Composition of Carolina Wren (*Thryothorus ludovicianus*) Nests in Urban and Rural Environments

Laurie M. Valentin Rios and Diane L.H. Neudorf



No. 13 **Urban Naturalist Notes** **2026**

Board of Editors

Hal Brundage, Environmental Research and Consulting, Inc, Lewes, DE, USA
Ran Dai, Huitong Engineering Consultant Co Lit., Kunming, Yunnan Province, China
Leonie Fischer, University Stuttgart, Stuttgart, Germany
Chad Johnson, Arizona State University, Glendale, AZ, USA
Sonja Knapp, Helmholtz Centre for Environmental Research–UFZ, Halle (Saale), Germany
Joerg-Henner Lotze, Eagle Hill Institute, Steuben, ME, USA • **Publisher**
Tibor Magura, University of Debrecen, Debrecen, Hungary
Michael McKinney, University of Tennessee, Knoxville, TN, USA • **Editor**
Zoltán Németh, Department of Evolutionary Zoology and Human Biology, University of Debrecen, Debrecen, Hungary
Rubén Ortega-Álvarez, Investigador por México de la Secihti, CIAD AC, Colima, México
Sarah Parsons, Western Carolina University, Cullowhee, NC, USA
Todd W. Pierson, Kennesaw State University, Kennesaw, Georgia, USA
Jeremy Pustilnik, University of Cambridge, Cambridge, England
Jose Ramirez-Garofalo, Rutgers University, New Brunswick, NJ, USA
Sage Raymond, University of Alberta, Edmonton, Alberta, Canada
Uliana Semak, Vasyl Stefanyk Carpathian National University, Ivano-Frankivsk, Ukraine
Sam Rexing, Eagle Hill Institute, Steuben, ME • **Production Editor**
Travis Ryan, Center for Urban Ecology, Butler University, Indianapolis, IN, USA
Michael Strohbach, Technische Universität Braunschweig, Institute of Geoecology, Braunschweig, Germany

Advisory Board

Myla Aronson, Rutgers University, New Brunswick, NJ, USA
Mark McDonnell, Royal Botanic Gardens Victoria and University of Melbourne, Melbourne, Australia
Charles Nilon, University of Missouri, Columbia, MO, USA
Dagmar Haase, Helmholtz Centre for Environmental Research–UFZ, Leipzig, Germany
Sarel Cilliers, North-West University, Potchefstroom, South Africa
Maria Ignatieva, University of Western Australia, Perth, Western Australia, Australia

♦ The *Urban Naturalist* is an open-access, peer-reviewed, and edited interdisciplinary natural history journal with a global focus on urban and suburban areas (ISSN 2328-8965 [online]).

♦ The journal features research articles, notes, and research summaries on terrestrial, fresh-water, and marine organisms and their habitats.

♦ It offers article-by-article online publication for prompt distribution to a global audience.

♦ It offers authors the option of publishing large files such as data tables, and audio and video clips as online supplemental files.

♦ Special issues - The *Urban Naturalist* welcomes proposals for special issues that are based on conference proceedings or on a series of invitational articles. Special issue editors can rely on the publisher's years of experiences in efficiently handling most details relating to the publication of special issues.

♦ Indexing - The *Urban Naturalist* is a young journal whose indexing at this time is by way of author entries in Google Scholar and Researchgate. Its indexing coverage is expected to become comparable to that of the Institute's first 3 journals (*Northeastern Naturalist*, *Southeastern Naturalist*, and *Journal of the North Atlantic*). These 3 journals are included in full-text in BioOne.org and JSTOR.org and are indexed in Web of Science (clarivate.com) and EBSCO.com.

♦ The journal's editor and staff are pleased to discuss ideas for manuscripts and to assist during all stages of manuscript preparation. The journal has a page charge to help defray a portion of the costs of publishing manuscripts. Instructions for Authors are available online on the journal's website (http://www.eaglehill.us/urna).

♦ It is co-published with the *Northeastern Naturalist*, *Southeastern Naturalist*, *Caribbean Naturalist*, *Eastern Paleontologist, Journal of the North Atlantic*, and other journals.

♦ It is available online in full-text version on the journal's website (http://www.eaglehill.us/urna). Arrangements for inclusion in other databases are being pursued.

Cover Photograph: Carolina Wren nest from a nest box in the City of Huntsville, TX. The nest contains one wren egg and snake shed within the nest cup. Photograph © Adelle Cannon.

