions referring to the presence of the **talar** and riparian vegetation, the presence of introduced trees and the meanings associated with them. Practices for the use of plants in general and as fuels were recorded.

Ethnobotany: Fieldwork was carried out between 2014 and 2017, prior to the extension of the area currently occupied by the PCS. During this period, numerous field trips were made in different months of the year, trying to cover all four seasons. Following the recommendations of ISE (2006), prior informed consent was obtained from 21 respondents living in the localities of Magdalena, Atalaya, Punta del Indio, Los Naranjos, Paraje El Pino, General Mansilla (Bavio) and La Capilla. These last two places are located outside the PCS area. In addition, five firewood sale sites and two **ladrilleras** (where bricks are made and sold) were recorded. A total of six women and 15 men between 45 and 75 years old participated in the study. Respondents were selected using the "snowballing" technique (Albuquerque *et al.* 2014). Sampling ended when no new information was recorded. Information was obtained through open and semi-structured interviews, free listing and participatory workshops. The identity of the participants was preserved by using only the first initial and age. The aim was to investigate which species are used, which ones are preferred, why, if they have had to be substituted for any reason, what they are used for, as well as their firewood procurement strategies and collection sites. In the retail sites, we inquired about which species are traded, which are sought after the most, which are the best and why. In addition, whether there are any restrictions on collecting or selling. These methods were complemented with other ethnobotanical techniques such as participant observation and guided walks with locals to identify plants (Albuquerque *et al.* 2014). Botanical reference material was collected, and the botanic identification of these specimens was made, for which the current nomenclature of IBODA (2018) for native species and WFO (2023) for exotic species was followed. With this material an herbarium was formed and deposited at the Laboratorio de Etnobotánica y Botánica Aplicada (LEBA, FCNyM, UNLP), following the recommendations for collections made by Martin (1995).

Results and Discussion

a- Pre-hispanic period

The anthracological assemblage recovered from the archaeological site Los Tres Ombúes was analysed in order to contribute to the knowledge of the practices associated with the use of firewood by the groups that inhabited the site (Ghiani Echenique *et al.* 2020). The methodology employed allowed for the taxonomic identification of 78% of the collection, with representation of six species, of which four are typical of the **talar-molle** (*n*=31), **tala** (*n*=25), **coronillo** (*n*=9) and **sombra de toro** (*n*=3)- and two of the Río de la Plata coast -**willow** (*n*=6) and **ceibo** (*n*=4)- (Fig. 3). Regarding the size of the firewood, approximately half corresponds to fine wood and half to thick wood, and there is no tendency to select by size according to the different species used.

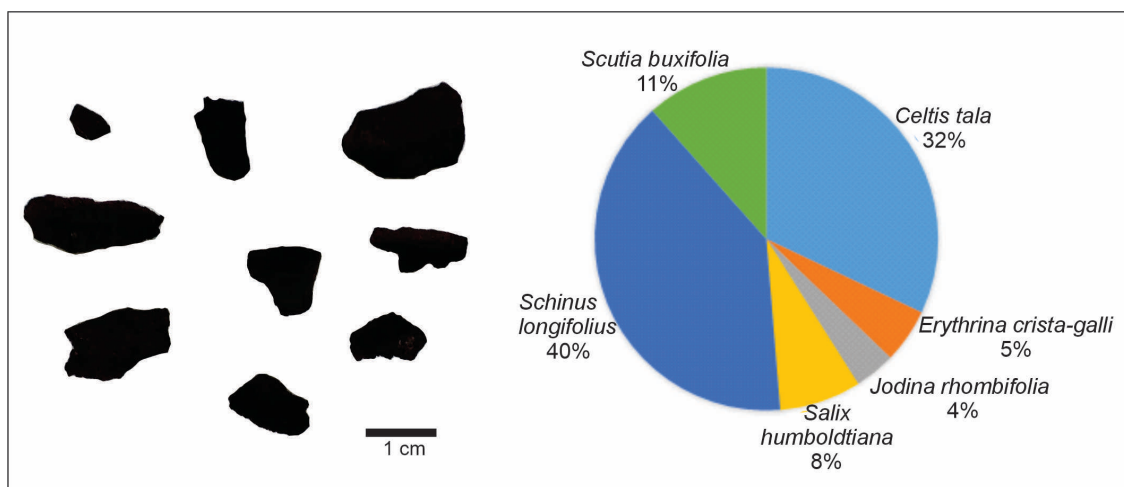


Figure 3. Photography of charcoals recovered at the archaeological site Los Tres Ombúes (left); percentage graph of the species identified in the assemblage (right).

The results obtained show the carbonization of wood from local species in the framework of social practices, and at the same time support the presence of these tree species in the past and their use as fuel by the inhabitants of Los Tres Ombúes. There, although no combustion structures were identified at the site, abundant ceramic fragments and thermo-altered bones were recovered, which provide evidence of the use of fire for cooking pottery and food, as well as possible actions for discarding these materials at the site. Thus, at Los Tres Ombúes there would have been combustion structures that were essential for everyday practices such as the preparation of food and the manufacture of ceramics, and for providing light, heat and protection. The hearths can be considered to have functioned as a meeting place and, consequently, as a node in which practices necessary for social reproduction were carried out. These structures are considered to have been disturbed by cleaning activities and trampling by the site's inhabitants. After their abandonment, different post-depositional agents would have acted, whose combined action, possibly with the influence of wind and trampling among other possible agents, would have caused the fragmentation, dispersion and burial of the charred wood.

It is also worth mentioning that the anthracological assemblage is mostly composed of charcoal from **coronillo**, **molle** and **tala**, hardwood/semi-hardwood species with high fuel yields (Hurrell 2004, Tortorelli 1956). On the other hand, **willow**, **ceibo** and **sombra de toro** coals, softwood species, are very scarce. Consequently, it is feasible to interpret the complementary use of hardwood/semi-hardwood and softwood tree species in the management of the hearths, without ruling out the use of non-tree species, such as shrubs and creepers, in feeding the fire. Moreover, some carbonised remains could correspond to different causes, such as accidental combustion, the medicinal use of the ashes and the discarding of broken or damaged wooden objects in the bonfires. Gathering practices were carried out around the site, possibly using dry firewood of different diameters and species. No tools would have been used for extraction, as the rock tools recovered from the site are of small sizes and would have been used for other purposes. The firewood was obtained from the coast of the Río de la Plata and mainly from the **talar**, due to the abundant availability in the environment, mediated by the social choices of the inhabitants of Los Tres Ombúes.

