

NEST CHARACTERISTICS OF SECONDARY CAVITY-NESTING BIRDS USING NEST BOXES IN LOWER PARANÁ DELTA PLANTATIONS

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ABSTRACT: The Lower Paraná Delta landscape has been heavily modified by forestry and livestock production, resulting in the transformation of original environments and changes in resource availability for bird communities. Insectivorous cavity-nesting birds are potential providers of biological pest control in productive systems, which is why the use of nest boxes has been proposed as a sustainable forest management tool and as an opportunity to study the reproductive biology of poorly known species. In this study, we characterized nests built in nest boxes by the Narrow-billed Woodcreeper (*Lepidocolaptes angustirostris*), Swainson's Flycatcher (*Myiarchus swainsoni*), Streaked Flycatcher (*Myiodynastes maculatus*), Greyish Baywing (*Agelaioides badius*), and Southern House Wren (*Troglodytes musculus*) in a forest landscape dominated by Salicaceae plantations in the Lower Paraná Delta, Buenos Aires, Argentina. Fifty nests from the 2020–2025 breeding seasons were analysed. Nests of the Swainson's Flycatcher were characterized by a predominance of soft materials (moss, plant fibers, hair, and feathers) and artificial material. Nests of the Greyish Baywing were mainly composed of plant fibers, while Southern House Wren nests consisted primarily of branches. Nests of the Streaked Flycatcher and the Narrow-billed Woodcreeper were composed of a single material: petioles and bark, respectively. All the aforementioned species built nests with a defined cup and species-specific morphometric parameters, except for the Narrow-billed Woodcreeper, whose nests lacked a defined structure. This study provides the first characterization of nests built in nest boxes by these species in the Lower Paraná Delta, including previously unpublished information on their reproductive biology.

KEYWORDS: nest box, nest composition, nest morphometry, Paraná Delta, Salicaceae plantations

Secondary cavity-using birds, in this case nesters, are those that use preexisting cavities, whether natural or excavated by other species. Thus, the availability and quality of these shelters condition their local survival (Cockle et al. 2011a, 2011b, Van der Hoek et al. 2017). Many of these birds are insectivorous and could play a fundamental role in insect control and the ecological balance of various ecosystems, particularly forested ones (Monteagudo et al. 2023). The replacement of native forests by commercial planta-

tions with exotic species tends to reduce the availability of cavities (Politi et al. 2009), which has driven the increasing use of nest boxes as a management strategy to mitigate this loss (Cockle et al. 2011a, Olah et al. 2014). The effectiveness of this measure in increasing reproductive success does not depend solely on the availability of nest boxes, but also on the availability of suitable building materials. Changes in vegetation can affect these materials and, consequently, nest structure and chick survival (Álvarez &

Barba 2009, Honorato et al. 2016). Nest composition is a good indicator of habitat use and quality during the breeding period, and fulfills key functions such as thermal insulation, support, and protection (Martínez Vilalta et al. 2002, Calvelo et al. 2006, Mainwaring et al. 2014). In turn, the position of the nest within the cavity also modulates these factors (Bulit & Massoni 2004). Despite the importance of these variables, in the Neotropical region there is little detailed information on how secondary cavity-nesting birds build their nests (Bonaparte et al. 2024).

In Argentina, the available information on these species has focused on characterizing eggs, chicks, and aspects of reproductive behavior, such as parental care, clutch size, and chick development (Di Giacomo & Lanús 1998, Salvador 2014, De la Peña 2019, Jauregui et al. 2019). Nests in cavities are usually described through *in situ* observations, and although in some cases the main materials and measurements such as cup size and depth are recorded, obtaining this type of data is limited due to the difficulty of accessing cavities.