The ***Urban Naturalist*** (ISSN # 2328-8965) is published by the Eagle Hill Institute, PO Box 9, 59 Eagle Hill Road, Steuben, ME 04680-0009. Phone 207-546-2821 Ext. 4. E-mail: office@eaglehill.us. Webpage: http://www.eaglehill.us/urna. Copyright © 2026, all rights reserved. Published on an article by article basis. **Special issue proposals are welcome**. The *Urban Naturalist* is an open access journal. **Authors**: Submission guidelines are available at http://www.eaglehill.us/urna. **Co-published journals:** The *Northeastern Naturalist*, *Southeastern Naturalist*, *Caribbean Naturalist*, and *Eastern Paleontologist*, each with a separate Board of Editors. The Eagle Hill Institute is a tax exempt 501(c)(3) nonprofit corporation of the State of Maine (Federal ID # 010379899).

Composition of Carolina Wren (*Thryothorus ludovicianus*) Nests in Urban and Rural Environments

Laurie M. Valentin Rios[1] and Diane L.H. Neudorf[1,*]

Abstract - Carolina Wrens (*Thryothorus ludovicianus*) are common, cavity-nesting, resident songbirds found in forests and urban backyards of the eastern United States and parts of Mexico and Central America. We compared nest composition for Carolina Wren pairs occupying an urban and a rural habitat in east Texas to determine how nest construction is impacted by urbanization. We found that the nest composition varied between habitats according to the materials available. Mosses, leaves, twigs, bark and pine needles were nest components common to both habitats, but urban nests contained significantly more leaves whereas rural nests had significantly more moss, twigs, bark and pine needles. Roots/grasses and dirt were contained within nests from both habitats, and their amounts did not differ significantly between habitats. Hair was used to line nests in both habitats, but it was significantly more abundant in the urban habitat where both domesticated animal and human hair was evident. Fifty-five percent of urban and no rural nests contained plastics. We did not observe negative impacts of plastics or domesticated animal/human hair on nesting success in our urban nests, but more study is needed. Snake shed was present in all rural nests and 72% of urban nests. Given its commonality, the significance of snake shed in Carolina Wren nesting success as a possible predator deterrent requires further investigation.

Introduction

As human populations increase, the encroachment of urban areas into the natural environment is inevitable as are the impacts on wildlife (Marzluff et al. 2001). Some bird species can live in suburban or urban areas, but they may experience a reduction in the resources that they use for cover, feeding and breeding (Reynolds et al. 2019). One potential impact is the availability of materials used for nest construction. Birds in urban areas use more anthropogenic components in their nests (Deeming and Mainwaring 2015, Reynolds et al. 2019). For example, *Pycnonotus sinensis* Gmelin (Chinese Bulbuls) used proportionately more anthropogenic materials in their nests along an urban gradient, although the authors did not examine the impacts on nesting success (Wang et al. 2009). Anthropogenic materials used in nest building can negatively impact nest success when adults or nestlings become entangled in plastic fibers (Lee et al. 2015, Townsend and Barker 2014, Winiewicz et al. 2025) or the birds may be exposed to toxins from anthropogenic materials (Suárez-Rodríguez et al. 2017). For example, cigarette butts have benefits in reducing parasites in the nest but expose the parents and nestlings to genotoxins (Suárez-Rodríguez et al. 2014). When given a choice some species prefer more natural materials (Lee et al. 2015), suggesting that the nest material found in urbanized areas may be less desirable. Nests are extremely important in the breeding success of birds (Hansell 2000) but how urbanization impacts nest structure has received less attention than other areas of breeding such as nest predation (e.g. Gering and Blair 1999, Twardek et al. 2017, Vincze et al. 2017, Kurucz et al. 2021) or song disruption from urban noise (e.g. Brumm 2004, Dooling et al. 2019, Slabbekoorn 2013). Given these findings, it is worthwhile to explore how nest composition differs in urban and rural habitats.

[1] Department of Biological Sciences, Sam Houston State University, Huntsville, TX, USA, 77340. [*]Corresponding author - Neudorf@shsu.edu.

Associate Editor: Ran Dai, Huitong Engineering.