b- Colonial period

South of the city of Buenos Aires, after its second foundation in 1580, Juan de Garay distributed lands in the "**mercedes**": territories of considerable extension that guaranteed access to fresh water. Although not far from the city of Buenos Aires, due to its location and border with the native populations, the area was marginal in early colonial times (García Lerena *et al.* 2023). Before the industrial era, also in these lands, energy use depended solely on muscle and biomass sources. Most of the work was provided by labour and animals, while biomass (mainly firewood) was used for heating and cooking energy needs (Rodríguez 2020). The intensive use of **talar** species as firewood has been recorded in various documentary sources since the beginning of the Hispanic occupation of Buenos Aires. As a palliative measure for the lack of firewood, the introduction of **peach trees** (*Prunus persica* (L.) Batsch) was suggested in the Acuerdos of the extinct Cabildo of Buenos Aires in the early 1600s. They considered it to be a fast-growing species and good for firewood, given that the colonists had to travel long distances to obtain this resource (Cabildo de Buenos Aires 1619, García Lerena *et al.* 2023). It is worth noting that iron tools such as axes were also introduced during the early colonial period and were quickly incorporated into the material repertoire of native societies in contact with Europeans (Latini 2011). Regarding the groves, the Jesuit Antonio Sepp, upon arriving in Buenos Aires in 1691, already highlights the early presence of "*whole forests of peach and almond trees (Prunus amygdalus Batsch). They grow free and belong to no one. The wood of these fruit trees is used as firewood*" (Sepp 1971 [1696]: 119).

The study region was inserted late into socio-economic spaces of importance for the colonisation process. At the same time, native populations continued to live further south and, with some exceptions, did not frequent the space under colonial control (Carlón 2007). An example of this is El Puesto site, which has a record corresponding to hunter-gatherer and potter groups with a radiocarbon dating those places it between 1650 and 1800. This places it in the period after the arrival of Europeans in the area, in a region considered to be a frontier between the native societies and the Hispano-Creole ones, settled further north until the 18th century (Ghiani Echenique *et al.* 2023).

In the analysis of the anthracological assemblage recovered at El Puesto, 56.5% of the charred woody remains were taxonomically identified, mostly corresponding to **tala** (n=23), and to a lesser extent to **molle** (n=2) and **sombra de toro** (n=1) (Fig. 4). Among the undetermined remains, there are fragments with an extremely small observable surface area and others made up of bark. Also, three remains could correspond to other taxa, which will have to be evaluated by expanding the reference collection. Regarding the estimated sizes, although the sample is very small, 75% corresponds to thick wood and 25% to fine wood. In coincidence with what was recorded at Los Tres Ombúes, the woody remains are scattered coals, considered to be indicators of combustion structures or hearths possibly made at different times and associated with

different social practices. There is also a similarity in terms of the size and condition of the sample. It should be noted that this site also shows no tendency to select sizes according to the species used. Through comparison with the reference collection, it could be established that most of the remains identified correspond to **tala**, a species that is almost exclusively found in the woodlands surveyed at the site and the surrounding area, where this resource would have been obtained, possibly from the collection of dry firewood. It is estimated that this species would have been used in the firing of ceramic pieces, as well as in the preparation of food, among other daily practices that took place at the site.

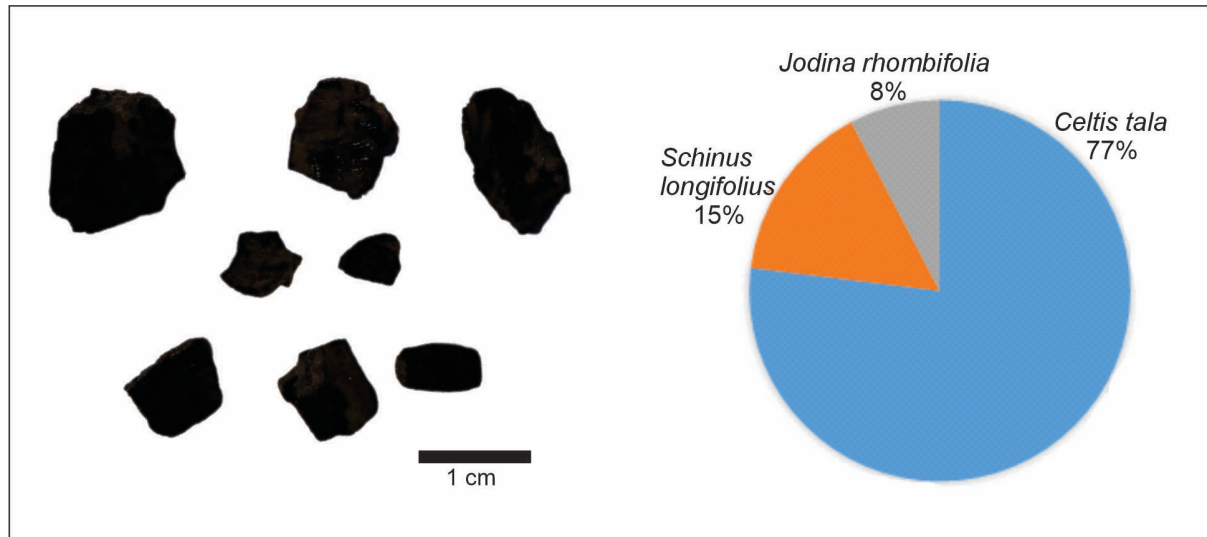


Figure 4. Photography of charcoals recovered in El Puesto archaeological site (left); percentage graph of the species identified in the assemblage (right).

In the 18th century, in a context of territorial advance, this situation changed, and a frontier society was formed in Buenos Aires countryside, a situation that led to the advance of settlers into indigenous territory and an increase in violence between the two societies (Pedrotta 2008). At this time, we find mentions by travelers and missionaries who travelled through the region, "*the tala is good for firewood but useless for construction*" (Cardiel 1930 [1748]) and they even warn about the consequences of its overexploitation: "... *talas and saucos, which give these fields of Buenos Aires the magnificent appearance of a park that makes them unique, but which they will soon lose, unfortunately, given the clumsy devastation to which they are subjected*" (Cardiel 1930 [1748]). Carrió de la Vandera 1997 [1773]), on his journey from Buenos Aires to Luján, also referred to the use of **tala** as firewood: "*After the stream, (...), there is a woodland not very thick with trees, which they call tala, and it extends for the space of two leagues. The owner has his house within the forest itself (...) they lived on the proceeds of the firewood from that forest, where the carters from Buenos Aires went to buy it*".

