El Hornero Volume 41 · Number 1 · August 2026
Article
doi.org/10.56178/eh.v41i1.1528

CAVITY-NESTING BIRDS: EVALUATING THE USE OF NATIVE AND EXOTIC TREE SPECIES IN THE ESPINAL ECOREGION

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ABSTRACT: This study assessed the use of trees for nesting by cavity-nesting birds in the Espinal ecoregion, Argentina. We analyzed data from 264 nests of tree cavity-users (114 woodpecker nests, and 150 from secondary cavity-nesting birds) found over a 49-year period (1970–2019) in a fragmented landscape. The main results showed that this group of birds makes greater nesting use of native trees, such as Chañar (*Geoffroea decorticans*) and Algarrobo (*Prosopis alba*), both live and standing dead, although the use of exotic trees was also recorded. Furthermore, secondary cavity-nesting birds showed a proportionally higher use of cavities generated by decomposition. These findings highlight the importance of retaining native, live, and standing dead trees in the landscape as key elements for the conservation of avifauna in fragmented landscapes.

KEYWORDS: *agroecosystems, Argentina, dry forests, nesting, reproductive biology*

Ecological studies on resource use for foraging, shelter, or nesting are one of the most effective ways to identify relationships among animal species within a given habitat (Atkinson et al. 2005, Ferger et al. 2014). Information on use of resources such as habitat types and anthropogenic disturbances can be effective for evaluating different responses of animal species to environmental change (Marzluff et al. 2004, Ossi et al. 2022). An example of this is tree cavities, which are an important resource in forests for many bird species that depend on them for nesting or shelter (Cockle et al. 2011, Schaaf et al. 2021). In this context, when cavity availability is limited, competition among species increases and reproductive opportunities are reduced, which can decrease the abundance of cavity-nesting birds (Brawn & Balda 1988, Newton 1994, Schaaf et al. 2021). This highlights that suitable cavities constitute a critical and potentially limiting resource, whose availability is key to understanding in modified landscapes (Newton 1994, Cockle et al. 2011).

Currently, approximately 18% of all bird species worldwide nest in tree cavities, with the greatest richness occurring in the Neotropics (van der Hoek et al. 2017). Within this group, primary cavity users can be distinguished, such as woodpeckers (Picidae), which excavate their own cavities for nesting or shelter; facultative excavators such as trogons (Trogonidae), which excavate or modify pre-existing cavities; and secondary users, within which there is a wide variety of taxa that use cavities generated by excavators or those created by decay and/or breakage of trees (Aitken & Martin 2008, Cornelius et al. 2008, van der Hoek et al. 2017, Di Sallo & Cockle 2025).

Because of these habitat requirements, this group of birds is often affected by the number of specific sites available for nesting. For example, bird species with greater body mass require cavities with larger entrances, which are usually found in trees of larger diameter, and this can significantly influence nest-si-

Received: 25/08/2025 · **Accepted:** 30/12/2025 · **Associate Editor:** Paulo Llambias · **Format Reviewer:** Paula S Garrido Coria · **Editor in English:** Abigail Williams
This article was originally written in Spanish. It was translated using an AI program (ChatGPT) and then reviewed by an English editor.

te selection by secondary users (Renton et al. 2015, Bonaparte et al. 2020, Di Sallo & Cockle 2022). On the other hand, excavating birds also have specific requirements that influence nest-site selection, as they need large trees with a certain hardness to house cavities suitable for excavation (Jauregui et al. 2021, Di Sallo & Cockle 2025). However, large trees, which are crucial for housing such cavities and necessary for excavation, are the scarcest and most frequently removed due to various anthropogenic activities, such as agriculture, forestry, or replacement by commercial forest species (Manning & Lindenmayer 2009, Ibarra & Martin 2015, Schaaf et al. 2021).