Thryothorus ludovicianus Latham (Carolina Wren) is a resident, cavity-nesting songbird found throughout the eastern USA and some areas of Mexico and Central America. They pair for life and defend a territory together, rarely leaving the area where they have established territory (Labisky and Arnett 2006). They forage on the ground or along tree branches gleaning insects and spiders (Haggerty and Morton 2020) and occasionally small vertebrates such as skinks (McNeese et al. 2021). Their nests usually consist of leaves, moss, small twigs or pine needles, snake shed and lining materials such as hair or feathers. They may also include artificial materials such as paper, plastic or string (Haggerty and Morton 2020, Laskey 1948). They typically lay clutches of 4 eggs (range 3–8 eggs; Neudorf, unpubl. data). Incubation lasts 13–18 days and nestlings remain in the nest for 10–16 days before fledging (Haggerty and Morton 2020). Although Carolina Wrens are a common backyard bird, our knowledge of how urbanization has affected the nesting of these birds is limited. One previous study to our knowledge has examined Carolina Wren nest components in urban compared with rural habitats, but the sample sizes were small and no significant differences were found (McNeese 2018). Our objective was to quantify differences in nest materials between urban and rural nests. We hypothesized that urban nests would contain more anthropogenic materials than rural nests. We also examined the potential impacts of anthropogenic materials on nest success.

Methods

Our study took place during the 2021 Carolina Wren breeding season. Each year, since 2011, we place nest boxes in urban and rural locations in Walker County, TX in late January through mid-February. The boxes are removed at the end of the breeding season in late July. Our rural study area is the Pineywoods Environmental Research Laboratory (PERL), owned by Sam Houston State University (Fig. 1a). The neighboring City of Huntsville, located 11 km from PERL, represents the urban habitat (see Bogrand et al. 2017 for details of the study sites; Fig. 1b). PERL is a 100-ha area adjacent to the Sam Houston National Forest. It consists of pine forest interspersed with bottomland habitat of mixed hardwoods, a dense understory, and a riparian zone along Harmon Creek. The urban study site consists of established residential neighborhoods with mature trees and large yards within the City of Huntsville. The city had an approximate population of 45,941 people and density of 417 persons per km^2 during our study (United States Census Bureau 2020). The pine wood nest boxes (18 cm x 14 cm x 15 cm with a 3 cm slot opening) were erected on 1.5 m conduit poles in the front yards of volunteer homeowners. Typically, two nest boxes are placed in each yard or in known territories of wrens at PERL.

In 2021, we monitored 26 nests (14 urban nests and 12 rural) in our study sites from egg laying through fledging to determine nest success. Of the 26, 19 (11 urban and 8 rural) Carolina Wren nests were collected from nest boxes that successfully fledged at least one offspring. We followed methods similar to Cerezo and Deeming (2016) and McNeese (2018) in the storage and drying of nests. We wore gloves to remove the nests from the nest boxes and placed them into plastic zipper style bags. The bagged nests were frozen for at least two weeks to dispatch any insects or parasites that may have been residing in the nests. The nests were then allowed to dry at room temperature for four months in vented bags.

Dried nests were weighed in plastic weigh boats, to the nearest 0.1 grams. Each nest was placed in a tray for separation of materials. Nest components were classified into the following groups: dirt, hair, leaves, moss, plastic, roots/grasses, snake shed, and twigs/pine needles/bark. The different components were separated into individual weigh boats using tweezers. Human hair, domesticated animal hair and plastics were considered anthropogenic materials.

We used unpaired t-tests to compare the amounts of materials in nests between the habitats and Fisher's exact test to compare the presence/absence of materials between the two habitats. A simple linear regression was used to test the relationship between amount of hair and nesting success in the urban habitat. All means are reported with standard errors.

Results

We did not find differences in the number of individuals fledged between rural (3.5 ± 0.5) and urban nests (3.2 ± 0.4; t test, t = 0.5, df = 17, p = 0.6) nor in the proportion of eggs hatched (p = 0.9) for the nests used in our study. The overall nesting success varied between habitats in 2021, with 93% of urban nests (n = 14) and 67% of rural nests (n = 12) producing at least one fledgling but this difference was not significant (Fisher's exact test, p = 0.1).

The mean mass of urban nests (38.1 ± 2.5 g) did not differ significantly from rural nests (39.3 ± 2.8 g; t-test, t = 0.3, df = 17, p = 0.8) but the nest components varied between the two habitats. Urban nests had more leaves (t = 4.1, df = 17, p = 0.0008), but fewer twigs, pine needles and bark (t = 2.2, df = 17, p = 0.04), compared to rural nests (Fig. 2). Rural nests contained more moss (t = 3.1, df = 17, p = 0.007). Amounts of roots/grasses (t = 0.8, df = 17, p = 0.4) and dirt (t = 0.5, df = 17, p = 0.6) did not differ between nests from the two different habitats (Fig. 2). Only urban nests contained plastic, and it was present in 55% of the nests, a difference that was significant (Fisher's exact test, p = 0.02). However, there was no significant difference in the proportion of eggs hatching in nests with plastic (0.9 ± 0.1) or without plastic (0.7 ± 0.3; t = 1.4, df = 9, p = 0.2) or in the number of young that fledged from nests with (3.2 ± 0.4) or without plastic (3.2 ± 0.8; t test = 0.04, df = 9, p = 0.9) in the urban habitat.