Another missionary, the English Jesuit Tomás Falkner, in the mid-18th century, travelled around what is now the Salado River, referring to the forests of **tala**: "*there are many forests of a tree called tala, which is only good for making fire, or for fencing*" (Falkner 2003 [1774]). Towards the end of the same century, Félix de Azara, Spanish military officer, engineer, explorer, cartographer, anthropologist, humanist, and naturalist, described Isla Postrera (near Chascomús), "*a hill full of talas, which can only be used for firewood, because the good sticks no longer exist*" (Azara 2006 [1837]).

In respect of the trees introduced at that time, a general study of the **estancias** in the Buenos Aires countryside for the period 1751-1815 shows that one in three establishments had trees in their inventories, with very marked regional differences (Garavaglia 1993). In an analysis of the **estancias** in the area, the omnipresence of **peach trees** stands out, ranging from a few dozen specimens to stands of more than a thousand trees, as in the estancia of Clemente López Osornio, a prominent landowner in the region (García Lerena *et al.* 2018). In the city of Mendoza, the use of firewood from introduced species is also observed, particularly **peach trees** in the colonial period. In the latter case, the anthracological analysis of the fruit species allows us to conclude that the branches obtained from pruning practices were used, an activity necessary for the fruiting of the plant, making the obtaining of fruit and firewood compatible, which would have implied care practices (Mafferra *et al.* 2015).

c. Post-independence period

In the last few centuries, this region was shaped as a space of rural exploitation in which the **estancia** as a productive unit played a central role in the introduction and multiplication of livestock and various plant species. From the beginning of the effective Hispano-Creole occupation of the area, changes can be observed with respect to previous periods, aimed at shaping a landscape that was functional to the interests of the new settlers. This process, linked to the consolidation of the **estancias** as productive spaces linked to the capitalist mode of production, was characterised by the massive introduction of arboreal specimens, which generated changes in the perception, circulation, and use of space, and was greatly enhanced by the widespread use of wire fences (García Lerena *et al.* 2018).

As previously mentioned, the omnipresence and great abundance of **peach trees** on the **estancias** are documented in numerous inventories of successions (Paleo *et al.* 2016), for fuel use and to supply their fruit, as Mac Cann points out in his tour of the pampas in the mid-19th century: "*The branches of the peach tree are used here as firewood: they cut them three years after the tree is planted and at that time they sell the firewood. After three more years, they cut the branches again and so on, as long as the plant does not dry out*" (Mac Cann 1969 [1853]). The **talar** species also provided firewood, timber, and charcoal for the inhabitants of the past, as can be seen in the authorisation given in 1812 by the Cabildo of Buenos Aires to Don Juan Carreto to fell trees in the Tordillo mountains (Vervoorst 1967). Also, about non-fuel uses, it is mentioned that "*the wood (from felling) is strong and is used for running shafts, whip ropes, turned objects, etc.*" (Latzina 1888: 743). The analysis of documentary sources from the 19th century, such as duplicate surveys, shows that the **tala** forests are graphically represented in the plans and mentioned in the writings (Dupl. 264 of MG), so it is inferred that they were a notorious and relevant element of the landscape, which could serve as a reference for the locals, although in general they are not inventoried in the successions or wills analysed (García Lerena *et al.* 2023).

The *Censo General de la Provincia de Buenos Aires*, carried out in 1881, provides a general characterisation of the population and different productive aspects of the province. For the district of Magdalena, which included the current territory of Magdalena and Punta Indio, 552 urban families and 1685 rural families were recorded, with a total of 10176 inhabitants, which means that almost 70% of the population was classified as rural. At this time, there were 2044 hectares corresponding to farms (0.55% of the area of the district), with 104 hectares cultivated with fruit trees and 165 hectares with trees for construction and fuel use. In respect to professions, 26 carpenters and 2 lumberjacks are recorded.

In El Santuario I, a fragment of carbonized **peach** endocarp was found in stratigraphy which shows the widespread presence of peach trees on the **estancias** at this time (García Lerena *et al.* 2023). In this archaeological context, a set of kaolin pipes was also recovered, a common finding in archaeological sites assigned to this temporality. The analysis of plant microrests recovered from the interior of these pipes, in dialogue with ethnographic and ethnohistoric data, allowed us to identify the presence of **tobacco** (*Nicotiana* sp.), and different foliar structures, such as rhomboidal crystals, druses, fibers, tissue fragments and starches related to **sombra de toro** (*aff. Jodina rhombifolia*) (Auge *et al.* 2022). Analysis of a set of pipes from a nearby site called Estancia Bertón, attributed to the family that owned the **estancia** and occasional consumers of the rural commerce that operated there, identified the presence of **molle** (*Schinus* sp.) and possibly **tala** (Auge *et al.* 2018). Although it does not correspond to the use of firewood in particular, these contexts allow to interpret the complexity of smoking practices involving **tobacco** and native species.

By the 19th century, various documentary sources point to the incorporation of other species for forestry purposes, for the protection of livestock. "*Eucalyptus* (*Eucalyptus* spp.), *acacia dealbata* [*Racosperma dealbatum* (Link) Pedley] and *paraíso* (*Melia azedarach* L.) are good, very healthy and very useful plants. The generalization of these plants is very convenient, because they take root well, grow quickly, do not have many enemies, and a few years after they are planted, they provide the establishment with shade, wood and firewood" (Hernández 1953 [1884]). The Rural Code of Buenos Aires (1865), declared thistles, straw, and other coarse grasses used as fuel, to be the property of the **estancia** owner, which meant they could not be collected without his permission (PBA, Rural Code, Article 293). The **estancias** analysed, of a certain size, had their own carpentry and used locally sourced timber, combining native and introduced species. Many of them also had blacksmiths' shops on their premises, as well as axes and saws in their inventories (AGN N° 8549). These tools are recorded in estate inventories from the end of the 18th century. The analysis of photographs of the **estancias** by the end of the 19th century shows the presence of **eucalyptus** trees in the area, introduced some decades ago in addition to the native species as **tala** (García Lerena *et al.* 2023).

In 1937, through Provincial Law 4621, the natural forests of the districts of Magdalena, Castelli, Dolores, Conesa and General Madariaga were declared of public utility, it means susceptible to subsequent expropriation, empowering the government

to prevent their felling and providing for the possible creation of nature reserves in the area. Later, in 1981, Ordinance 12/81 of the Magdalena district declared the area a "preservation zone" and, in 1984, the municipality signed an agreement with the National Parks Administration, through which it undertook to provide human resources for the implementation of the protected area (Pastorino 2009). As mentioned above, in the same year the PCS was declared a Biosphere Reserve by UNESCO.