For this group of birds, the loss of large native trees and standing dead trees in modified landscapes forces some bird species to depend on the use of exotic tree species for nesting (Zapponi et al. 2014, Bonaparte et al. 2020). The use of exotic trees for nesting has been recorded in several Neotropical species and may be associated with the expansion of anthropogenic activities where exotic vegetation is abundant, a pattern that is important to investigate in fragmented areas of Argentina (Jauregui et al. 2019, Maya-Elizarrarás et al. 2025). One of the Argentine forest ecoregions most affected by landscape transformation in recent decades is the Espinal (Nanni et al. 2020). Therefore, data on the relationships between avifauna and cavities in different tree species within this ecoregion have important conservation implications.

This study aims to describe the use of nesting sites by cavity-nesting birds in the Espinal ecoregion, seeking to determine the use of arboreal substrates in native and exotic species, as well as the condition of the tree (alive or standing dead). In addition, we examined whether secondary user birds (classified by body mass) differentially depend on cavities generated by decay or excavated by woodpeckers. Finally, we analyzed the importance of these relationships for avifaunal conservation in an ecosystem facing high levels of transformation in Argentina. This information may be fundamental for formulating better forest retention policies aimed at bird conservation.

METHODS

Study area

The work was carried out in the "Médico Veterinario Martín R. de la Peña" Natural Reserve, a protected area of the Universidad Nacional del Litoral that covers an area of approximately 70 ha (31°20'S, 60°40'W). This reserve belongs to the Espinal Ecoregion and is located about 5 km from the city of Esperanza, in the center of Santa Fe province, Argentina (Fig. 1). The regional climate is subhumid, with mean annual temperatures of 20°C and rainfall that can exceed 1100 mm per year (Lovino et al. 2020). Regio-

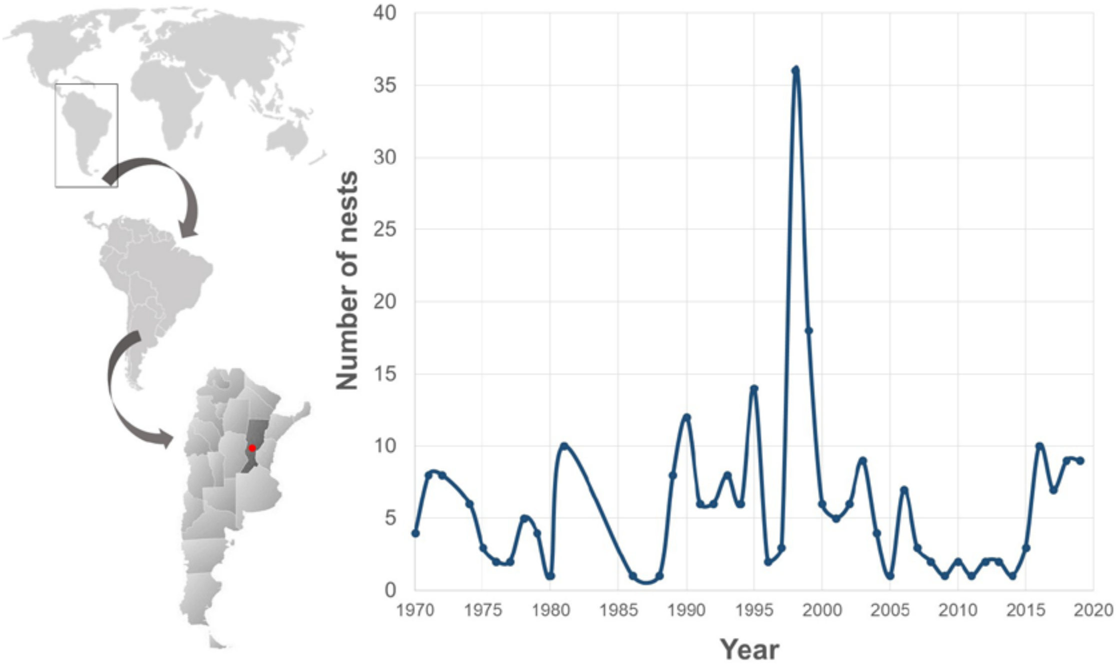

Figure 1. Study area and timeline of the total number of cavity-nesting bird nests found between 1970–2019 in the Espinal Ecoregion, Santa Fe province, Argentina.