The Paraná Delta is an extensive wetland system that harbors a high diversity of birds, including resident and migratory species, some of them with some degree of threat (Quintana & Bó 2011, Fracassi et al. 2021). In the Buenos Aires sector of the Lower Delta, the landscape has undergone marked transformation in recent decades, mainly due to the expansion of plantations of salicaceous species (willows – *Salix* sp. and poplars – *Populus* sp.) that have replaced natural environments such as riparian forests and grasslands (Fracassi et al. 2021). The riparian forests of the Lower Parana Delta is dominated by characteristic tree species such as *Ocotea acutifolia*, *Nectandra falcifolia*, *Citharexylum montevidense*, *Inga vera* and *Erythrina crista-galli*, but is also composed of shrubs, vines, epiphytes, and herbaceous plants that currently exists in the form of relictual patches (Burkart 1957, Kalesnik et al. 2008). These changes in vegetation structure and composition could affect the availability of cavities for nesting, as well as the supply of materials that birds can use to build their nests, which could impact their reproduction and persistence in these productive environments (Atienzar Navarro et al. 2010).

With the aim of understanding nesting requirements and providing relevant information for management and conservation in productive forest environments, this study characterized the structure and composition of nests built in nest boxes, and described general aspects of the reproductive biology of five bird species: Streaked Flycatcher (*Myiodynastes maculatus*), Southern House Wren (*Troglodytes musculus*), Na-

row-billed Woodcreeper (*Lepidocolaptes angustirostris*), Swainson's Flycatcher (*Myiarchus swainsoni*) and Greyish Baywing (*Agelaioides badius*), in productive and natural forest environments of the Lower Delta of Buenos Aires.

METHODS

Study area

We conducted this study on the island sector of Campana and San Fernando (34°04'S, 58°53'W), Buenos Aires province, Argentina, within the Paraná Delta and Islands ecoregion (Burkart et al. 1999), covering an approximate area of 58,000 ha (Borodowski & Suárez 2005). It is a deltaic plain influenced by fluvial dynamics, which shapes the insular landscape (Summerfield 1991). Currently, it presents a mosaic of islands crossed by artificial channels, where livestock production and forestry of salicaceous species are mainly developed under embankment systems (Kandus et al. 2003). The climate is temperate and subhumid, with mean annual temperatures of 16.7°C to 18°C, annual precipitation of 1000 mm, and relative humidity of 79% (Arana et al. 2021).

Typically, the islands have a basin-like shape, with lowlands (80% of the surface) and levees (20%; Borodowski 2017). The lowlands, formerly occupied by tall grasslands of *Scirpus giganteus*, were transformed into exotic pastures for livestock and areas destined for poplar and willow plantations (Kandus 1997, Kandus et al. 2003, Biondini & Kandus 2006). The levees and mid-slopes, previously dominated by the riparian forests ecosystem—gallery forest and *Erythrina crista-galli* stands—were transformed into poplar plantations and secondary forest (Kalesnik & Quintana 2005).

The environments of the Lower Delta are strongly influenced by the implementation of land systematization works (i.e., ditches, embankments, and semi-closed systems) that allow drainage and flood control to adapt the land for forestry production (Borodowski & Suárez 2005). This change occurred due to practices of traditional silvicultural practices associated with the forest species, such as weeding, pruning, and thinning (Fracassi et al. 2021). In general, poplar plantations present low tree density, little stratification, and an understory dominated by herbaceous plants, mainly *Carex chilensis*. In contrast, willow plantations form denser environments, with two to three shrub strata dominated by exotic species such as American Pokeweed (*Phytolacca americana*) and Blackberry (*Rubus ulmifolius*; Fracassi et al. 2021). Likewise, patches of secondary forest are recorded within plantations, resulting from the abandonment

of productive areas, where original riparian species (*Myrsine laetevirens*, *Nectandra angustifolia*; *Erythrina crista-galli*) coexist with invasive species such as Yellow Iris (*Iris pseudacorus*) and Privet (*Ligustrum* sp.), forming a heterogeneous mosaic of habitats in the forested landscape (Rossi & De Magistris 2014).