The fuel use of **talar** species in the first half of the 20th century was mentioned in interviews conducted at the PCS. For example, the Catella family, owners of the Santa Rita ranch, was involved in forest production for firewood destined for Buenos Aires during the First World War, due to the need for fuel for power plants in the face of the coal shortage linked to the war (D'Amico 2020). On the other hand, an interviewee in Atalaya referred to the commercial production of methyl alcohol distilled from wood used exclusively as fuel, by the company Destilación de Maderas del Plata, Sociedad Comercial e Industrial de Responsabilidad Limitada, created in 1943: "*The Destilación de Maderas del Plata burned about 8/10 lorries of tala, of tala trunks, and as it burned green, they distilled the condensate that came out of the steam and extracted methyl alcohol, which they bottled in 40/50 litre bottles. And where did they take it? For national consumption because there was no methyl alcohol here during the Second World War. And at the same time, they made charcoal (...) There were piles (of charcoal) there and they used to hold up the railway car to load the charcoal and sell it*" (C. 82 years old, Atalaya, 2021).

Another important antecedent corresponds to a memorandum sent to the director of the La Plata Museum in 1943 by the agricultural engineer Ricardo Pearson, a well-known rancher in the area. This document, intended to be submitted to the Directorate General of Livestock and Industry of the Province of Buenos Aires, requests the protection of the Magdalena woodlands: "*the high price currently being paid for firewood by making its exploitation economically possible, puts these old Magdalena woodlands, which give their characteristic stamp and have made the whole coastal area famous for its beauty, in great danger of being destroyed*". However, he considered that the exploitation does not solve the fuel shortage "*because of the small amount of firewood that can be obtained from them (...), since the large plantations of eucalyptus and other trees that exist here are sufficient for (household consumption) and produce more and better firewood at a much lower cost of exploitation*" (Pearson 1943). In 1950, Pearson set aside 500 hectares of his **estancia** El Destino to create a reserve, now included in the PCS area. This private reserve, administered by the Elsa Shaw de Pearson Foundation, created in honour of his wife, is dedicated to promoting the study and conservation of nature in the area (Pernigotti 2009).

d. Current populations

The ethnobotanical survey recorded the domestic use of firewood in 19 dwellings, where it is mainly used (95%) for heating rooms during the winter. The most used appliance is the potbelly stove, due to its ease of construction and placement inside the dwellings and its greater energy efficiency compared to open fires. To a lesser extent, hearths and firewood-stoves are used for heating. In turn, 35% of those interviewees use firewood for cooking food in a wood-fired clay oven, grill, barbecue and/or firewood-stoves.

The interviewees positively value the heat generated by firewood and the flavour it gives to food, being essential for cooking certain typical meals such as **asado** (meat cooked over hot coals or lit embers), the preparation and consumption of which involves socially important moments of gathering. In this case, species such as **acacia melanosa** (*Racosperma melanoxylon* (R. Br.) Pedley), **black acacia**, **eucalyptus**, **laurel** (*Laurus nobilis* L.) or **ligustrum** are often used. Also used for cooking in clay ovens are **almez** (*Celtis australis* L.), **cina cina** (*Parkinsonia aculeata* L.), **eucalyptus**, **laurel**, **ligustrum**, **mora** which produce a good flame, or **tala**, **coronillo**, **black acacia**, **aromo** (*Racosperma dealbatum* (Link) Pedley) due to the production of abundant embers. In addition, in the absence of a natural gas network in the area and the high cost of bottled gas, woody vegetation has become a key resource in the daily lives of the PCS inhabitants, especially during the winter season.

The fire is lit with fine wood and leaves, dried thistles and/or newspaper are added. Sometimes species such as **poplar** (*Populus* spp.), **willow** or **eucalyptus** are used, which light quickly and make a good flame. Once lit, larger diameter branches are added and replenished as needed. Although most of the cookers used are closed, in general, they are handmade devices that can leak smoke into the house and do not achieve complete combustion. In addition, the use of additional fuels to light the fire and the use of recycled wood that may contain toxic paints and glues hurt health. Nevertheless, the interviewees did not mention having had health problems because of the smoke and neither to the need of replacing the stoves, as programs developed in other regions of Argentina have done (INTA 2018, Pazzarelli 2016).

These fast-burning species are also used to light brick ovens, as found in two **ladrilleras** in rural areas of the Magdalena district, where only **eucalyptus** and **poplar** are used. These species are collected in the area and are complemented by the purchase of firewood, as large quantities are required (3,000 kilos per firing approximately).

Six firewood sale sites were also recorded, corresponding to stores and sites selling firewood exclusively (**leñeras**) that sell firewood informally (Fig. 5). In these cases, firewood is considered a source of monetary income. It is arranged in a single pile, even when more than one species is sold so that the different species are mixed.



Figure 5. Top: Firewood sale sites in Magdalena (left) and Atalaya (right); Bottom: Domestic firewood collection in Los Naranjos (left) and Punta Indio (right).

A total of 28 woody species belonging to 23 genera and 14 botanical families used as fuelwood were recorded (Table 1). The best represented families are Fabaceae and Myrtaceae. Sixty-eight per cent are exotic species, 21% native to the Río de la Plata region and 11% native to other regions of Argentina. Most of the species are arboreal (96%), and only a few are shrubs (4%). Eighty-three per cent of the species are obtained through the collection of timber, 14% through purchase and only 3% through the recycling of disused timber. It should be noted that the native species surveyed are: **tala**, **coronillo**, **willow**, **brusquilla**, **molle** and **espinillo**.

Thirty-one local names were collected; in some cases, the same species is called by different names according to the interviewees. For example, **acacia melanosa**, **acacia melanoxylon** and **aromo** refer to *Acacia melanoxylon* R. Br. In other cases, different species (*Eucalyptus globulus* Labill.; *E. camaldulensis* Deginani; *E. saligna* Sm. or other species of the genus present in the area) are included under the same local name, e.g., **eucalyptus**. On the other hand, some interviewees distinguished between two types of **eucalyptus**: white and red. **White eucalyptus** corresponds to *E. globulus*, while **red eucalyptus** includes two species: *E. camaldulensis* and *E. saligna*.

Table 1. PCS firewood species: local name, scientific name, family, biogeographic origin and reference sample, acquisition strategies, uses and local valuation of wood as fuel. Species highlighted in bold are species native to the study area, while * implies that no reference sample is available.

