



The Resident Bird Species at Tin Mountain Conservation Center, New Hampshire

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Introduction

Many of the avian species found residing in New Hampshire, and much of North America, utilize cavities as nest sites each spring. Many of these cavities are created by some of the same species that nest in them, including a variety of woodpeckers, including Hairy, Pileated, and Downy woodpeckers, Northern Flickers, Yellow-bellied Sapsuckers, and White- and Red-breasted Nuthatches. In addition, numerous other avian species seek out these created cavities, including Black-capped Chickadees, Tufted Titmice, Eastern Bluebirds, and Tree Swallows, as well as many other swallow species, wrens, flycatchers, ducks, sparrows, and owls. In total, there are 85 North American bird species that excavate nesting holes, use decaying tree matter that results in a cavity, or use cavities that were created by another bird species¹.

Understanding this instinctive behavior is vital to the management of many of these species. While most of the aforementioned species are not of great conservation concern, it is imperative to understand the dynamics and interactions of the species and the environment, particularly as the climate changes and impacts are noted. As a result of previous studies, researchers are now able to provide artificial cavities in the form of nest boxes, and a large percentage of the cavity nesting species will use them when the conditions are suitable.

Keeping these central ideas in mind, Tin Mountain Conservation Center constructed 120 nest boxes in 2014 and an additional 32 in 2015. Subdivided into 5 groupings on the 138 acre property in Albany, New Hampshire, the boxes were placed in grids, saturating the conserved land with more boxes than avian territories. Targeting 4 main species, Black-capped Chickadees (BCCH), Red-breasted Nuthatches (RBNU), White-breasted Nuthatches (WBNU), and the Tufted Titmouse (TUTI), the boxes were designed with cavity openings just large enough for a small passerine to fit through, but not large enough to allow larger potential nest predators, such as grackles, crows, and Blue Jays. These 4 focal species are residents to New Hampshire, and as they do not migrate, are found year round at the sanctuary.

In addition to the four main resident bird species previously introduced, a fifth species is being monitored at Tin Mountain. Black-throated Blue Warblers (BTBW) had been negatively impacted by the destruction of the eastern forests in the 17th and 18th centuries, but numbers are currently stable or increasing in the majority of their range. They readily nest in mountain laurel, an abundant flowering plant found on much of the property. BTBW populations are of little conservation concern, but many populations are being monitored throughout the Northeast.

While much knowledge can be acquired by studying the now accessible nests of the focal species, a study was designed with two goals in mind. First, it became important to obtain an understanding of where these species can be found on the property, and in what habitat types. Second, once it is known where the species reside, it becomes possible to determine what their behaviors are and what their yearly fitness is as offspring fledge each summer. The answers to these questions could help determine the management strategies at the sanctuary, and how current management activities impact the resident bird populations.

Methods

There are four different procedures that are used simultaneously at Tin Mountain. They are as follows:

Point Counts:

Point counts are a field method that aids in identifying in avian population trends or responses to treatments such forest clearings. In this case, the biologist follows a set path with fixed observation points, and records every bird s/he hears or sees, and notes the direction and approximate distance. At Tin Mountain, there are 36 points placed 300 feet apart on 5 transect lines. The observer records for a timed duration of 5 minutes May through mid-July, and for 3 minutes the remainder of the year. Additionally, birds detected on the transect lines between points are similarly recorded during the majority of the year. Each point count transect is completed weekly. Counts are conducted at 6:00 AM May through mid-July, and at 8:00 AM the remainder of the year.

Banding:

Since June of 2011, 308 individual birds have been banded on property. Of those, 180 are BCCH, 14 are RBNU, 7 are TUTI, and 8 are WBNU. Additionally, 80 of the banded birds are BTBW. Resident birds are banded with a metal federal band, and up to three color bands. The pattern of the color bands uniquely identifies each individual, and each nine-digit code on the federal band is completely unique; no other bird in North America will have a band with the same number. Birds are captured via nest boxes, potter traps, and mist nets, and each bird is measured, weighed, sexed, and aged.

Nest Boxes:

This methodology was introduced to the sanctuary in 2015. Currently, there are 152 nest boxes at Tin Mountain. The boxes are divided into 5 groupings around the property, and were placed with two goals in mind. First, to saturate the landscape with suitable nesting cavities. This helps insure, over time, that the cavity nesting species learn to use the artificial structures, making the monitoring easier to accomplish. Second, to distribute the boxes into different habitat types. There are 8 types of forests on the Tin Mountain property, which allows researchers to observe species' use in multiple types of habitat in one season.