nally, the Espinal is a highly modified and fragmented landscape due to deforestation and intense agricultural and livestock exploitation, with little remaining intact forest. The vegetation of the reserve includes native species such as White Algarrobo (*Prosopis alba*), Chañar (*Geoffroea decorticans*), Tala (*Celtis tala*), Curupí (*Sapium haematospermum*), White Quebracho (*Aspidosperma quebracho-blanco*), and exotic species such as Eucalyptus (*Eucalyptus* sp.) and Chinaberry (*Melia azedarach*), constituting one of the forest remnants within this productive matrix (de la Peña & Pensiero 2003, Exner et al. 2004).

Data collection and analysis

A dataset of cavity-nesting bird nests collected by one of the authors (MRDP) over a non-consecutive period of 49 years (between 1970 and 2019) was analyzed. Nesting data came from casual observations and surveys carried out in the study area during the breeding season (spring–summer), considering only cavities that presented minimum physical characteristics to allow nesting (an adequate entrance opening and a vertical depth greater than 5 cm). Cavities were recorded as active nests when reproductive evidence was observed (presence of eggs, nestlings, or adults carrying nesting material or food).

The main variables analyzed were bird species, type of cavity used (excavated or generated by decay), tree species type (native or exotic), and tree condition (alive or standing dead). For secondary users, we followed Cockle et al. (2015), separating them into three groups based on body mass: small birds (< 100 g), medium-sized birds (100–400 g), and large birds (> 400 g). This classification was adopted to increase the effective sample size within each category, allowing the grouping of data from species with a low number of individual nesting observations. Body mass for each bird species was obtained from Dunning (2007).

The data were analyzed using descriptive statistics, calculating the frequency of use of each category (cavity type, tree species, tree condition) for each bird group (woodpeckers and secondary users).

RESULTS

During the study period, a total of 264 nests from tree cavities were recorded and characterized, and the number of findings fluctuated widely throughout the field sampling period (Fig. 1). Of this total, 114 nests of eight species of woodpeckers and 150 nests corresponding to 36 species of secondary cavity-using birds were identified. Among excavators, the species with the highest abundance of recorded nests were the Green-barred Woodpecker (*Colaptes melanochloros*, n = 35) and the White-barred Piculet (*Picumnus cirratus*, n = 25). With respect to secondary users, the abundance of nests found varied according to body size: among small-sized species, the most abundant were the White Monjita (*Xolmis irupero*, n = 17) and the Saffron Finch (*Sicalis flaveola*, n = 15); the Tropical Screech-Owl (*Megascops choliba*, n = 10) was the species with the highest number of nest records in the medium-sized group; whereas the Black Vulture (*Coragyps atratus*, n = 13) showed the highest abundance among species classified as large. It should be noted that medium-sized species that are facultative users of tree cavities were also found, such as the Rufous-bellied Thrush (*Turdus rufiventris*) and the Rock Pigeon (*Columba livia*). Nests of the European Starling (*Sturnus vulgaris*), an exotic invasive species and a well-known user of tree cavities, were also found (Table 1 & Supplementary Material).

The analysis of secondary cavity-using birds (n = 150 nests) showed a higher proportion of use of cavities generated by decay (66%), whereas the remaining nests used cavities excavated by woodpeckers (34%). In turn, the frequency of cavity use varied with body mass: small-sized birds, which constituted the most numerous group (n = 100 nests), and medium-sized birds (n = 26 nests) mostly used cavities generated by decay (54% and 81%, respectively); whereas large birds (n = 24 nests) showed complete dependence on cavities generated by decay, with no nests recorded in cavities excavated by woodpeckers (Fig. 2, Table 1). Among secondary users that used cavities excavated by woodpeckers, most used those excavated by *Colaptes* sp. (n = 48), whereas the Tufted Tit-Spinetail (*Leptasthenura platensis*) and the Northern House Wren (*Troglodytes aedon*) used cavities excavated by the White-fronted Woodpecker (*Melanerpes cactorum*; n = 2); and only one cavity excavated by the White-barred Piculet (*Picumnus cirratus*) was used by the House Wren.