Local name, scientific name, family, biogeographic origin and reference sample	Acquisition strategies	Uses	Local valuation
ACACIA BLANCA, ACACIA COLORADA <i>Robinia pseudoacacia</i> L. (Fabaceae). Exotic. R13; L1; L2	Gathered	Heating (potbelly stove). Cooking. Commercialization	Good/very good. It is also used to make posts due to its durability
ACACIA MELANOSA, ACACIA MELANOXYLON, AROMO <i>Racosperma melanoxyton</i> (R. Br.) Pedley (Fabaceae). Exotic. R8	Gathered	Heating (potbelly stove). Cooking (roasting). Commercialization	Very good/ Good ember
ACACIA NEGRA, ALGARROBO <i>Gleditsia triacanthos</i> L. (Fabaceae). Exotic. R19	Gathered	Heating (potbelly stove, hearth). Cooking (wood-fired clay oven, roasting). Commercialization	Good/ very good ember
ÁLAMO Varias spp. del género <i>Populus</i> (Salicaceae) Exotic. R12; R20	Gathered	Heating. Cooking (brick oven)	Good flame
ALMEZ <i>Celtis australis</i> L. (Cannabaceae) Exotic. R11	Gathered	Heating (potbelly stove). Cooking (wood-fired clay oven)	It is not so good
AROMO <i>Racosperma dealbatum</i> (Link) Pedley (Fabaceae) Exotic. R35	Gathered	Heating (hearth). Cooking (wood-fired clay oven, firewood-stove)	Good. Good ember
BRUSQUILLA <i>Colletia spinosissima</i> J. F. Gmel. (Rhamnaceae) Native. R16	Gathered	Heating (potbelly stove)	Good
CASUARINA <i>Casuarina cunninghamiana</i> Miq. (Casuarinaceae). Exotic. R4; L3	Gathered	Commercialization	Good
CINA CINA <i>Parkinsonia aculeata</i> L. (Fabaceae) Doubtful origin. Possibly introduced in the early colonial period. R21	Gathered	Heating (potbelly stove). Cooking (wood-fired clay oven)	Good
CIRUELO <i>Prunus domestica</i> L. (Rosaceae). Exotic. R14	Gathered	Heating (hearth). Commercialization	Good
CORONILLO <i>Scutia buxifolia</i> Reissek (Rhamnaceae). Native. R5	Gathered	Heating (potbelly stove and hearth). Cooking (wood-fired clay oven). Commercialization	Very good. Good ember
ESPINILLO <i>Vachellia caven</i> (Molina) Seigler y Ebinger (Fabaceae). Native. R31; L4A,B	Gathered	Heating (hearth)	Very good/good, hardwood
EUCALIPTO Varias spp. del género <i>Eucalyptus</i> . (Myrtaceae). Exotic. R9; R23; R28; L5A,B,C,D,E	Gathered and purchased	Heating (potbelly stove, hearth, firewood-stove). Cooking (wood-fired clay oven, ladrillo, firewood-stove, roasting). Commercialization	Good/very good
EUCALIPTO BLANCO <i>Eucalyptus globulus</i> Labill. (Myrtaceae). Exotic. R23	Gathered	Commercialization	Good. Good flame
EUCALIPTO COLORADO <i>Eucalyptus camaldulensis</i> Dehnh; <i>E. saligna</i> (Myrtaceae). Exotic. R9; M1; L5A,B,C,D,E	Gathered and wood recycling	Heating (potbelly stove). Cooking (roasting). Commercialization	Good. Good flame

FRESNO <i>Fraxinus pennsylvanica</i> Marshall (Oleaceae). Exotic. R15; L7	Gathered	Heating (potbelly stove). Commercialization.	Good/very good
ITÍN <i>Neltuma kuntzei</i> (Harms ex Kuntze) C.E.Hughes & G.P.Lewis (Fabaceae) Native. L10A,B	Purchased	Heating (potbelly stove). Commercialization.	Hard, very good
LAPACHO NEGRO <i>Handroanthus heptaphyllus</i> (Vell.) Mattos* (Bignoniaceae). Native	Purchased	Heating (potbelly stove). Commercialization	Hard, very good
LAUREL <i>Laurus nobilis</i> L. (Lauraceae). Exotic. R10	Gathered	Heating (potbelly stove, hearth). Cooking (wood-fired clay oven, roasting). Commercialization	Regular/good
LIGUSTRO <i>Ligustrum lucidum</i> W.T. Aiton (Oleaceae). Exotic. R7; L11A,B	Gathered	Heating (potbelly stove, hearth). Cooking (wood-fired clay oven, roasting). Commercialization	Good
MOLLE <i>Schinus longifolius</i> (Lindl.) Speg. (Anacardiaceae). Native. R33	Gathered	Heating (hearth)	Good
MORA <i>Morus alba</i> L. (Moraceae). Exotic. R3; L13	Gathered	Heating (potbelly stove and hearth). Cooking (wood-fired clay oven)	Good
PARAÍSO <i>Melia azedarach</i> L. (Meliaceae). Exotic. R6; L4	Gathered	Heating (hearth). Commercialization	Good
PINO <i>Pinus sp.</i> (Pinaceae). Exotic. R229; R30	Gathered	Commercialization	Regular
QUEBRACHO COLORADO <i>Schinopsis balansae</i> Engl. (Anacardiaceae). Native. L16A,B,C	Purchased	Heating (potbelly stove). Commercialization.	Hard, very good
SAUCE Varias spp. del género <i>Salix</i> (Salicaceae). Native and exotics. R1; R42	Gathered	Heating (potbelly stove). Commercialization	Good flame
TALA <i>Celtis tala</i> Gillies ex Planch. (Cannabaceae). Native. R17; L17	Gathered	Heating (potbelly stove, hearth). Cooking (wood-fired clay oven). Commercialization	Very good. Good ember

At the household level, collection generally takes place in the vicinity of the household (80%). It is mostly obtained by walking, collecting dry firewood from the ground, but also from the pruning/extraction of a tree from their home or a neighbour's and then left to dry. In these cases, the firewood is carried in arms or a crate. Some 26% travel longer distances (2 to 6 kilometres) in a vehicle. In all cases, an attempt is made to use firewood that is as dry as possible. Several authors have highlighted the importance of using dry firewood in cookers to increase energy efficiency (Arré *et al.* 2015, Cardoso *et al.* 2013). Harvesting is carried out by people of both sexes and of different ages, although in the case of pruning and extractions, only adult men carry them out. In 93% of the cases, it is carried out by a single person and the remaining 7% is carried out by families: mother/father-child and/or grandfather-grandchild. In winter, 67% of the interviewees collect firewood daily or every two or three days as needed, and the remaining 33% collect firewood during the year or a few months before winter starts. Only in a few cases an axe is used to reduce firewood fragments, while in general no tools are used for collection. Only in two cases located outside the PCS at the time of the interviews the use of a chainsaw for wood collection was mentioned.