Resights and Recaptures:

Once an individual bird is color banded, it becomes possible for the researcher to locate the individual on the property by identifying the color pattern. Once the color pattern is identified, the researcher can mark the location of the individual and any behaviors. Resights are completed while on point counts, nest box monitoring events, and opportunistically during any additional events on site. Recaptures are completed by potter traps and mist nets; individual birds are drawn in to potter traps by seeds, or are

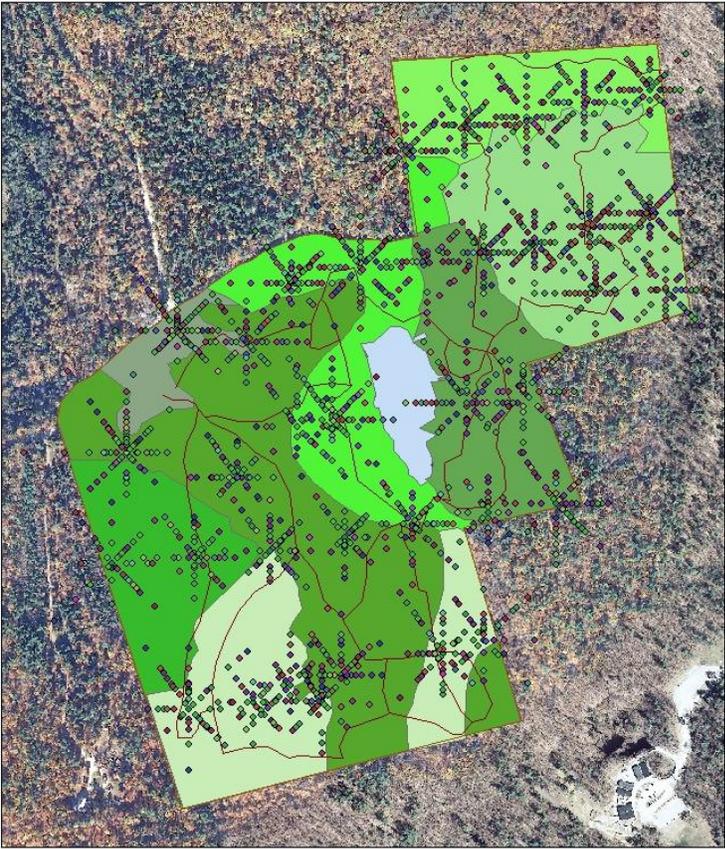
called into mist nets via playbacks, and are then identified via the federal code and the color combination. Measurements are taken at each event.

Results

Each of the four methods are addressed separately.

Point Counts:

Point count surveys were conducted throughout the year at the Rockwell Sanctuary in order to not only pinpoint the locations of the resident species, but to also note the locations of migratory species when they return to the property each spring (Figure 1).



Species by Point Count Location	◆ BR CR	◆ DE JU	◆ HO ME	◆ OV EN	◆ RU GR	◆ UN WA
◆ AMCR	◆ BTBW	◆ DOWO	◆ INBU	◆ OVEN	◆ SCTA	◆ UNWO
◆ AMGO	◆ BTNW	◆ EABL	◆ LISP	◆ PISI	◆ SOSP	◆ VEER
◆ AMRO	◆ BWHA	◆ EAKI	◆ LOWA	◆ PWA	◆ SPSA	◆ WAVI
◆ BAEA	◆ CANG	◆ EAPH	◆ MALL	◆ PWVO	◆ TRES	◆ WBNU
◆ BAWW	◆ CEDW	◆ EAWP	◆ MAWA	◆ PRWA	◆ TUTI	◆ WITU
◆ BCCH	◆ CHSP	◆ GCFL	◆ MODO	◆ RBGR	◆ TUVU	◆ WIWR
◆ BHVI	◆ COGR	◆ GCKI	◆ NOCA	◆ RBNU	◆ UNBI	◆ WOTH
◆ BLBW	◆ CORA	◆ GRCA	◆ NOFL	◆ RCKI	◆ UNHA	◆ WTSP
◆ BLJA	◆ COYE	◆ HAWO	◆ NOPA	◆ REVI	◆ UNSP	◆ YBSA
	◆ CSWA	◆ HETH	◆ NOWA	◆ RTHU	◆ UNTH	◆ YRWA

Figure 1. A map of the Rockwell Sanctuary point count surveys results for 2016. As visualized in Figure 1, certain species are only found in specific habitat types on the property, while others are more generalists and are found throughout. As an example, Common Yellowthroats

(COYE), a migratory species, are only heard or seen in areas close to water, often near Chase Pond, a vernal spring, or a marsh-like habitat, whereas BCCH, a resident species, can be heard or seen at every point count station at some point at least once during the year.

