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# Sex in the



A Brown-headed Nuthatch brings food to the nest. Color-coded leg bands enable the authors and their colleagues to discern the curious and potentially complex relationships among the various individuals at Tall Timbers Research Station on the Florida–Georgia line. *Photo by © Tara Tanaka.*

## The curious lives of

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# Sitta

Warblers are gorgeous, jays boisterous, and sparrows elusive, but words like “cute” and “adorable” come to mind when the conversation shifts to Brown-headed Nuthatches.

The word “cute” doesn’t appear in the scientific literature regularly, but science may help to explain its frequent association with nuthatches. The large heads and small bodies nuthatches possess have proportions similar to those found on young children. Psychologists have found that these proportions conjure up “innate attractive” responses among adult humans even when the proportions fall on strange objects (Little 2012).

This range-restricted nuthatch associated with southeastern pine-woods has undergone steep declines in recent decades and is listed as a species of special concern in most states in which it breeds (Cox and Widener 2008). The population restricted to Grand Bahama Island appears to be critically endangered (Hayes et al. 2004). Add to these concerns some intriguing biology that includes helpers at the nest, communal winter roosts, seed caching, social grooming, and the use of tools, and you have some scintillating science all bound up in one “cute” and “adorable” package.

## Brown-headed Nuthatches

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## BROWN-HEADED NUTHATCH



The Stoddard Bird Lab at Tall Timbers Research Station and Land Conservancy has studied Brown-headed Nuthatches for a decade on 850 hectares (2,100 acres) of mature pines that dominate the station's forest lands. Tall Timbers Research Station lies about 20 miles north of Tallahassee, Florida, and abuts the Florida–Georgia state line. During the past three years, additional eyes provided by Florida State University have greatly enhanced monitoring and research efforts. We capture about 45 new adults and anywhere from 100–200 nestlings each year and provide each one with unique, colored leg-band combinations.

Reading band combinations can be challenging with a small bird that spins around branch and bole with great agility. Left becomes right and down becomes up, and most sightings are logged using the narrow view provided by spotting scopes, not binoculars. With care and patience, however, the comings and goings of individual birds can be monitored to help unearth some of the intriguing biology of *Sitta pusilla*.

### Digging Deep for the Next Generation

Brown-headed Nuthatches spend most of their lives flitting like gymnasts among canopy limbs, but they abandon tall trees and seek out low-stature structures when the nesting season arrives. Most species of nuthatches use existing crevices and cavities (Harrap and Quinn 1996), but the Brown-headed Nuthatch excavates a new cavity almost every year in stumps that rise a few feet above ground; the entrance is within reach of a typical human teenager. The soft,

Top: Individual Brown-headed Nuthatches are monitored by means of unique combinations of colored leg bands. This individual is known as “HPDG/AILB,” our acronym for hot pink over dark green (left leg)—aluminum over light blue (right leg). A nine-year old male, he was banded as a nestling in 2006 and has lived within 260 meters of this nest site ever since. HPDG/AILB spent two years as a helper but has been the dominant male since 2009. Photo by © Tara Tanaka.

Bottom: By filming activities at the nests, researchers are able to tease apart adult vs. helper nuthatches' relative contributions toward the care of young. In this image, a dominant female is shown leaving (dark green–black bands) while the dominant male (light green–aluminum bands) brings a small worm. Photo by © Tara Tanaka.





The mature pinelands on Tall Timbers Research Station are managed with frequent controlled burns that promote grass-dominated groundcover and mature, open pines but that inhibit the number of hardwood trees and shrubs. Approximately 60% of the upland pines on the property are burned every year. These conditions mimic the open pinelands that once dominated the coastal plains of the southeastern U.S., and that supported Red-cockaded Woodpeckers, Brown-headed Nuthatches, and Bachman's Sparrows. *Photo by © Tara Tanaka.*

decayed wood is easily penetrated, and the broad base seems to provide secure footing compared to other nest sites selected on our study area (for example, flimsy dead limbs on trees).