Figure 1. Nest boxes in (a) rural and (b) urban sites. Photos by D.L.H.N.

One material within both urban and rural nests was snake shed, but the amount was so small it did not register on the scale. Seventy-two percent of urban nests and all rural nests contained snake shed and this difference was not significant (Fisher's exact test, p = 0.4).

Hair and fine grasses were used as lining material in nests of both habitats. All urban nests and 50% of rural nests contained hair and this difference was significant (Fisher's exact test, p = 0.02). *Canis familiaris* Linnaeus (dog) hair and some human hair were present in the urban nests and was recognizable by its length, texture and colors. Dog hair was often white and softer in texture whereas human hair was in long, thin strands. Hair in the rural nests was coarser, in some cases brittle, and often with bands of color characteristic of wild mammals such as *Odocoileus virginianus* Zimmermann (White-tailed Deer; Heffelfinger 2006) or *Procyon lotor* Linnaeus (Raccoon; Lotze and Anderson 1979). There was significantly more hair within the urban nests (t = 3.6, df = 17, p = 0.002). Hatching success ($R^2 = 0.03$; $F_{1,9} = 0.3$, p = 0.6) and fledgling success ($R^2 = 0.01$; $F_{1,9} = 0.1$, p = 0.7) were not related to the amount of hair in urban nests.

Discussion

While the nest masses were very similar in both environments, urban and rural nest materials were different. In the urban setting, more leaves were used as opposed to twigs, bark and pine needles (Fig. 2, 3a, b). This could be due to human manipulation of yards in the urban areas. Yards in the urban area typically had more hardwoods than pines, making leaves a more common nest material. We found more mosses in rural nests (Figs. 2, 3a, b). Typically, mosses are used in nests as insulators and to help bind nest materials together (Deeming et al. 2020, Fäth et al. 2023). Mosses are often less common in urban areas than rural habitats due

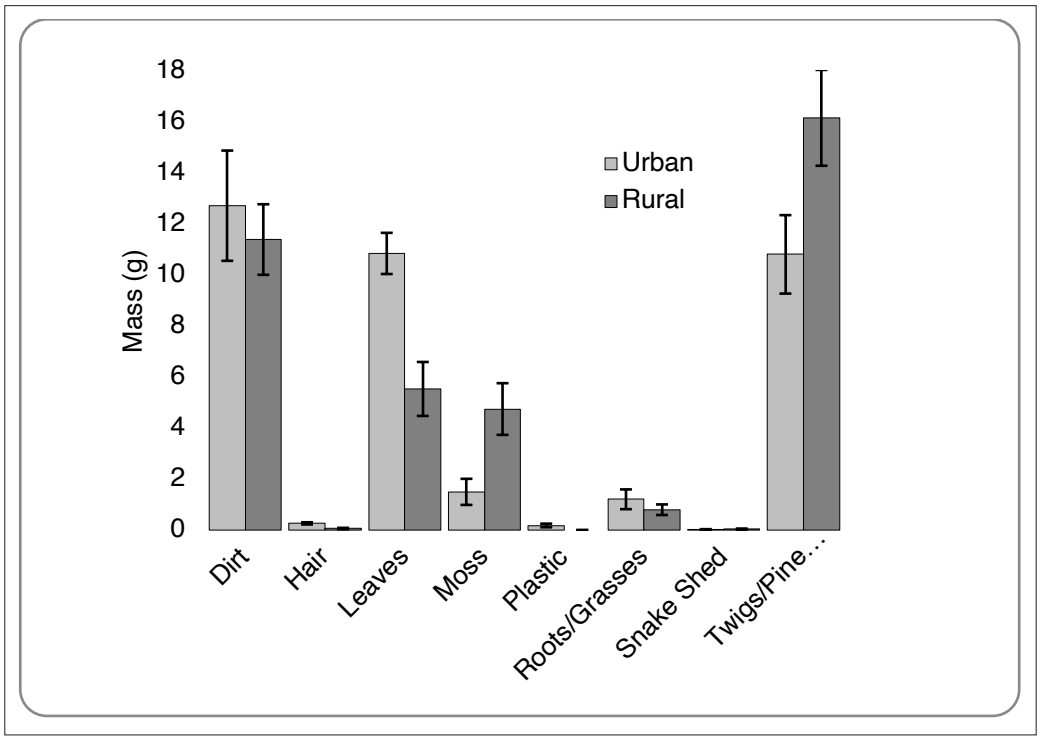


Figure 2. Mean ± SE weights (g) of nest materials from urban (n = 11) and rural (n = 8) Carolina Wren nests.

to their sensitivity to air pollution (Sujetovienė and Galinytė 2016) and the poorer growing conditions within urban areas. Urban areas often have less shade and a focus on cultivated lawns, which is less hospitable to moss growth (Edmunds and Kowlewski 2017, Oishi 2019).