Examining BCCH a little closer, it is possible to start to distinguish areas where BCCH are found, but are not generally as prevalent (Figure 2). One of the main areas of importance is the mountain laurel habitat. BCCH are frequently seen or heard in those areas during point count surveys, but not nearly as often as other species, such as BTBW who tend to nest in the mountain laurel. BCCH are found most often in areas of white pine/eastern hemlock/northern red oak and eastern hemlock/red maple, which frequently coincides as suitable nesting habitat.

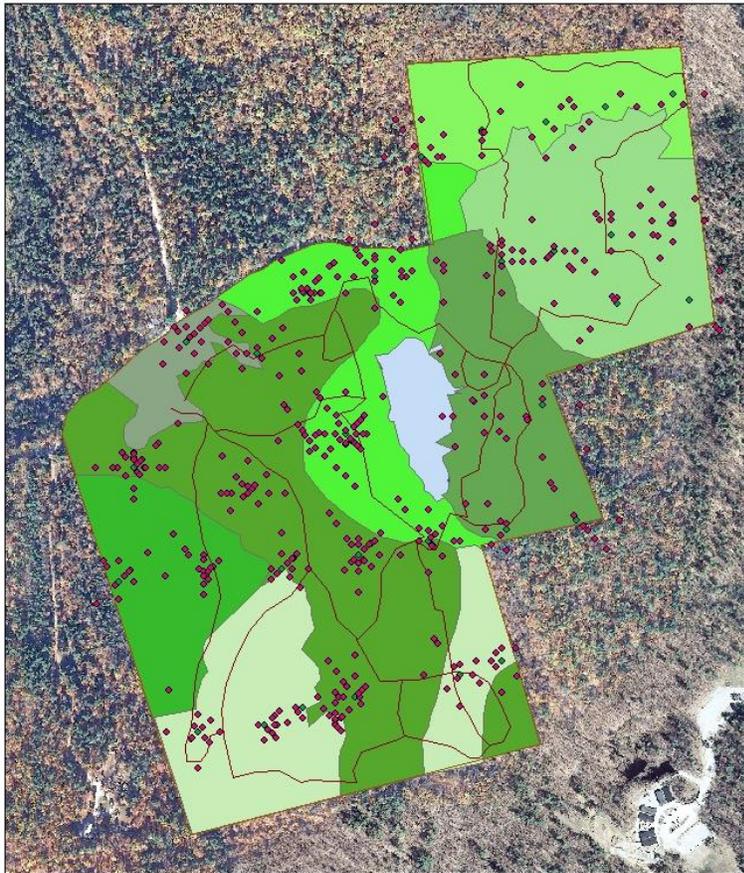


Figure 2. A map of the Rockwell Sanctuary highlighting locations of BCCH as noted during point count surveys in 2016.

Previous interns conducted kernel densities and zonal densities in order to examine BCCH flocking behaviors based on point count results, and similar results were seen in 2016, and will not be discussed further.

Banding:

As previously stated, there have been 308 individual birds banded at Tin Mountain since 2011. The species included are the four focal species, BTBW, a Blackburnian Warbler (BLBW), a Brown Creeper (BRCR), a Blue-headed Vireo (BHVI), two Black-throated Green Warblers (BTNW), a Downy Woodpecker (DOWO), two Hairy Woodpeckers (HAWO), a Hermit Thrush (HETH), a Myrtle Yellow-rumped Warbler (MYWA), a Northern Waterthrush (NOWA), an Ovenbird (OVEN), a Palm Warbler (PAWA), three Pine Warblers (PIWA), and two Red-eyed Vireos (REVI) (Figure 3).