Excavations start in late January and often focus on snags used previously. An excavation can take weeks to complete, and false starts occur when a thin veneer of soft, exterior wood is breached only to reveal rock-hard heartwood. Some excavations also begin on portions of a snag that lack the proper dimensions needed for a nest. Birds literally drill into open space and abandon the effort or, alternatively, try to shore things up using wood chips and other caulking material.

Other species watch closely as nuthatch excavations progress. Secondary cavity-nesters that frequently attempt to usurp completed cavities include Great Crested Flycatcher, Eastern Bluebird, White-breasted Nuthatch, Carolina Chickadee, and Tufted Titmouse. Particularly strong interactions occur among bluebirds, chickadees, and nuthatches, and we've discovered dozens of species of mammals, reptiles, and amphibians using

nuthatch cavities after the breeding season.

Eggs are laid in late February. They are nestled in a well-insulated nest lined with hair, feathers (often not nuthatch), moss, and pine seed wings. We once thought nuthatches secure hair by ganging up on squirrels, but then we discovered a more likely source. A nuthatch grabbed hair-laden bobcat feces lying on a trail, whisked it about in a nearby pool of water, and then flew off into the trees.

The typical nest contains 4 or 5 eggs, but rare outliers may contain as many as 9 eggs. Nests that successfully fledge young typically represent only 35–45% of the nests initiated each year. Nest success is variable, and there are steep drops in nesting success some years.

The oldest marked male (still with us!) is at least 12 years old, while the oldest marked female (also still with us) is in her ninth year. Nuthatches appear to human eyes to be monomorphic, but sexes can be distinguished based on vocalizations (Norris 1958). Males give strident, two- and three-syllable calls,



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while females produce more subtle two-syllable calls as well as sputtering chips and chortles. A recording by Paul Marvin (Xeno-Canto XC138622) provides great examples of female chips and male calls. The squeaky-toy quality of nuthatch vocalizations adds yet another youthful element to the appreciation of this bird; we even use dog squeaky toys to call birds into view.

Pairs may occupy the same 4-hectare (10-acre) patch of pine-woods for years, but “divorce” coupled with dispersal also occurs. As suggested by the sex-based differences in maximum ages, female survival is lower than male survival in part due to factors associated with nesting. Only females incubate eggs (for ca. 14 days) and brood young (for the first 4–6 days after hatching). The low nest sites are easily reached by predators, and each year we find rat snakes (genus *Elaphe*) sitting in nests with large protruding bulges in their bellies; gently pressing the bulge forces the snake to regurgitate the female nuthatch. The threat posed by snakes could be a factor influencing the early nest-initiation dates. By nesting when cooler ambient temperatures prevail, the nuthatch avoids the increased snake activity that comes with warmer temperatures. Less frequently, we find nests with adult feathers, dismembered body parts, and bro-

ken eggs, suggesting a deadly visit by the eastern flying squirrel (*Glaucomys volans*).

### Family Living and Not-So-Family Living

“Cooperative breeding”, uncommon among birds, is the name given to the mating system whereby mature individuals forego the chance to breed on their own and instead assist the breeding efforts of others. The Brown-headed Nuthatch exhibits this behavior throughout its range. In fact, cooperative breeding was described for the nuthatch well before it was described for the Red-cockaded Woodpecker, the Acorn Woodpecker, and other species that dominate the recent literature on the subject (Koenig and Dickinson 2004). Skutch (1961) posed some interesting questions about this behavior in birds and referred to the Brown-headed Nuthatch six times in his seminal article on the subject, while not mentioning Acorn or Red-cockaded Woodpeckers anywhere.

Nuthatch helpers appear in 20–30% of the nests we monitor each year, with higher proportions reported for populations in other portions of the species’ range (Cox and Slater 2007). Helpers feed nestlings, remove fecal sacs, defend territories,

These two images depict the nest excavation process. The nuthatches require two weeks to complete the excavations, and the process requires that the birds fling out copious quantities of sawdust (left) and wood chips (right). Photos by © Tara Tanaka.