With respect to the tree species and condition used for nesting, both woodpeckers and secondary cavity-using birds showed a higher frequency of use of native trees (70%) compared with exotic trees (30%). In detail, woodpeckers recorded most of their nests in living trees (72%); whereas secondary cavity-using birds that used cavities generated by decay also nested mainly in living trees (61%), but showed a higher frequency of use of standing dead trees (39%) compared with woodpeckers (Fig. 2). Native tree species, both living and standing dead, were mainly Chañar (*Geoffroea decorticans*, 37%), Algarrobo (*Prosopis alba*, 25%), and Curupí (*Sapium haematospermum*, 15%), whereas the remainder were White Quebracho (*Aspidosperma quebracho-blanco*), Red Quebracho (*Schinopsis balansae*), Ceibo (*Erythrina crista-galli*), and Willow (*Salix humboldtiana*). On the other hand, exotic living and standing dead trees used belonged mainly to Chinaberry (*Melia azedarach*, 60%), *Eucalyptus* sp. (22%), and Ash (*Fraxinus pennsylvanica*, 12%); whereas the remainder were species such as Mulberry (*Morus alba*) and Black Locust (*Gleditsia triacanthos*).

DISCUSSION

This study evaluated the use of nesting resources by cavity-nesting birds in the Espinal ecoregion, an area characterized by a high rate of land-use conversion (Nanni et al. 2020). Specifically, Chañar (*Geoffroea decorticans*) and Algarrobo (*Prosopis alba*) stand out as the most frequently used native species. This pattern has also been reported in other ecoregions such as the Humid Chaco, where native trees of the genus *Prosopis* constitute a key nesting substrate, as their low wood density facilitates excavation by woodpeckers whilst providing cavities generated by decay that are suitable for non-excavating birds (Di Sallo & Cockle 2022, 2025).

Despite the higher proportion of use of native trees, the use of exotic trees for nesting suggests a degree of plasticity in certain bird species, indicating that these trees could function as substitute resources in altered habitats (Zapponi et al. 2014). This pattern is not exclusive and has also been observed, albeit to a lesser extent, in other altered ecoregions such as the Atlantic Forest and the Espinal of Buenos Aires Province (Bonaparte et al. 2020, Jauregui et al. 2021). Although this study did not quantify tree availability at the site, evidence from these modified forests in Argentina suggests that the use of exotic species (such as Chinaberry and Eucalyptus) may increase as the availability of suitable native trees decreases. For this reason, it is important to study in-depth the potential role of different native and exotic tree species in a fragmented forest context such as the Espinal.

Regarding cavity type, secondary users showed a proportionally higher use of cavities generated by decay compared with those excavated by woodpeckers, in agreement with what has been reported in other ecoregions of the country (e.g., Yungas, Atlantic Forest, Humid Chaco), where natural decay is the main mechanism of cavity creation used by secondary cavity nesters (Cornelius et al. 2008, Cockle et al. 2011, Schaaf et al. 2020, Di Sallo & Cockle 2022). Additionally, because cavities generated by decay usually reach