Experimental design

The nests analyzed in this study came from a long-term research project developed by researchers from INTA Delta del Paraná, in which the contribution of insectivorous birds to the control of pest insects in forest systems and the use of nest boxes as a management tool are evaluated. Within that project, nest boxes made of poplar wood (2 cm thick) were designed, mailbox-type, measuring 30 × 15 × 15 cm (height × width × length) and with entrance holes of 4.5, 5, 6, and 7 cm in diameter, in order to attract five species of secondary cavity-using insectivorous birds (hereafter, focal species) present in plantations of the Lower Paraná Delta (Fracassi et al. 2021). The dimensions and characteristics of the boxes were defined according to body size and nesting preferences of these species. Among them, the range of entrance diameters sought to cover a potential range for the five focal species, adapting models previously used by these or other ecologically similar species (Proyecto VOLCAM 2007, Llambías & Fernández 2009, Calderón Martínez 2018). The nest boxes were installed in poplar and willow plantations and patches of secondary forest, at 25 m between each other and two meters above the ground, matching the vertical nesting range of the five focal species (De la Peña 2006), oriented northward and attached to tree trunks with wire. The boxes remained active for five consecutive breeding seasons (spring–summer 2020 to 2025), during which they were checked weekly. Identification of nesting species was carried out through direct observation of adults and recognition of nests, eggs, and chicks, with the support of specialized guides (De la Peña 2006).

During the development of this study, at the end of each breeding season (March–April), we recorded morphometric variables of the nest *in situ* (nest height, cup diameter, and depth) and collected the nests in paper bags for subsequent laboratory processing, where we evaluated their composition. We obtained the position of the cup relative to the entrance of the box and the percentage of cup/nest volume from photographs of the interior of the boxes taken during the breeding season, which allowed us to document nest structure and fresh materials before the appearance of chicks. In addition, these images made it possible

to obtain variables related to reproductive aspects of the different species, such as clutch size, incubation duration, and chick development time until fledging. Entrance diameters of five and six cm were the most represented among the nests analyzed and were used by all focal species, although this distribution reflects only the nests that could be collected.

Species characterization

For this study, we obtained nests from the five focal species: Streaked Flycatcher, Southern House Wren, Narrow-billed Woodcreeper, Swainson's Flycatcher, and Greyish Baywing. All these species use natural cavities, abandoned nests of woodpeckers (*Colaptes* sp.) or Rufous Hornero (*Furnarius rufus*), or artificial structures for nesting (Salvador 2014, Salvador & Narosky 2025), and are included in the insectivorous niche, although some incorporate seeds and/or fruits into their diet (Kirwan et al. 2022). Their local breeding period is concentrated between October and March. Among the mentioned species, Swainson's Flycatcher and the Streaked Flycatcher are migratory, being present in the region during the breeding season, while the rest are resident (Narosky & Yzurieta 2010, López-Lanús 2020). Clutch size varies between two and six eggs, and in all species both parents participate in the care and feeding of the chicks until they become fledgings (Salvador 2014, De la Peña 2019).

Nest selection and analysis

We analyzed nests corresponding to the breeding seasons between 2020–2021 and 2024–2025. Whenever possible, we considered 'non-stacked' nests; that is, those not located below or above nests of other species in the same box, except in exceptional cases in which their morphology or composition remained intact. We based the analysis and morphometric and compositional characterization of nests on methodologies adapted from Bulit & Massoni (2004), Atienzar Navarro et al. (2010), and Honorato et al. (2016).

Morphometric analysis. For this analysis we considered a set of quantitative measurements describing the shape, dimensions, and physical structure of each nest. These metrics allow characterization of nest architecture associated with the construction strategy of each species. Given that all focal species (except the Narrow-billed Woodcreeper) present a cup-shaped nest, we recorded: (a) cup diameter and depth (Supplementary Material, Fig. 1Sa) and (b) nest height. We measured the three variables *in situ*, in centimeters and with a millimeter ruler, inside the nest box

and prior to nest collection, to avoid biases derived from deformation of the material during extraction and storage. We estimated other variables visually, based on images taken from inside the nest boxes during monitoring in the breeding season: (1) cup location (anterior, central, or posterior) relative to the entrance cavity of the nest box (Supplementary Material, Fig. 1Sb) and (2) percentage volume of the cup relative to the nest (Supplementary Material, Fig. 1Sc).