In support of our hypothesis, urban nests contained more anthropogenic materials than did the rural nests. Urban nests contained more hair compared to the rural nests and it may be because hair from domesticated animals is readily available in urban settings where pets spend time outside (pers. obs.). If domesticated animals are treated with flea and tick preventatives, the exposure to hair can be potentially harmful to birds that use these materials for nesting. For example, Tassin de Montaigu et al. (2025) found fipronil, imidacloprid and permethrin in the nests where companion animal fur was used for the inner linings of nests. The presence of these chemicals was directly correlated with higher mortality rates in eggs and nestlings of *Parus major* Linnaeus (Great Tit) and *Cyanistes caeruleus* Linnaeus (Blue Tit; Tassin de Montaigu et al. 2025). In our study, some human hair was also evident in urban wren nests, although not as common as animal hair. Due to its length, human hair can be dangerous for nestlings if it entangles the wings or legs and potentially cuts off blood circulation (Kim et al. 2020). We did not observe cases of nestling entanglement in hair and nesting success did not vary with the amount of hair in the nest; however, this requires further study as our sample sizes were small.

We found plastic in 55% of urban nests confirming that plastic is available to wrens in our urban habitat, a finding that aligns with recent studies showing increased presence of anthropogenic materials in bird nests over the last 200 years (Reynolds et al. 2019, Potvin et al. 2021). Plastic can be harmful to nestlings and adults through entanglement, ingestion and exposure to toxic chemicals (Janic et al. 2023, Nguyen et al. 2025). Antczak et al. (2020) observed that in one study area 9% of *Lanius excubitor* Linnaeus (Great Grey Shrike) nestlings died from entanglement in plastic strings used in nest construction. Similarly, Lee et al. (2026) observed nestling *Passer montanus* Linnaeus (Eurasian Tree Sparrow) mortality when wings, legs and necks were entangled with plastic line. Hammer et al. (2017) found

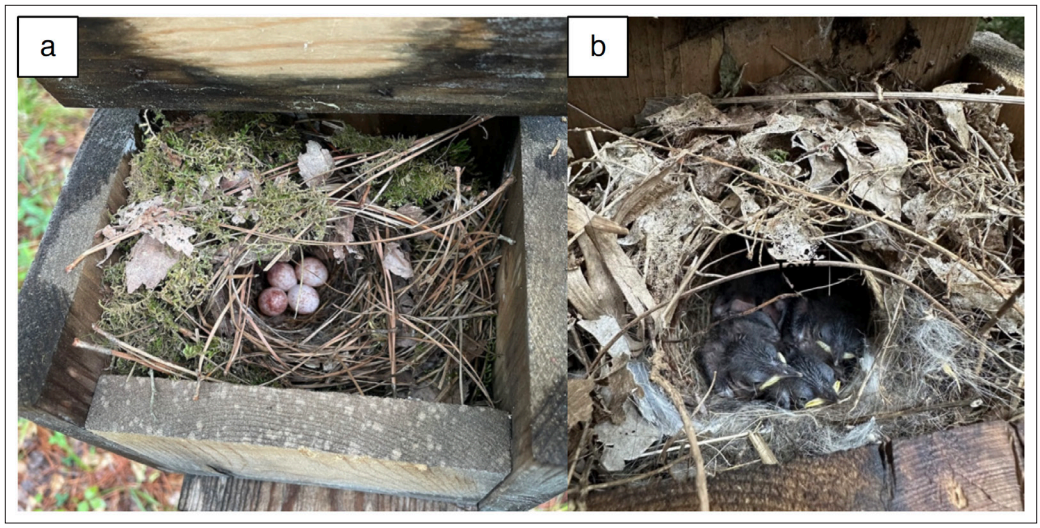


Figure 3. Nests from (a) rural and (b) urban study sites. Note the use of moss and pine needles in the rural nest. The urban nest contains more leaves and white hair is evident. Photos by D.L.H.N and Ellena Bruhn (used with permission).