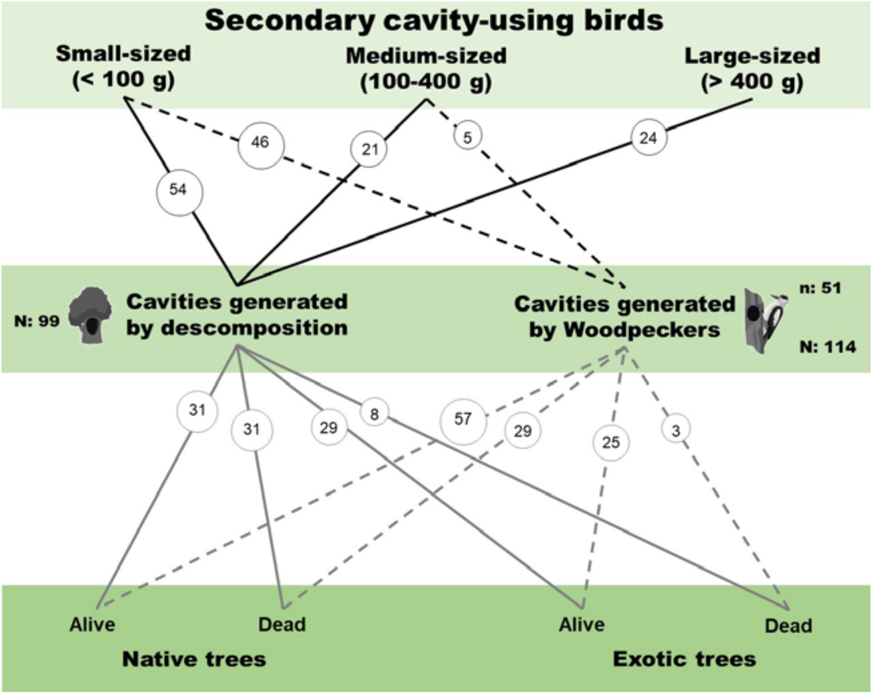

Figure 2. Schematic diagram of the total number of cavity-nesting bird nests found in the Espinal Ecoregion. The total number of nests (circles) is shown for woodpeckers (dashed lines) and secondary cavity-using birds (solid lines), separated by body mass. In addition, the total number of woodpecker nests found (N), the total number of these nests used by secondary cavity-using birds (n), and the type of arboreal substrate are detailed.

Table 1. Nests of cavity-nesting birds found between 1970–2019 in the Espinal Ecoregion, Santa Fe, Argentina. Common and scientific names are provided, along with the total number of nests found and the percentage of nests (relative to the total) in native and exotic trees, in excavated cavities (E) and decay-generated cavities (D), for each bird species.