Compositional analysis. In the laboratory we disassembled each nest and classified its materials by type: 1. hair, 2. feathers, 3. bark, 4. petioles/fine branches ($\varnothing < 2$ mm), 5. thick branches ($\varnothing > 2$ mm), 6. leaves, 7. inflorescences, 8. grasses/reeds, 9. moss, 10. artificial material, 11. roots, and 12. 'other plant structures', recording the percentage volume of each, estimated visually after disaggregating each nest. Material identification was carried out through consultation with experts in botany and plant breeding at EEA INTA

Delta, complemented with specific keys for *Salix* sp. and *Populus* sp. (Zuloaga & Belgrano 2017, Monteoliva 2024) and with regional flora guides of the Lower Paraná Delta and associated riparian areas (Rossi & De Magistris 2014, Rodriguez et al. 2018).

Data analysis

For each species, we calculated the mean percentage value and standard deviation (SD) of the volume of each material item used in nest construction, as well as of the morphometric variables analyzed, based on the set of nests selected during the 2020–2025 breeding seasons.

RESULTS

We analyzed 50 nests from the five focal species: 44 for structure and composition and six for composition only (four nests of the Narrow-billed Woodcreeper

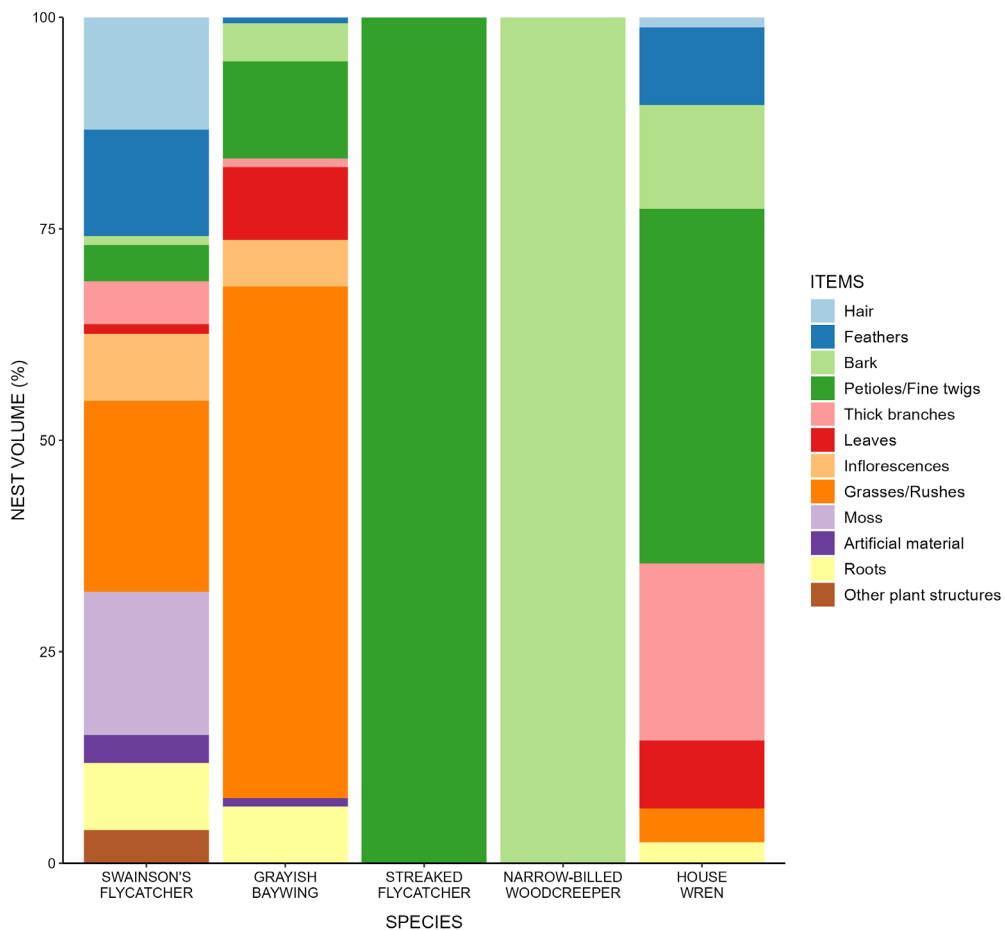


Figure 1. Mean percentage volume of the materials used for nest construction of Swainson's Flycatcher (*Myiarchus swainsoni*), Greyish Baywing (*Agelaioides badius*), Streaked Flycatcher (*Myiodynastes maculatus*), Narrow-billed Woodcreeper (*Lepidocolaptes angustirostris*), and Southern House Wren (*Troglodytes musculus*), in nest boxes located in a forest matrix in the Lower Paraná Delta, Buenos Aires, Argentina, during five consecutive breeding seasons (2020–2025).