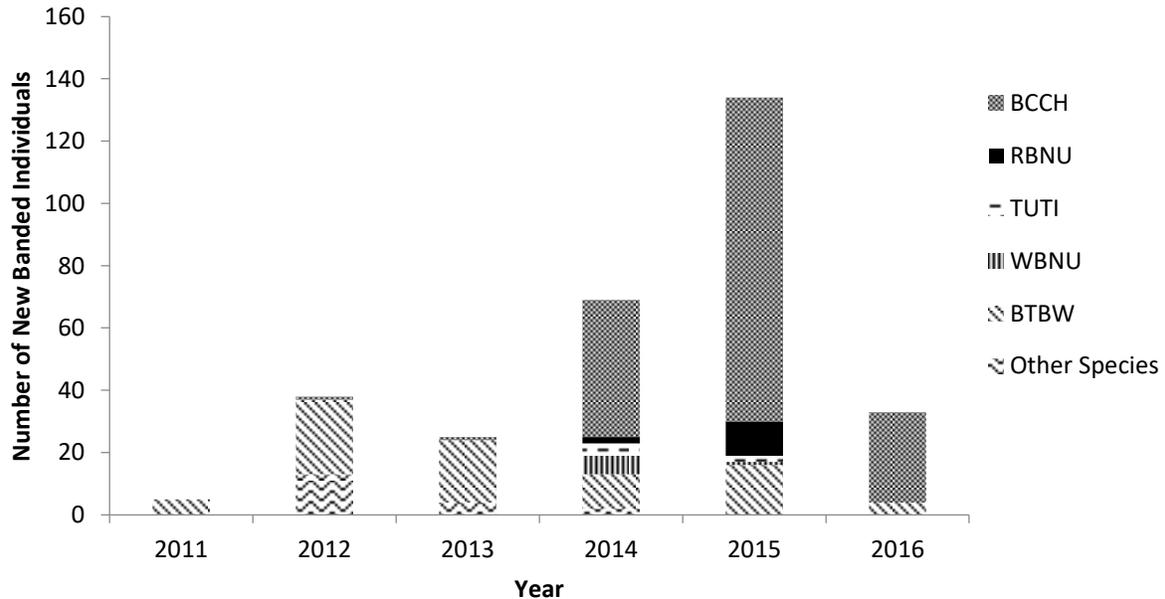


Figure 3. A comparison of species banded from 2011 to 2016. Note that this graph does not represent banding effort for each year.

The drastic increase in total number of birds banded in 2015 was caused by the introduction of the nest box study to the property. Of the 104 BCCH banded that year, 43 were BCCH fledglings banded at a nest box, and 12 of the 16 BTBW banded where fledglings banded at the nest. Additionally, there was more focus in previous years to band captured species that were not part of the newly developed resident bird study, resulting in a greater amount of non-target species banded in 2012 and 2013 than 2014 through the present.

Focusing on BCCH, the main target species for the resident bird study, it was found that the BCCH on site were on average comparable to the generally accepted measurement values for the species, validating the chosen measurements as an appropriate way to monitor the species over time. BCCH at Tin Mountain weighed an average of 11.9 grams, with a range of 8-16 grams. Tarsus, tail and wing chord averages were 17.07, 59.01, and 64.38 millimeters, respectively. Additionally, the culmen average was 9.10 millimeters.

Comparing males and females, it was found that males have, on average, larger tarsus, wing chord, and mass values. However, known females had longer tails and culmens than known males, with values of 58.73mm and 9.23mm as tail and culmen values, compared to 58.5mm and 8.92mm for males.

Nest boxes:

Nest box results varied significantly from 2015 to 2016. Using the Mayfield method for estimating nesting success, we were able to determine that there was a drastic decline in success between the two field seasons. In 2015, there were 11 successful BCCH nests and 3 unsuccessful. In total, there were 222 calculated exposure days, leading to a daily survival probability of 0.9865 and a nest survival of 0.6296. Hatch dates in 2015 varied from late May through late June, though many nests were found late or not followed to fledging.

In 2016, heavy predation led to only 4 successful BCCH nests and 12 failed BCCH nests (Figure 4). Exposure days for the season totaled 212.5, leading to a daily survival probability of 0.9435 and a nest survival probability of 0.1386. Hatch dates ranged from early June through early July, with many nests not reaching the hatching stage due to predation during incubation (see Table 1 for further information on timing during the nesting season)

	2015			2016		
	Range	Average	Mode	Range	Average	Mode
First Egg	5/29 - 6/10	6/4		5/18-6/16	5/29	
Last Egg	6/5 - 7/15	6/22		5/25-6/18	6/5	
Hatch Date	5/31 - 6/27	6/9		6/2-7/1	6/15	
Fledge Date	6/18 - 7/16	6/26		6/18-7/10	7/1	
# Eggs	4 -7 eggs	5.7 eggs	6 eggs	1-8 eggs	4.7 eggs	4 eggs
# Nestlings	3 - 6 nestlings	5.4 nestlings	6 nestlings	4-6 nestlings	4.9 nestlings	5 nestlings

Table 1. A chronology of the BCCH breeding season in 2015 and 2016 based on 15 nests in 2015 and 16 nests in 2016.

Several banded BCCH that used nest boxes in 2015 returned to use boxes again in 2016. Out of the 5 returning BCCH, four were female and one was male. Three of these individuals chose a box in 2016 very close to the box they had chosen in 2015. Additionally, one of the females was in a box in 2016 one down the row from where she nested in 2015, and when her box was predated, moved one box diagonally and had a successful brood. A similar occurrence was noted in 2015 when a banded male and female nested in two boxes during the same season; the difference was that the first brood in 2015 was successful while the outcome of the second was unknown (Table 2).