		Common name	Scientific name	Total nests	Native (%)		Exotic (%)	
					E	D	E	D
Primary cavity-using birds		Green-barred Woodpecker	*Colaptes melanochloros*	35	86	0	14	0
		White-barred Piculet	*Picumnus cirratus*	25	96	0	4	0
		White-fronted Woodpecker	*Melanerpes cactorum*	24	71	0	29	0
		Checkered woodpecker	*Veniliornis mixtus*	10	80	0	20	0
		White woodpecker	*Melanerpes candidus*	4	50	0	50	0
		Campo flicker	*Colaptes campestris*	9	0	0	100	0
		Cream-backed Woodpecker	*Campephilus leucopogon*	5	100	0	0	0
		Little woodpecker	*Veniliornis passerinus*	2	100	0	0	0
Secondary cavity-using birds	Small-sized	White Monjita	*Xolmis irupero*	17	47	53	0	0
		Saffron finch	*Sicalis flaveola*	15	67	33	0	0
		White-rumped swallow	*Tachycineta leucorrhoa*	11	45	45	0	10
		Scimtar-billed woodcreeper	*Drymornis bridgesii*	10	20	0	60	20
		Southern house wren	*Troglodytes musculus*	10	60	40	0	0
		Narrow-billed woodcreeper	*Lepidocolaptes angustirostris*	9	12	44	0	44
		Ferruginous Pygmy Owl	*Glaucidium brasilianum*	3	0	34	33	33
		Chopi blackbird	*Gnorimopsar chopi*	3	0	33	67	0
		Streaked flycatcher	*Myiodynastes maculatus*	3	33	67	0	0
		Short-crested flycatcher	*Myiarchus ferox*	2	0	100	0	0
		Swainson's flycatcher	*Myiarchus swainsoni*	2	50	50	0	0
		House sparrow	*Passer domesticus*	2	0	0	0	100
		Common starling	*Sturnus vulgaris*	2	0	0	100	0
		Chaco earthcreeper	*Tarphonomus certhioides*	2	0	100	0	0
		Great Rufous Woodcreeper	*Xiphocolaptes major*	2	0	100	0	0
		Euler's Flycatcher	*Lathrotriccus euleri*	1	0	100	0	0
		Tufted Tit-Spinetail	*Leptasthenura platensis*	1	100	0	0	0
		Brown-crested Flycatcher	*Myiarchus tyrannulus*	1	0	100	0	0
		Buff-browed Foliage-gleaner	*Syndactyla rufosuperciliata*	1	0	100	0	0
		Black-crowned Tityra	*Tityra inquisitor*	1	0	100	0	0
		Rufous-bellied Thrush	*Turdus rufiventris*	1	0	0	0	100
		Grey Monjita	*Nengetus cinereus*	1	0	0	0	100
	Medium-sized	Tropical Screech Owl	*Megascops choliba*	10	20	40	20	20
		Blue-crowned Parakeet	*Thectocercus acuticaudatus*	4	0	50	25	25
		Ringed Teal	*Callonetta leucophrys*	3	0	33	0	67
		American Kestrel	*Falco sparverius*	3	0	33	0	67
		Eared Dove	*Zenaida auriculata*	3	0	100	0	0
		Rock Dove	*Columba livia*	1	0	100	0	0
		Chimango caracara	*Daptrius chimango*	1	0	0	0	100
		White-eyed Parakeet	*Psittacara leucophthalmus*	1	0	100	0	0

		Common name	Scientific name	Total nests	Native (%)		Exotic (%)	
					E	D	E	D
Secondary cavity-using birds	Large-sized	Black vulture	*Coragyps atratus*	13	0	23	0	77
		American Barn Owl	*Tyto furcata*	5	0	20	0	80
		Turkey Vulture	*Cathartes aura*	2	0	100	0	0
		Black-bellied Whistling Duck	*Dendrocygna autumnalis*	2	0	0	0	100
		Muscovy Duck	*Cairina moschata*	1	0	0	0	100
		Laughing Falcon	*Herpetotheres cachinnans*	1	0	100	0	0

larger dimensions (e.g., diameter, depth, entrance size) than woodpecker cavities, their greater use by large secondary users may be directly related to these requirements (Schaaf et al. 2020, Di Sallo & Cockle 2022). In the case of excavating birds, these also show specificity, actively selecting mature trees with sufficient diameters and appropriate wood hardness (Jauregui et al. 2021, Di Sallo & Cockle 2025). This is relevant because mature trees (both living and standing dead) are often removed early in the forest intervention cycle (Manning & Lindenmayer 2009, Schaaf et al. 2021).

The results of this study, based on natural history data collected over decades, may be crucial for the design of conservation and environmental education strategies in the Espinal and other ecoregions facing similar anthropogenic pressures. The presence of exotic trees used by birds could provide an opportunity for the creation of biological corridors or supplementary habitats (Bonaparte et al. 2020, Jauregui et al. 2021, Ossi et al. 2022), but it is essential to better understand the effect of these trees on the ecological dynamics of native forests. Monitoring cavity dynamics and their use by birds in landscapes with different degrees of anthropogenic modification could provide key information to better understand the resilience of bird species to landscape change.

ACKNOWLEDGMENTS

The authors thank the Editor, Associate Editor of the journal, and the anonymous reviewers for their valuable contributions to improving the manuscript. We also thank the Instituto de Ecorregiones Andinas (INECOA-CONICET UNJu) for allowing us to carry out this work.

SUPPLEMENTARY MATERIAL

You can access the supplementary material for this article by visiting the link: https://doi.org/10.56178/eh.v41i1.1528.

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