without defined structure, and two flattened nests). From the Southern House Wren and Swainson's Flycatcher, we collected nests in poplar plantations, willow plantations, and secondary forest (House Wren: $n = 5, 5$ and 7 ; Swainson's Flycatcher: $n = 5, 5$ and 2). In the case of the Greyish Baywing and the Streaked Flycatcher, we collected nests in poplar and willow plantations (Greyish Baywing: $n = 5$ and 5 ; Streaked Flycatcher: $n = 5$ and 2), which were the only environments with nesting records. Finally, for the Narrow-billed Woodcreeper we collected nests in willow plantations ($n = 4$), which was the only environment where it was nested. In general, nests presented a defined cup (except in the Narrow-billed Woodcreeper) and varied in volume and position within the box, with nest dimensions characteristic of each species (Table 1).

The incubation period ranged between 13 and 16 days (minimum in Swainson's Flycatcher, maximum in Streaked Flycatcher), while chick duration in the nest ranged between 14 and 17 days (minimum in the Southern House Wren, maximum in Streaked Flycatcher), and clutch size was larger in Swainson's Flycatcher, Greyish Baywing, and Southern House Wren (~4–5 eggs) than in Streaked Flycatcher and Narrow-billed

Woodcreeper (~2–3 eggs; Table 2).

Nests were built mainly with plant materials, with a lower contribution of animal and artificial materials. In multiple species we found a predominant use of material from plantation salicaceous species (virtually 100% of the composition in nests of Streaked Flycatcher and Narrow-billed Woodcreeper, and 80% in Southern House Wren in plantations). The most frequent elements were branches and petioles, herbaceous fibers, and bark (exclusive material in Narrow-billed Woodcreeper), whereas moss, feathers, hair, and nylon were characteristic of Swainson's Flycatcher (Fig. 1).

Below, we detail compositional characteristics by species.

Swainson's Flycatcher

We recorded up to 12 material items forming a dense interwoven structure of diverse soft materials, with a predominance of wild plant materials; that is, not derived from planted salicaceous individuals, especially grasses and reeds (23%), moss (17%), and inflorescences (8%) corresponding to the silky fruit material (pappus) of the inflorescence of thistles of the

Table 1. Mean values (\pm SD) of the morphometric variables analyzed in the nests of: Swainson's Flycatcher (*M. swainsoni*), Greyish Baywing (*A. badius*), Streaked Flycatcher (*M. maculatus*), and Southern House Wren (*T. musculus*), in nest boxes located in a forest matrix in the Lower Paraná Delta, Buenos Aires, Argentina, during five consecutive breeding seasons (2020–2025).

| | Swainson's Flycatcher | Greyish Baywing | Streaked Flycatcher | Southern House Wren |
|------------------------------|-----------------------|-------------------|---------------------|---------------------|
| Number of nests | 12 | 10 | 7 | 15 |
| Cup/nest volume (%) | 26.66 \pm 5.36 | 45.00 \pm 15.27 | 46.42 \pm 11.70 | 34.33 \pm 10.32 |
| Cup diameter (cm) | 6.28 \pm 1.45 | 7.40 \pm 2.22 | 8.14 \pm 1.37 | 5.70 \pm 0.80 |
| Cup depth (cm) | 1.97 \pm 0.62 | 3.35 \pm 1.81 | 2.15 \pm 0.78 | 3.95 \pm 1.36 |
| Nest height (cm) | 4.30 \pm 1.72 | 7.33 \pm 1.74 | 8.29 \pm 2.70 | 7.86 \pm 2.03 |
| Cup position within the nest | Back (11/12) | Center (7/10) | Back (6/7) | Variable |

Table 2. Reproductive variables recorded by species: incubation period (days), nestling period (days), clutch size, and number of chicks, calculated from images of the interior of nest boxes taken during the 2020–2025 breeding seasons, located in a forest matrix in the Lower Paraná Delta, Buenos Aires, Argentina.