that anthropogenic materials were associated with increased ectoparasite presence, which can negatively impact nestling growth and survival. However, we did not find evidence of ill effects from plastic in our urban nests. Most of the plastics used by wrens were small, soft, pliable pieces that would not likely entangle birds (Fig. 4). One suggestion is that wrens may use plastic pieces similar to how they use snake shed as a soft lining material (Skutch 1960, p.206). Wrens in our study placed snake shed and plastic pieces within or around the top of the nest cup. Espinoza et al. (2024) found high amounts of plastic use in the nests of *Pica pica* Linnaeus (Eurasian Magpie) and *Serinus serinus* Linnaeus (European Serin) in an agricultural landscape. The birds utilized filamentous plastics that resembled natural vegetative filaments they would use in nest building over other types of plastic debris. Future studies could examine the types of anthropogenic materials used in nest building and the resemblance to natural materials.

Snake shed was found in small amounts in almost all nests indicating that it is an important component for the nests and attainable in both habitats. Snake shed is often used by cavity-nesting songbirds, like wrens, possibly as a deterrent to mammalian predators (Medlin and Risch 2006, Rohwer et al. 2024). Raccoons, *Didelphis virginiana* Kerr (Virginia Opossum), and *Sciurus niger* Linnaeus (Fox Squirrel) are potential nest predators in both habitats and Raccoons have been problematic predators at our rural site (Neudorf, pers. obs.). The use of snake shed by Carolina Wrens as a predator deterrent is an intriguing possibility that requires further investigation.

As in other bird species, Carolina Wrens in urban environments use materials commonly found in this environment. Our study shows that Carolina Wrens are opportunistic when it comes to nest building and adapt well to changes in their habitat even when faced with human development. Nest success for wrens in our study did not differ according to habitat or the types of nest materials utilized but our sample sizes were relatively small. There are few studies that compare the presence of anthropogenic materials in bird nests in different



Figure 4. Examples of typical plastics found in Carolina Wren nests. Photo by D.L.H.N.

habitats (Blettler et al. 2020, Jagiello et al. 2023) and fewer that examine the relationship between anthropogenic materials in nests and nest success, especially in songbirds. Vasquez et al. (2022) found higher proportions of plastic in urban nests in *Baeolophus atricristatus* Cassin (Black-crested Titmouse) but they did not observe impacts of plastic on nest success. Future studies on Carolina Wrens and other songbirds should examine nest composition along an urban-rural gradient and relate presence of anthropogenic materials including plastics and hair from domesticated animals or humans to nestling health and survival.

Acknowledgments

We would like to thank the residents of Huntsville, Texas, who allowed us to place nest boxes in their yards to conduct our research. We are grateful to Sam Houston State University for allowing us to use the Pineywoods Research Laboratory (PERL) and for the continued logistical support of the field station manager, A. Byboth. R. Dai and two anonymous reviewers provided excellent feedback on the manuscript. Thank you to E. Bruhn and A. Cannon for use of their photos.

Literature Cited

Antczak, M., M. Hromada, P. Czechowski, J. Tabor, P. Zablocki, J. Grzybek, and P. Tryjanowski. 2010. A new material for old solutions—the case of plastic string used in Great Grey Shrike nests. Acta Ethologica 13:87–91.

Blettler, M.C.M., L. Gauna, A. Andréault, E. Abrial, R.E. Lorenzón, L.A. Espinola, and K.M. Wantzen. 2020. The use of anthropogenic debris as nesting material by the Greater Thornbird, an inland–wetland-associated bird of South America. Environmental Science and Pollution Research 27(33):41647–41655.

Bogrand, A.L., D.L. Neudorf, and P. Matich. 2017. Predator recognition and nest defence by Carolina Wrens *Thryothorus ludovicianus* in urban and rural environments: does experience matter? Bird Study 64(2):211–221.

Brumm, H. 2004. The impact of environmental noise on song amplitude in a territorial bird. Journal of Animal Ecology 73:434–440.

Cerezo, A.T., and D.C. Deeming. 2016. Nest insulation in the European Robin (*Erithacus rubecula*): effects of latitude and construction materials. Avian Biology Research 9(2):96–102.

Deeming, D.C., A.M. Dickinson, R.E. Broughton, E. Locke, L.A. Gray, S.L. Bennett, R. Gilchrist, S. Muniz, A.M. Goodman, and L.E. Biddle. 2020. Factors affecting thermal insulation of songbird nests as measured using temperature loggers. Physiological and Biochemical Zoology 93(6):488–504.