On the other hand, the interviewees who sell firewood are older adults, four men and two women. In Punta Indio, firewood is obtained through the purchase of forest plantations of *Eucalyptus* spp. located in the area, and only in one case are native hardwood species such as **black lapacho** (*Handroanthus heptaphyllus* (Vell.) Mattos), **itín** (*Neltuma kuntzei* (Harms ex Kuntze) C.E. Hughes & G.P. Lewis) and **red quebracho** (*Schinopsis balansae* Engl.) imported from the north of Argentina. In the localities corresponding to Magdalena district, firewood is obtained through pruning and extraction of trees on private properties; often, instead of charging for the work carried out, the firewood is taken by the vendors as a form of payment. Species harvested and/or extracted from the area are sold at different prices, which diversifies the firewood used. In general,

these trees correspond to forest plantations of multipurpose exotic species (repair, provision of firewood, food, wood for rural and ornamental constructions), such as **eucalyptus**, **ash tree** (*Fraxinus pennsylvanica* Marshall), **pine** (*Pinus* spp.), **casuarina** (*Casuarina cunninghamiana* Miq.), **willow**, **tala**, **white acacia** (*Robinia pseudoacacia* L.), **acacia melanosa**, **black acacia**, **laurel**, **ligustrum** and peridomestic fruit trees such as **plum** (*Prunus domestica* L.). Only in one case, corresponding to a woodshed located outside the PCS, it is extracted from the logging areas (**tala** and **coronillo**).

The main supply season for sale is the summer, as the firewood is expected to be dry by winter. The only tool mentioned by vendors in Punta Indio was the axe, used to chop firewood. The two stores are run by women, who do not use tools because they already buy the firewood in pieces, ready to sell. On the other hand, in the localities of Magdalena located outside the PCS, they use a greater diversity of tools (chainsaws, axe, scales) because they obtain it through extraction. It is sold in bulk and its main customers are people who use it domestically, mainly in winter for heating their homes.

Often, because of the need to obtain wood of larger diameter (which is not available from dry firewood collected from the ground, as they tend to be small diameter branches) or with better qualities (due to restrictions on the use of **tala** and **coronillo**), people resort to buying firewood. This implies an additional monetary cost for the families when it could be supplied exclusively through the collection. Furthermore, it is considered that as long as the settlers maintain their practices and knowledge about firewood through direct contact with the vegetation, collecting the firewood they need for their daily tasks (and not through purchase), they will be able to glimpse processes of change in the landscape that would not otherwise be evident. This is why it is essential to promote traditional practices of vegetable collection (Cardoso *et al.* 2013).

The preferred species are those selected by the settlers because of their own experience, guided by their knowledge, looking for the best woods to be used as firewood, as stated by Cardoso *et al.* (2013). The interviewees prefer woods that produce good embers and last for a longer period when lit; in some cases, the production of a good flame for lighting the fire and cooking, and low smoke emission, are also valued.

For family self-consumption, the species of the genus *Eucalyptus*, **tala** and **coronillo** are the most widely used. These species are in turn mentioned as preferred, mainly the last two, which are native, to produce good embers and their duration. One might think then that these are the species with the highest pressure of use; however, the collection is mainly done, as mentioned above, by simply gathering the dry firewood found on the ground around the dwellings, so the conservation of the talar would not be affected. In addition, numerous exotic species are harvested, many of which are invasive, so the collection/extraction of firewood could be controlling them and thus favouring the regeneration of native species. Furthermore, from an ethnobotanical point of view, the incorporation of exotic species is considered a positive aspect as it tends to diversify practices, in this case, woodcutting (Jiménez-Escobar *et al.* 2021). Such is the case of **black acacia** and **acacia melanoxylon**, which are highly valued, in the words of one interviewee: "**acacia melanoxylon** and **black acacia** are the best" (A. 50 years old, Punta del Indio, 2016). Some studies have shown that the native/exotic dichotomy is not operational, because it is not always significant for the local inhabitants. Many species commonly considered invasive exotic species are also valued and prioritized to conservation because of the utility -for provide wood, fruits, or shade, among others (Doumecq *et al.* 2021, Martínez 2015, Martínez & García Manzano 2019). Understanding vernacular knowledge, local categories, and preferences, which differ according to social actors, could be the basis for *in situ* conservation and cultivation of high-value woody species in protected areas (Martínez 2015).

In relation to this, inside the PCS and particularly in Punta del Indio there is a great diversity of points of view about the native/exotic dichotomy in relation to the broad influence of the reserve management, the academy, and the local naturalists which priority the preservation of native species. Furthermore, within the PCS, all the interviewees mentioned the legislation that prohibits the use of native species, which is why they avoid using them, while in the localities corresponding to the Magdalena district, located outside the PCS at the time of the fieldwork, only 50% of the people did so. This represents a problem, as the preferred species are **tala** and **coronillo**. In this regard, some interviewees said: "*Here you can't, but I grew up in the countryside and I use them*" (P. 55 years old, Punta del Indio, 2015). "*I prefer tala and coronillo, but in the reserve, you can't gather them, and here there is no coronillo; tala yes, there is some*" (M. 45 years old, Magdalena, 2016). "*Preferably, I prefer tala and coronillo, and if not eucalyptus, but here we use everything*" (M. 62 years old, Punta del Indio, 2016). These two species are valued as "good firewood" because of the duration of their embers and the heat they generate: "*The best is the tala and coronillo, they last five hours, while the laurel lasts two*" (E. 75 years old, Punta del Indio, 2017). In relation to the **coronillo**, one interviewee said that it is "*harder than the espinillo, it is similar to the quebracho*" (A. 85 years old, Los Naranjos, 2014). Despite being the preferred species, some do not use them for fear of being fined: "*You cannot cut much, it is forbidden*" (M. 65 years old, Punta del Indio), "*There are places where they do not let you take firewood out*" (P. A. 70

years old, Magdalena), while others emphasize the importance of their care, "*We try not to use them to preserve*" (C. 45 years old, Punta del Indio, 2016). In any case, the available firewood is used even if it is not so highly valued, for example, the **alméz** "*It is not very useful, its wood is like a cork*" (A. 50 years old, Punta del Indio, 2016) or **pine** "*some of it is mixed in, but it is not very useful, it has a long smell*" (R. 55 years old, Bavio, 2014).

In the sale sites, **eucalyptus** (including several species that are cultivated in the area) and to a lesser extent **ash tree** are the most sold. It is worth noting that all the vendors indicate that there are restrictions on the use of firewood of native species within the park, but they know that **tala** and **coronillo** are good for firewood. One interviewee who sold firewood of these species up to the time of the creation of the PCS commented: "*On the Punta Indio side you cannot.... We were cutting for many years, but then the Coastal Park was built, and we didn't cut any more*" (P. 70 years old, Magdalena).