| Species | Incubation (days) | Nestling period (days) | Number of eggs | Number of chicks |
|---------------------------|-------------------|------------------------|-----------------|------------------|
| Swainson's Flycatcher | 13.88 \pm 0.72 | 16.38 \pm 0.72 | 4.75 \pm 0.48 | 4.25 \pm 0.63 |
| Greyish Baywing | 13.44 \pm 0.34 | 14.89 \pm 0.39 | 5.38 \pm 0.46 | 4.63 \pm 0.42 |
| Streaked Flycatcher | 15.94 \pm 0.50 | 17.19 \pm 0.67 | 3.75 \pm 0.16 | 2.63 \pm 0.42 |
| Narrow-billed Woodcreeper | 15.30 \pm 0.49 | 15.60 \pm 0.30 | 2.60 \pm 0.66 | 2.20 \pm 0.49 |
| Southern House Wren | 14.70 \pm 0.58 | 14.70 \pm 0.85 | 4.60 \pm 0.24 | 4.20 \pm 0.37 |

genus *Cirsium* sp., and materials of animal origin (hair, 13% and feathers, 13%; Fig. 1). Plant fibers (grasses and reeds), moss, and hair were used to interweave the nest matrix, and feathers and part of the hair to line the cup and cover the eggs (Fig. 2A). The use of other materials was lower; bark (1%), roots (8%), fine branches (4%), coarse branches (5%), and notably artificial material (3%; Fig. 1). In the latter category we classified materials such as nylon, plastic bags, and adhesive tape, used in low volume, in 50% of cases to line the cup. In two nests, we found uncommon plant materials (classified as ‘other plant structures’): pine needles in one case and an aquatic plant of the genus *Salvinia* sp. (‘Acordeón’), placed whole as part of the nest matrix.

Greyish Baywing

Nests showed a semi-dense to dense weave, with up to nine material items recorded (Fig. 1). Herbaceous fibers grouped under grasses and reeds were most common, representing on average 61% of the volume, including species such as reeds of the genus *Carex* sp., Pampas Grass (*Cortaderia selloana*), and other unidentified grasses. The finer material of this category, together with roots (7%), formed the cup (Fig. 2B). In lower proportion, fine branches (11.5%) and coarse branches (1%), leaves (9%), and inflorescences (5.5%) from plantation individuals were incorporated, forming the nest matrix. We also recorded nylon in one of the 10 analyzed nests, classified under ‘artificial material’. It is worth noting that we observed a high frequency of nests built on top of those of other birds, mainly Southern House Wren (six of the 10 analyzed nests).

Streaked Flycatcher

Nests consisted of a semi-dense to dense weave of a single material (100% of nest composition) classified as petioles/fine branches (Figs. 1 & 2C), which could be identified in all analyzed cases as belonging to poplars

due to the presence of floral peduncles with cotton-like remains characteristic of their inflorescences.

Narrow-billed Woodcreeper

The nest structure consisted exclusively of a layer of bark without forming a defined cup, therefore we did not record morphometric measurements. Eggs were laid on this layer, generally located in the center (Fig. 2D). In all cases, bark fragments retained characteristic features of the cultivated willow varieties where the species nested.

Southern House Wren

We identified a total of eight material items in the nests (Fig. 1). The main material for nest construction was branches of varying thickness (fine with diameter < 2 mm and coarse with diameter > 2 mm; Fig. 2E), originating both from plantation species (poplars or willows) and from wild woody vegetation of species growing in the plantation understory (e.g., European Dewberry, *Rubus caesius*), or from species of secondary forest, depending on the environment where the nest was built. Branches, which represented on average 62.7% of nest volume, were arranged forming a structural matrix of crossed branches and delimiting the cup (Fig. 2E). The contribution of other materials was low: we recorded grasses (4%), bark (12%), and leaves (8%). Among the latter, the use of poplar leaf blades was common in nests from this type of plantation. We found feathers lining the cup or more generally incorporated into the nest matrix.