Deeming, D.C., and M.C. Mainwaring. 2015. Functional properties of nests. Pp. 29–49, *In* D.C. Deeming and S.J. Reynolds (Eds.). Nests, eggs and incubation: new ideas about avian reproduction. Oxford University Press. 312 pp.

Dooling, R.J., D. Buehler, M.R. Leek, and A.N. Popper. 2019. The impact of urban and traffic noise on birds. Acoustics Today 15(3):19–27.

Edmunds, B.A., and A. Kowlewski. 2017. Managing moss in lawns in western Oregon. Oregon State University Extension Service. EM 9175.

Espinoza, M.J., I. Laviada, A.T. Cerezo, Á. Luna, A.J. Gil-Delgado, and E. Bernat-Ponce. 2024. Do birds select the plastics debris used for nest construction? A case study in a Mediterranean agricultural landscape. Environmental Research 255:119117.

Fäth, L., E. Obermaier, and R. Pfeifer. 2023. Picky Blue Tits—selective moss utilization for nest construction in *Cyanistes caeruleus*. Zeitschrift bayerischer und baden-württembergischer Ornithologen 61(1):1–15.

Gering, J.C., and R.B. Blair. 1999. Predation on artificial bird nests along an urban gradient: predatory risk or relaxation in urban environments? Ecography 22(5):532–541.

Haggerty, T.M., and E.S. Morton. 2020. Carolina Wren (*Thryothorus ludovicianus*), version 1.0. *In* Poole, A.F. (Ed.) Birds of the World. Cornell Lab of Ornithology, Ithaca, NY, USA.

Hammer, H.J, R.L. Thomas, G.J.F. Beswick, C.P. Bradley, and M.D.E. Fellowes. 2017. Use of anthropogenic material affects bird nest arthropod community structure: influence of urbanisation, and consequences for ectoparasites and fledging success. Journal of Ornithology 158:1045–1059.

Hansell, M. 2000. Bird nests and construction behaviour. Cambridge University Press, Cambridge, UK. 280 pp.

Heffelfinger, J. 2006. Deer of the southwest. Texas A & M University Press. College Station. 282 pp.

Jagiello, Z., S.J. Reynolds, J. Nagy, M.C. Mainwaring, and J.D. Ibáñez-Álamo. 2023. Why do some bird species incorporate more anthropogenic materials into their nests than others? Philosophical Transactions of the Royal Society B: Biological Sciences 378(1884):20220156.

Janic, B., J. Bańbura, M. Glądalski, A. Kaliński, M. Kamiński, L. Marszał, D. Pieniak, J. Wawrzyniak, and P. Zieliński. 2023. Plastic occurrence in nests of a large forest bird. Ecological Indicators 153:110470.

Kim, E., H. Seo, J. Oh, and C. Park. 2020. The first report of an Eastern Great Tit *Parus minor* nestling's foot entanglement with human hairs at Hongneung Experimental Forests in Seoul. The Korean Journal of Ornithology 27(2):146–150.

Kurucz, K., J.J. Purger, and P. Batáry. 2021. Urbanization shapes bird communities and nest survival, but not their food quantity. Global Ecology and Conservation. 26:e01475.

Labisky, R.F., and J.E. Arnett Jr. 2006. Pair roosting of nesting Carolina Wrens (*Thryothorus ludovicianus*). Wilson Journal of Ornithology 118(4):566–569.

Laskey, A.R. 1948. Some nesting data on the Carolina Wren at Nashville, Tennessee. Bird-Banding 19(3):101–121.

Lee, J.H., D.H. Cho, S.J. Oh, and H.C. Sung. 2026. Entanglement mortality associated with using plastic debris as nesting material in the Eurasian Tree Sparrow (*Passer montanus*). Environmental Science and Pollution Research 33:5199–5207.

Lee, K., Y.C. Jang, S. Hong, J. Lee, and I.K. Kwon. 2015. Plastic marine debris used as nesting materials of the endangered species Black-faced Spoonbill *Platalea minor* decreases by conservation activities. Journal of the Korean Society for Marine Environment and Energy 18:45–49.

Lotze, J.H., and S. Anderson. 1979. *Procyon lotor*. Mammalian Species 119:1–8.

Marzluff, J.M., R. Bowman, and R. Donnelly. 2001. A historical perspective on urban bird research: trends, terms, and approaches. Pp. 1–17, *In* J.M. Marzluff, R. Bowman, and R. Donnelly (Eds.). Avian ecology and conservation in an urbanizing world. Springer, Boston, MA. 585 pp.