Ph.D. candidate Jessica Cusick sets up a video camera on an active nuthatch nest. The snag shown here was used by the same family for four consecutive years before they moved to another snag nearby. The many holes are the result of previous excavations and false starts; the plastic wrapped around the base helps to deter some predators. *Photo by © Tara Tanaka.*

and perform other care-giving functions. Most cooperative groups of Brown-headed Nuthatches (ca. 70%) contain a young male hatched the previous year and closely related to at least one breeder (Han et al. 2015). However, we also find young males that disperse and assist unrelated breeders (ca. 25% of cooperative groups). Groups containing two or more male helpers also occur regularly, and still other curious, albeit less common, arrangements feature brothers nesting with a female, young females assisting parents, and young males and females that provide assistance at multiple nests. Finally, nuthatches also provide special assistance known as “redirected helping” that takes place when a nest fails and the breeders decide to help a neighbor rather than attempt a second nest.

For the past three years, we’ve served as the key grips for a little-known—and not syndicated—reality show documenting nuthatch family life. By filming activities at nests, we are endeavoring to determine how nuthatch helpers benefit breeders, and possibly themselves,



Biologist James Cox uses a dental mirror to examine the goings-on in a nuthatch nest. *Photo by © Tara Tanaka.*



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Top: Life at the nest can be harrowing! Eastern Bluebirds nest regularly in the cavities excavated by Brown-headed Nuthatches and often are not willing to wait for the nuthatches to complete their nesting efforts. *Photo by © Tara Tanaka.*

Middle: Keeping nests tidy is an important function performed by all group members. Here the dominant female removes a fecal sac ejected by a young. Like many other birds, adults swallow the small fecal sacs produced by recent hatchlings and carry away the larger fecal sacs of older young. *Photo by © Tara Tanaka.*

Bottom: The nuthatches' primary nest predators on Tall Timbers are red rat snakes (here) and gray rat snakes; together, they account for ca. 40% of all nest losses. These constrictors climb well and regularly take adult females that are incubating eggs or brooding young. When we find snakes in nuthatch cavities with a large bulge, we gently palpate the contents out to gather DNA from the deceased females. *Photo by © Tara Tanaka.*



during the nesting season. We are still working through thousands of hours of video footage and field observations documenting the comings and goings of color-marked individuals, so results are preliminary. Surprisingly, benefits typically accrued to other cooperative breeders—lightening parental workloads, enhanced productivity, and assistance with nest excavation—aren't clearly evident in this system. However, helpers may enjoy benefits not easily recorded on video.

While many birds appear to breed as pairs, a lot of behind-the-scene action takes place that is not picked up until you gather DNA from everyone at the party. Scientists use the term "extra-pair fertilization" to describe what is commonly called adultery in human societies, and recent advances in genetic testing have turned up extensive "adultery" among birds.



Top: Another common nest predator is the broadhead skink (*Plestiodon laticeps*). Males have the bright red coloration, as here, and may reach up to a foot in length. The large adults have powerful jaws and may attempt to take young, in addition to eggs. Photo by © Tara Tanaka.



Middle: Each nest typically contains four or five eggs, but some nests may contain as many as nine. Special nest boxes provided in 2015 were attractive to the nuthatches. This nest produced eight young; all eight fledged, and two of the fledged males were still with the adults in late December 2015. Photo by © Tara Tanaka.



Bottom: At Tall Timbers and throughout much of the range, Brown-headed Nuthatches excavate low nests. The soft, decayed wood typically found in snags in the final stages of decay is easily excavated, and, by nesting as early as possible, nuthatches avoid snakes and other predators emerging from their winter slumbers. This exceptionally low nest successfully fledged four young in 2011. Photo by © Tara Tanaka.