DISCUSSION

This study constitutes the first comprehensive characterization of nests of five species of secondary cavity-nesting birds in nest boxes in the Lower Paraná Delta. In particular, we present the first detailed



Figure 2. Image of the interior of the nest box with nest and eggs of A) Swainson's Flycatcher (*Myiarchus swainsoni*) in willow plantations, B) Greyish Baywing (*Agelaioides badius*) in willow, C) Streaked Flycatcher (*Myiodynastes maculatus*) in poplar plantations, D) Narrow-billed Woodcreeper (*Lepidocolaptes angustirostris*) in willow, and E) Southern House Wren (*Troglodytes musculus*) in willow. All images correspond to the 2021–2022 breeding season, in a forest matrix in the Lower Paraná Delta, Buenos Aires, Argentina.

description of nest box nests of Swainson's Flycatcher and Greyish Baywing, substantially expanding the information previously available in Argentina.

Although information on the nest of Swainson's Flycatcher is scarce, the general structure was similar to that described in other studies (De la Peña 2019, Joseph 2020), and its composition to that observed in other members of the family Tyrannidae (Hansell 2000). The use of soft materials, that is, those that do not contribute to a rigid nest structure, such as moss, plant fibers, and feathers, has been suggested to be associated with thermal insulation, structural cohesion, and, in the case of moss, possible antimicrobial benefits (Clark & Mason 1985, Dubiec et al. 2013, Mainwaring et al. 2014). A novel finding was the incorporation of plastics and other artificial materials in cup lining, a practice common in urban birds (Reynolds et al. 2019), but not previously documented in this species. Although this behavior reveals flexibility in material selection, it is necessary to evaluate its potential impact on reproductive success. Multiple studies have reported negative effects on reproductive success associated with the use of artificial materials (Townsend & Barker 2014, Wang et al. 2021, Corrales-Moya et al. 2023). At the local level, research in the Pampas region has documented critical consequences such as open wounds, amputations, and mortality by strangulation, mainly associated with the use of polypropylene threads and fishing lines (Yassin et al. 2025). These findings are consistent with regional reports warning about risks of suffocation by plastics, alterations in nest thermoregulation, and increased predation due to the high visibility of artificial materials (Azevedo-Santos et al. 2022, Lindwedel Cruz 2023).

Most nest materials could be found in the understory of the collection environment. For example, nests collected in poplar stands under silvopastoral management showed a higher proportion of hair. This raises questions about the scale of resource search and the effect of local availability on nest quality, especially in forest systems where management reduces understory vegetation. In this sense, it is important to integrate future vegetation surveys with nest studies to evaluate how silvicultural management, particularly practices such as weeding, influences the availability of construction resources. On the other hand, we recorded a higher average clutch size (+ 2 eggs) compared to that reported in the existing literature, and a slightly shorter incubation period (- 2.12 days; De la Peña 2019).

Nests of the Greyish Baywing showed a construction pattern consistent with that described for nests in natural cavities: coarse materials forming the base and

periphery of the cup, and fine and flexible materials in the interior (De la Peña 2019, Quiroga & Llugdar 2019). In this study, we recorded the predominance of herbaceous fibers (grasses) as the main nest material. We also observed a high frequency of nests built on structures previously constructed by other birds, mostly Southern House Wren. Although our study did not directly assess secondary parasitism, this pattern is consistent with behaviors previously documented for the Greyish Baywing (Luchesi & Astié 2017). On the other hand, the average clutch size documented in this study may be biased, as during the examination of field photographs we could not distinguish eggs of this species from those of the Screaming Cowbird (*Molothrus rufoaxillaris*), which parasitizes its nests (Lowther et al. 2020).

The composition of Streaked Flycatcher nests matched what has been reported for the species (Di Giacomo & Lanús 1998), although here a marked use of poplar petioles was recorded. In contrast to observations in natural cavities, we recorded smaller diameter and depth than those documented by other authors (e.g., Di Giacomo & Lanús 1998). However, as experimental studies have shown (Evans et al. 2002), structural characteristics of artificial cavities can modify certain nest attributes. This bias associated with the use of nest boxes is a general limitation for comparison with descriptions from natural cavities and should be considered when interpreting the results for all analyzed species (Bonaparte et al. 2024).