McNeese, H.C. 2018. Carolina Wren nest composition in urban and rural habitats. Honors Thesis. Sam Houston State University, Huntsville, TX, USA. 21 pp.

McNeese, H.C., A.M. Burgess, D.L.H. Neudorf, and J.D. Daza. 2021. Ground Skink (*Scincella lateralis*) tails found in Carolina Wren (*Thryothorus ludovicianus*) nests. Southeastern Naturalist 20(3):N88–N91.

Medlin, E.C., and T.S. Risch. 2006. An experimental test of snake skin use to deter nest predation. The Condor 108:963–965.

Nguyen, D., M.K. Nguyen, M.T. Pham, D.D. La, S.W. Chang, S.S. Kim, and D.D. Nguyen. 2025. Plastic debris in bird nests: sources, ecological impacts, and bioindicator potential for monitoring microplastic pollution. Environmental Geochemistry and Health 47(10):405.

Oishi, Y. 2019. Urban heat island effects on moss gardens in Kyoto, Japan. Landscape and Ecological Engineering 15:177–184.

Potvin, D.A., F. Opitz, K.A. Townsend, and S.A. Knutie. 2021. Use of anthropogenic-related nest material and nest parasite prevalence have increased over the past two centuries in Australian birds. Oecologia 196:1207–1217.

Reynolds, J.S., J.D. Ibanez-Alamo, P. Sumasgutner, and M.C. Mainwaring. 2019. Urbanization and nest building in birds: a review of threats and opportunities. Journal of Ornithology 160(3):841.

Rohwer, V.G., J.L. Houtz, M.N. Vitousek, R.L. Bailey, and E.T. Miller. 2024. The evolution of using shed snakeskin in bird nests. The American Naturalist 205(2):170–183.

Skutch, A.F. 1960. Life histories of Central American birds II. Cooper Ornithological Society. Berkeley, CA, USA. 593 pp.

Slabbekoorn, H. 2013. Songs of the city: noise-dependent spectral plasticity in the acoustic phenotype of urban birds. Animal Behaviour 85(5):1089–1099.

Suárez-Rodríguez, M., and C. Macías Garcia. 2014. There is no such a thing as a free cigarette; lining nests with discarded butts brings short-term benefits, but causes toxic damage. Journal of Evolutionary Biology 27:2719–2726.

Suárez-Rodríguez, M., R.D. Montero-Montoya, and C. Macías Garcia. 2017. Anthropogenic nest materials may increase breeding costs for urban birds. Frontiers in Ecology and Evolution 5:4.

Sujetovienė, G., and V. Galinytė. 2016. Effects of the urban environmental conditions on the physiology of lichen and moss. Atmospheric Pollution Research 7(4):611–618.

Tassin de Montaigu, C., G. Glauser, S. Guinchard, and D. Goulson. 2025. High prevalence of veterinary drugs in bird's nests. Science of the Total Environment 964:178439.

Townsend, A.K., and C.M. Barker. 2014. Plastic and the nest entanglement of urban and agricultural crows. PLoS ONE 9(1):e88006.

Twardek, W.M., K.S. Peiman, A.J. Gallagher, and S.J. Cooke. 2017. Fido, Fluffy, and wildlife conservation: The environmental consequences of domesticated animals. Environmental Reviews 25(4):381–395.

United States Census Bureau. 2020. Available online at https://data.census.gov/profile/Huntsville_city,_Texas?g=160XX00US4835528. Accessed 20 April 2026.

Vasquez M.P., R.J. Rylander, J.M. Tleimat, and S.R. Fritts. 2022. Use of anthropogenic nest materials by Black-crested Titmice along an urban gradient. Journal of Fish and Wildlife Management 13(1):236–242.

Vincze E., G. Seress, M. Lagisz, S. Nakagawa, N.J. Dingemanse, and P. Sprau. 2017. Does urbanization affect predation of bird nests? A meta-analysis. Frontiers in Ecology and Evolution 5:29.

Wang, Y., S. Chen, R. Blair, P. Jiang, and P. Ding. 2009. Nest composition adjustments by Chinese Bulbuls *Pycnonotus sinensis* in an urbanized landscape of Hangzhou (E China). Acta Ornithologica 44:185–192.

Winiewicz, A., W. Mierzejewska, M. Nartowicz, A. Syguła, A. Hryszko, L. Kabacińska, M. Karpiesiuk, J. Koscielniak, A.T. Dubis, and K. Deoniziak. 2025. Entangled in fibers: a preliminary study of a Great Tit's (*Parus major)* fatal encounter with anthropogenic nesting material. The European Zoological Journal 92(1):660–668.