Kin Han, Sarah Haas, and Rebecca Kimball at the University of Florida developed genetic markers for the Tall Timbers nuthatch population that enable us to precisely determine the relatedness of adults and offspring. Between 2008 and 2010, DNA collected from all the birds associated with 59 nests showed that paternity involved someone other than the dominant male at 40% of the nests (Han et al. 2015). An incestuous helper was a father at one nest, while unrelated mystery males fathered offspring at remaining nests. This rate of extra-pair activity is moderately high compared to the 20% average among songbirds generally (Westneat and Stewart 2003) and 10% average for bird species that breed cooperatively (Cornwallis et al. 2010). Access to a neighboring breeder could be a benefit that some helpers enjoy while helping adults at the nest.

Still other benefits of nuthatch cooperation might accrue outside the breeding season. Larger groups may control better winter food resources, and there's much more to be learned about communal winter roosts. Communal roosts are known to be essential for the closely related Pygmy Nuthatch of western North America, and dead Brown-headed Nuthatches reported in cavities following freezing blasts of wintry cold suggest winter roosts could be important for the latter species as well. In the breeding season of 2015, we developed a method for peeking into nests at night, and we found variation in the number of individuals present. We found pairs roosting together on nights when temperatures dropped near 0° C (32° F) but only a single adult (presumably the female) inside when temperatures were around 5° C (40–42° F).

## Ready to Launch

The decision to stay and help rather than to disperse and breed is a defining moment in the life of a young nuthatch. Monitoring dispersal can be a daunting task for small, free-flying birds, but some special surveys allow us to track many of the



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movements taking place. Starting in late May, we conduct monthly visits to all the territories that fledged young to determine which young are holding tight. To locate individuals that disperse (rather than those that die), we visit random points generated by computer mapping software. The random points fall within mature pine forests and are at least 300 meters from

successful nests; all points are within a 6-kilometer area at Tall Timbers. Nuthatches are then lured into view using recorded vocalizations that mimic a territorial intrusion.

The decision to disperse comes early in life for many nuthatches. In May 2012, we found a marked juvenile female at a random point that was 3.2 kilometers (2 miles) south of the

This nest site is typical. The decaying sapwood encircling the outer edges of old trees is particularly easy to excavate, while the dense heartwood interior to the sapwood is more difficult to excavate. Nests found in snags with a narrow band of sapwood often have a crescent shape as a result. *Photo by © Tara Tanaka.*

At this nest site, the excavation process opened up a hole at the base of the cavity. To shore things up, the adults "caulked" the hole up using wood chips collected from a nearby snag. *Photo by © Tara Tanaka.*





nest where she fledged in late March. This individual made the decision to leave home with only a month of flight experience under her wings. Some juveniles in natal territories are still begging for food at this point, but this young nuthatch decided a better future lay elsewhere.

Other post-fledging observations documented several additional behaviors that might affect group cohesion in the Brown-headed Nuthatch. Allopreening—a form of social grooming found in several bird species—occurs regularly at this time of year and involves all group members. Infrequently, two nuthatches have been seen jointly preening a bird sitting between them; the birds then switch places so that everyone eventually receives attention. Allopreening was once thought to be important for maintaining pair bonds but is now believed to have broader significance (Cox 2012).

Some pretty hostile interactions occur during the post-fledging period! Individuals that have found food frequently are displaced by dominant individuals who then appropriate the food. Juvenile males also regularly peck and chase one another, and once in a while we see a particularly aggressive exchange we call a “battle.” Two individuals lock feet and begin pecking and striking one another as they spin slowly toward the ground with wings aflutter. Harsh scolding notes accompany the action, and it frequently doesn’t end until birds hit the ground.