The composition of Narrow-billed Woodcreeper nests agrees with that reported by Pizo (2018) in Brazil and Jáuregui et al. (2019) in Argentina, who also recorded rudimentary bark nests, although other studies mention the use of leaves, herbs, or wood chips (Marantz et al. 2020). This study suggests an almost exclusive preference for willow bark in Delta plantations. The absence of an elaborate structure indicates a simple construction strategy, likely associated with the reproductive biology of the species, in line with what has been reported for other members of the genus, such as the Scalloped Woodcreeper (*Lepidocolaptes falcinellus*; Bodrati & Cockle 2011). Regarding reproductive variables, we recorded a smaller clutch size (-1 egg) compared to average values reported in the current literature (De la Peña 2019).

The Southern House Wren is the species with the most information available in the literature (Atienzar Navarro et al. 2010, Honorato et al. 2016, Medrano et al. 2019) due to its wide distribution and adaptability, which allow it to occupy a vast variety of environments (Honorato et al. 2016, León 2024). The use of artificial structures, such as nest boxes, is a widely documented

and consistent behavior across studies in this species (Muller et al. 1997, Alworth & Scheiber 2000, Vergara 2007, Llambías & Fernández 2009, Fernández et al. 2020). In this context, this work expands that knowledge by characterizing for the first time the material with which this species builds its nest and its general structure in salicaceous plantations of the Paraná Delta. In this context, it maintained a conserved construction pattern in the set of analyzed nests: accumulation of crossed branches as a structural matrix, complemented with leaves and feathers, varying the origin of these materials (plantation or wild) depending on the environment where the nest was collected, suggesting a strategy of exploiting local resources.

In all species we evaluated the position of the cup relative to the entrance of the nest box, a trait associated both with reducing predation risk (the main cause of failure in nest boxes; Llambías & Fernández 2009) and with regulating thermal conditions (Mainwaring et al. 2014, 2015b, Deeming & Mainwaring 2015). As we found no specific previous records for the species analyzed here, these results represent a novel contribution. Likewise, standardized recording of nest microarchitecture may be a key tool for future comparative studies (Mainwaring et al. 2023), allowing identification of adaptive patterns among species and evaluation of the influence of management and local conditions on their reproductive strategies.

FINAL REMARKS

This work provides novel information on nest structure and composition in forest plantations, relevant for understanding reproductive biology in transformed landscapes and for designing management measures that favor the persistence of these birds and their potential ecosystem service of pest control.

Likewise, we provide a detailed description of the nests of *L. angustirostris*, *M. swainsoni*, *M. maculatus*, *A. badius*, and *T. musculus*, as valuable input for future studies. In general, although we recorded species-specific variations relative to what has been described for natural cavities, a construction pattern consistent with the identity of each species was maintained, suggesting some stability in nesting strategies despite the context of modified environments.

In forest plantations, some species depend on resources closely associated with the planted species (e.g., poplar petioles, willow bark), whereas others rely on materials from the understory, surrounding vegetation, associated fauna, or even artificial elements. This diversity in the origin of resources and in construction

strategies, from simple and specialized designs to more flexible compositions, may influence the ability to persist in transformed landscapes (Collias & Collias 1984, Mainwaring et al. 2014, Honorato et al. 2016).

From a management perspective, these differences are relevant. More dependent species may have their reproduction limited by changes in the availability of specific resources, whereas more generalist species may persist in modified environments. Future comparisons between plantations and native forest will allow evaluation of the functional value of these strategies and contribute criteria for silvicultural practices that favor the availability of nesting resources.

Finally, although nest boxes allowed standardization of sampling and access to the internal structure of nests, their use has limitations (Zhang et al. 2023, Bonaparte et al. 2024). Box dimensions may modify nest volume and the amount and proportion of materials used (Deeming et al. 2019), as well as alter the internal microclimate relative to natural cavities, introducing potential biases (Sudyka et al. 2022, 2023). Added to these limitations is the small sample size, which restricts detection of intraspecific variation and generalization of results (Verma & Verma 2020). Together, these constraints indicate that some observed patterns may be influenced by box design and low statistical representativeness, and future studies should incorporate natural cavities, microclimatic measurements, and larger sample sizes.

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SUPPLEMENTARY MATERIAL

You can access the supplementary material for this article by visiting the link: <https://doi.org/10.56178/eh.v41i1.1535>.

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