The assessments and preferences for firewood expressed by the interviewees coincide with those registered by Ramos *et al.* (2008) and Cardoso *et al.* (2015), who observe a direct relationship between the preference for woods and their physical characteristics. Of the species present in the area, **tala** and **coronillo** have the hardest and heaviest timbers, with densities of 0.8 and 1-1.1 (kg/dm³), respectively (Tortorelli 1956), characteristics that are directly related to the fuel value of the timbers (Abbot & Lowore 1999, Cardoso *et al.* 2015). However, other factors such as accessibility and availability within the reserve also come into play and therefore other species are used, even if they are not as highly valued.

Changes and continuities: some reflections

For the pre-hispanic period, the combustible use of local flora can be observed. At the Los Tres Ombúes site, the importance of firewood of the tree species of the **talar** (**coronillo**, **molle**, **tala** and **sombra de toro**) and the **Río de la Plata** coast (**ceibo** and **willow**) stands out, as well as its collection and use in the framework of various daily practices of the human groups that inhabited the site some 1000 years ago. These possibly included the collection of dry branches in the vicinity of the inhabited site, without the use of tools for extraction. These branches, of varying thickness, would have been used to make hearths as a source of light, heat, protection, food preparation and pottery production. Regarding the latter, experimental studies with **tala** and **coronillo** wood have demonstrated its suitability for firing pottery over an open fire, reaching temperatures of 700°-800°C (Paleo & Pérez Meroni 2000). Subsequently, according to the anthracological record from El Puesto, the native societies on the frontier continued to use the native species of the **talar**, particularly **tala**, and **molle** and **sombra de toro**, as firewood, in similar ways to earlier times, without any recorded use of coastal species. This indicates a broad knowledge of the place by these groups and the use of a variety of woody species native to the area.

The analysis of historical documentation reflects the continuity in the use of the **talar** species as firewood since the colonial period, and even their overexploitation, in addition to the early introduction of exotic species for this purpose. These species were introduced for their use as fuel in combination with food, livestock shelter, and housing protection, among others. An example of this is the **peach tree**, which quickly spread in the area. Different documents of the time record this tree in large quantities and mention it with a dual purpose: for fruit consumption and as a source of firewood (García Lerena *et al.* 2018). A noteworthy aspect from early colonial times is the introduction of metal tools (Latini 2011), particularly axes, which were widely used as part of firewood procurement strategies. Moving forward in time, already in the 19th century, multipurpose forest species such as **acacia dealbata**, **eucalyptus** and **paraíso** were massively introduced, which quickly became conspicuous in the area and which use continues to this day (García Lerena *et al.* 2018).

At present, firewood continues to be a key resource in the daily life of the inhabitants of the PCS for heating and cooking, as most of them do not have access to the natural gas network. In this context, firewood is the fuel that allows them to keep the rooms of their homes heated during the winter season and is therefore positively valued. The use of 28 species was recorded, of which 22 are exotic and six are native to the **Río de la Plata** region: **tala**, **coronillo**, **molle**, **willow**, **espinillo** and **brusquilla**. Some differences were found about the species used, the procurement strategies and the extracted volumes depending on whether it is for self-consumption or trade. At the domestic level, the predominant practice is the collection of dry firewood from the ground, without the use of tools, mainly from exotic species, although native species, particularly **tala** and **coronillo**, are highly valued and used. The situation is different in the sale sites, where considerably larger volumes of firewood are traded, mainly obtained from standing trees, although only in one of them, located outside the PCS, this wood corresponds to native species from the area.

Another aspect to highlight from this work is the practices that have been maintained over time, mostly linked to the use of firewood in the domestic sphere, mainly for cooking and heating. However, some uses mentioned in some documentary sources or interviews recalling the 20th century, such as fuel for power plants or railways, and as raw material for producing

liquid fuel and charcoal, are not maintained today. It is worth mentioning that in the production of handmade pottery, as identified in pre-hispanic times, locally collected firewood is used. In the ethnobotanical work carried out, no interviewee mentioned this use, although the sample had no representation of ceramists. On the other hand, one use recorded today is the production of bricks by the few **ladrilleras** that remain in the area, which generally use **eucalyptus** and **poplar** firewood. The firewood trade began in the colonial period, as detailed in some documents of the time, and continued over time. In this process, some changes have been identified in the species traded because of the introduction of trees, with native species losing relative importance and introduced species gaining prominence. At present, the commercialization of native species is not registered in the PCS due to the protection that governs them, although one case of sale of **tala** outside the reserve has been reported. The sale of charcoal has also been recorded at different times.

Firewood and its use as a generator of meeting and gathering spaces as interpreted for the pre-hispanic period are recurrent throughout time. Likewise, there are documentary and archaeological records of the meeting and gathering space around hearths, as evidenced at El Santuario I. The link between people and firewood transcends the mere utilitarian sphere, giving rise to aspects related to the symbolic, emotional, affective, and culinary, among others (Doumecq *et al.* 2023). Also, from the different strategies of procurement and use, it is possible to glimpse the transmission of knowledge, even intergenerational, which is evident in the conducted interviews. It is considered that these processes of circulation of knowledge associated with the ways of doing things would also have taken place in the past in relation to the practices of obtaining and using firewood carried out by hunter-gatherer groups.

The indiscriminate felling of native species for firewood was at its peak in the colonial and post-independence periods. This generated certain protection measures, some very early, such as the agreements of the Cabildo in the 17th century, as well as different initiatives throughout the 20th century that constitute the background to the creation of the PCS, in addition to the recent extension of the protected area. Although no regulations for its protection have been found in the intermediate period, some writings propose the promotion of other species for this purpose, as well as warnings from naturalists and travelers about the overexploitation of this forest formation.

It should be noted that since the end of the 20th century, there have been quarries generated by shell exploitation in the current territory of the PCS, some of which are still in operation. To extract shellfish, it is necessary to cut down the **talar** that grows on this substrate, so the pressure on this plant formation has gradually increased (Paleo *et al.* 2016). In addition, shell extraction eliminates freshwater reservoirs that are found in the form of lenses in the shell strands, affecting the water sustainability of the area (Tejada *et al.* 2011). This economic activity has a high environmental impact as it eliminates the forest in the affected area, which has no possibility of regeneration due to the destruction of the substrate on which it grows.

As in the pre-hispanic period, the use of firewood at the domestic level and the collection of firewood predominates today. Throughout this process, the use of firewood obtained in the **talares** has been verified with varying degrees of intensity over time, and the gradual incorporation of exotic species has gradually shaped the current landscape. In this sense, it is worth noting that the landscape of the PCS includes both the original grasslands and **talares** of the area, as well as the different species introduced over the last few centuries. Even though these introductions respond to criteria and valuations characteristic of each era, they are conceived as part of the local environment, giving identity to the region (García Lerena *et al.* 2018).