### The Less Robust Sister Species?

Brown-headed and Pygmy nuthatches split from a common ancestor about a million years ago (Pasquet et al. 2014). These two nuthatches are “sibling species”—each other’s closest relatives. The Pygmy-Brown-headed sister group falls within a subgroup of nuthatches containing eight species that long ago developed a preference for the seeds of coniferous trees rather than a generalist diet (Harrap and Quinn 1996). Not a great deal of morphological differentiation has occurred since Pygmy and Brown-headed Nuthatches split, but substantive changes have occurred in the two species’ vocalizations, breeding biology, and ecology. Norris (1958) summarized some key differences: (1) Within appropriate habitat Pygmy Nuthatches are three times



Nuthatch nests include an assortment of pine seed wings, fur, feathers, and even string. This nest was placed in a special cylindrical nest box constructed from downed snags. The top half of the box can be removed to provide better access to eggs and young. Photo by © Tara Tanaka.

more abundant year round than Brown-headed Nuthatches; (2) Pygmy Nuthatches hold territories a third the size of Brown-headed Nuthatch territories; and (3) “life intensity or standard metabolic rate is greater in the Pygmy Nuthatch.”

It is difficult to quantify variation in “life intensity,” but Brown-headed Nuthatches do exhibit less stability on Breeding Bird Survey routes (Slater et al. 2013) than Pygmy Nuthatches, as well as greater variation in abundance within the pineland habitats occupied. For example, the Brown-headed Nuthatch is rare or absent across vast acreages of mature pinelands in central Florida. The areas known as “sandhill habitats” are dominated by the venerable longleaf pine (*Pinus palustris*) sitting on deep, sandy soils. Somewhat incongruously, many sandhill sites that have few or no Brown-headed Nuthatches support scores of Red-cockaded Woodpeckers (Cox et al. 2012).

To add to the puzzle, Brown-headed Nuthatches are extremely common in younger pine stands that sit on moist soils at lower elevations only a few miles away from sandhill sites (Cox et al. 2012). The low-lying sites may be dominated by slash pines (*P. elliotii*), not longleaf pine, but the findings run counter to the common belief that Red-cockaded Woodpecker habitat is always great for nuthatches. The stark changes in



abundance also occur over short distances where “source–sink” dynamics might be studied. This is the ecological idea that simple abundance may mask regional variation in high productivity and survivorship (occurring in “source” habitats) vs. low productivity and survivorship (occurring in “sink” habitats). Simply knowing whether productivity and adult survival changes dramatically in the different settings can help to identify limiting factors. Seed-caching behavior in autumn also varies among the pine-dominated areas occupied. Nuthatches in coastal pinelands in Florida spend much more time caching pine seeds each day than the nuthatches we watch on Tall Timbers.

### Loads of Interesting Biology in a Small, Convenient Package

The Brown-headed Nuthatch has been roaming southeastern pine forests for

thousands of years. A fossil collected from a rock quarry north of Tampa dates back more than 100,000 years and comes to us by way of prehistoric owls that regurgitated prey items in a cave (Hamon 1964). During its time in southern pinelands, the nuthatch has developed a rich suite of interesting behaviors shaped both by where it came from and where it now occurs.

Cooperative breeding is one of the more interesting of these behaviors and may be influenced by a diversity of factors, ranging from mate shortages to opportunities for extra-pair copulation to defense of nest sites. Some factors can be carefully manipulated in field experiments to see what effect they might have on behavior; in this way, we can investigate the possibility that cooperative breeding is affected by multiple factors, working independently or interactively. To make the puzzle even more complicated, cooperation

also could be what is known as a “legacy” behavior, one that may formerly have had adaptive value and that persists because it does not entail the costs that we assume are incurred when an individual decides not to breed.

Documenting this diversity of behaviors requires detailed and painstaking field observations, but field observations are absolutely a pleasure to collect for this charismatic songbird. We watch as individuals chisel into dead wood, hack nuts, scale tree bark, glean from pine needles, and probe pine cones from almost any angle. Mental evaluations seem to be taking place in a variety of different contexts, and it’s increasingly appreciated that the cognitive feats of “bird brains” far exceed our earlier assessments of avian mental capacity. To be sure, there seems to be a lot happening in those big, adorable heads.

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