The creation of the PCS has had an impact on firewood production, as it restricts the use of native species based on municipal ordinances and decrees. Many settlers recognise the need to take care of them and to carry out practices that are sustainable with the native forest. Others argue for changes in their choice to avoid sanctions. Those interviewed sought alternatives such as collecting dry firewood from the soil of these species and the incorporation of exotics. On the other hand, one firewood vendor opted not to continue with the activity, while others dedicated themselves to the sale of introduced species, leaving only one vendor who extracts wood from native species and who is located outside the PCS area, where the use of tools (chainsaw) is still used to obtain it. Nowadays, the extraction zone has been reduced even more, due to the extension of the reserve area; therefore, part of the population that lived outside the PCS was forced to start complying with the regulations. This highlights the need to re-examine the conditions associated with the use of fuelwood in commercial and domestic activities. These changes reflect the flexibility of the inhabitants in the face of socio-environmental changes, with innovations and transfers of uses from one plant to another that enrich local practices.

Conclusions

As a general summary, based on this work we can state that, in the PCS and the surrounding area, there is continuity over time in the use of species from the **talar** and the **Río de la Plata** coast as firewood, and the incorporation of various exotic species since the colonial period. A greater diversity of species is used nowadays than in previous periods, both native and exotic, and the collection of dry firewood from the ground predominates. Of the native species used in the pre-hispanic past, **tala**, **coronillo**, **molle** and **willow** continue to be used as fuel, with no record of the current use of **sombra de toro** or **ceibo**. As for the species mentioned in the documentary sources, all of them are currently used as firewood, except **peach** and **almond**, whose use was characteristic of the colonial period.

An important point for reflection is that conservation policies that imply the prohibition of the use of native species are contrary to the concept of a Biosphere Reserve, where the community lives in close relationship with the environment, interacts and can make use of its resources sustainably. The history of use, occupation, and management of the **talares** detailed here leads to their appropriation by the local inhabitants as part of their biocultural heritage. The strategy of conservation through use can be much more effective than conservation *per se*, as the use of available resources by local people tends to value and conserve them rather than eliminate them (Evans 1993, Petrucci *et al.* 2022). Thus, biodiversity conservation cannot be separated from cultural memory and local botanical knowledge (Nazarea 2006). In this case, it should be evaluated how the commercialisation of firewood affects the conservation of the logging area, as it implies the extraction of standing firewood in large quantities, to adapt it as an activity that allows for the sustainable development of families and at the same time is compatible with the Reserve (Doumecq 2023). The operation of shell quarries, which requires the removal of vegetation cover, should also be reconsidered.

The long-term perspective developed in this work, with an interdisciplinary approach that recognises the multiple practices, representations and social actors involved, provides elements to historicise the bond between societies and their plant environment in a particular territory over time. This knowledge, which links the past with the present through the continuities and transformations of practices and meanings in the construction of a particular landscape, can contribute to the design and implementation of long-term sustainable conservation policies.

Declarations

List of abbreviations: BP: Before Present; CONICET: Consejo Nacional de Investigaciones Científicas y Técnicas dm3: cubic decimeter; FCNyM: Facultad de Ciencias Naturales y Museo Fig.: Figure; INDEC: Instituto Nacional de Estadística y Censos ISE: International Society of Ethnobiology; Kg: Kilogram; LEBA: Laboratorio de Etnobotánica y Botánica Aplicada m: meter; mm: millimeter; PBA: Buenos Aires province PCS: Parque Costero del Sur; Sp: specie; Spp: species; UNESCO: United Nations Educational, Scientific and Cultural; Organization UNLP: Universidad Nacional de La Plata, Argentina

Ethics approval and consent to participate: We have previously informed consent, as detailed in the manuscript. An agreement of will was established between the interviewees and the researchers, where the framework in which the work is carried out, the objectives and importance of the research and the commitment to deliver a copy of the work carried out to the families interviewed and not to use the information provided for commercial purposes. On the other hand, the interviewee explicitly agrees to participate in conducting the interview and chooses as to the possibility of spreading his name, photos, recordings and/or knowledge. In relation to the archaeological research, the Laboratorio de Análisis Cerámico has the permissions granted by the Centro de Registro del Patrimonio Arqueológico y Paleontológico of the Buenos Aires province. It should be clarified that the archaeological sites are situated on private properties, so we necessarily have the owner's permission to research these places.

Availability of data and materials: All the materials were deposited in the ethnobotanical collections of LEBA, except the archaeobotanical reference collection that is preserved by the LAC.

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Appendix 1. Documentary sources

Author	Date	Characteristics of the author	Type of source	Type of document	Geographic scope
Cabildo de Buenos Aires	1608 - 1619	-	Published	Acuerdos del Extinguido Cabildo de Buenos Aires	Buenos Aires- today's city of Buenos Aires
Antonio Sepp	1696	Jesuit missionary of Italian origin	Published	Travelers' diaries	Italy to Spain. From there to the city of Buenos Aires. Then they continued on to Misiones
José Cardiel	1748	Jesuit missionary of Spanish origin	Published	Travelers' diaries	Buenos Aires- zona costera
Alonso Carrió de la Vandra	1773	Spanish colonial officer	Published	Chronicle	Buenos Aires- proximidades de la actual ciudad de Buenos Aires
Tomás Falkner	1774	Jesuit missionary of English origin	Published	Travelers' diaries	Coastal area of the Pampean region. Pago de la Magdalena. Also Patagonian region
Félix de Azara	1837	Spanish naturalist	Published	Travelers' diaries	Buenos Aires- Pampean region, inland province.
William MacCann	1853	English traveler	Published	Travelers' diaries	Pampean region
Archivo ARBA	1863	Surveyors	Unpublished	Duplicates of measurements	Buenos Aires. Magdalena
Province of Buenos Aires	1865	Legislation	Published	Rural Code	Buenos Aires
Province of Buenos Aires	1881	Edited by Dardo Rocha	Published	General Census of the Province of Buenos Aires. Demographic, Agricultural, Industrial and Commercial.	Buenos Aires
José Hernández	1884	Argentine poet, politician, journalist and military man.	Published	Instructions for the establishment and management of a rural establishment.	Rural establishments in general
Francisco Latzina	1888	Austrian-born astronomer, cartographer, meteorologist and mathematician	Published	Geography of Argentina book	Argentina
AGN	1897	Several	Unpublished	Succession of a local	Magdalena

				rancher	
Ricardo Pearson	1943	Argentine Agronomist	Unpublished	Memorandum to the Directorate of the La Plata Museum	Talares of the Province of Buenos Aires. Includes current Parque Costero del Sur