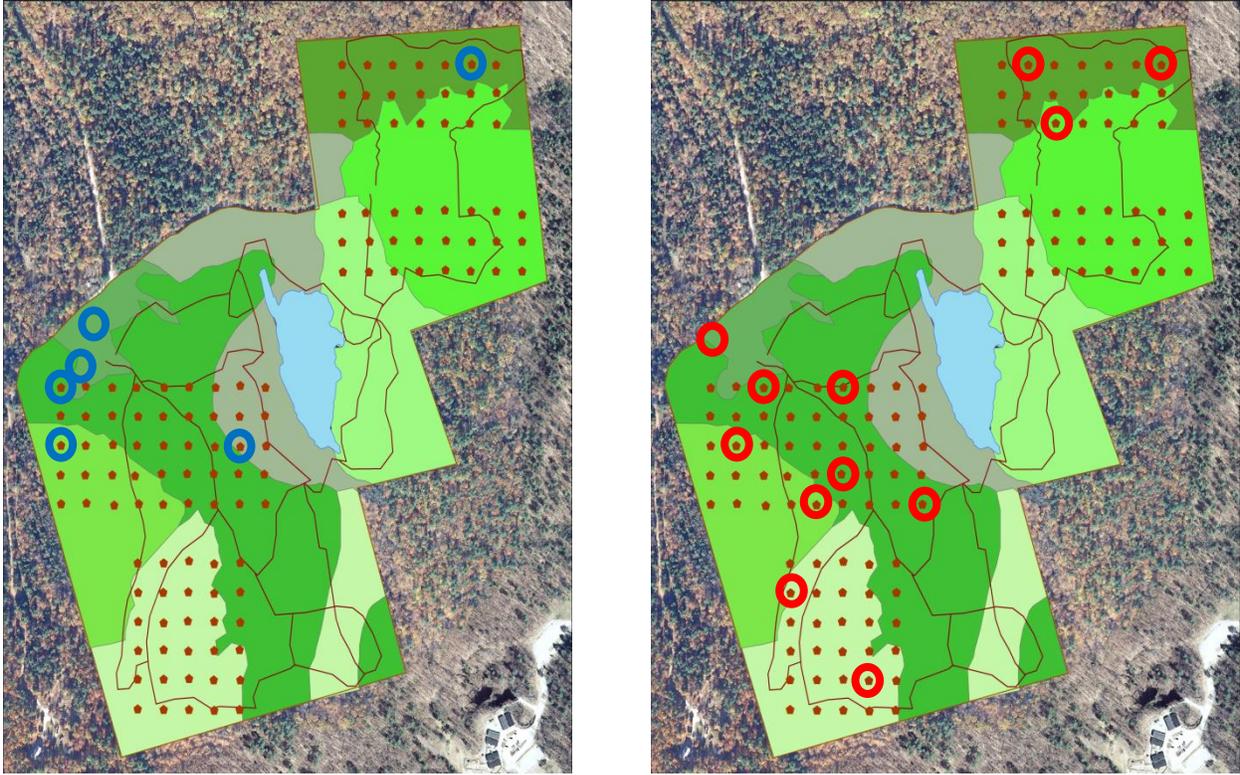


Figure 4. A comparison of successful and unsuccessful nest box locations for 2016. Successful boxes are circled in blue, and unsuccessful boxes are circled in red.

Individual	Nest Box 1 – 2015	Nest Box 2 – 2015	Nest Box 1 – 2016	Nest Box 2 – 2016
YY/Gx – Phaedra	A00	-	A1	-
OG/Bx – Dipper	A40	-	A19	-
RY/Lbx – David Bowie	14	-	A6	-
RB/Rx – Starr King	A27	-	A33	A26
Yr/Gx - Neville	A36	-	A45	-
RR/Rx – Morgan le Fey	D20	D14	-	-
OB/Gx - Sweetheart	D20	D14	-	-

Table 2. The color combinations and name of the banded BCCH that nested in a nest box at least 2 times between 2015 and 2016, including a pair that renested in 2015 but did not use a nest box in 2016.

Comparing the different forest types where the boxes are located, it should be noted that some boxes found in eastern hemlock/balsam fir, hardwood, and northern red oak/aspen forests were predated during both years of the study. However, in 2016, predated boxes were also found in the field, northern red oak/pine/mountain laurel, and pine/northern red oak/eastern hemlock forests. Additionally, all of the occupied boxes in the hardwood and northern red oak/pine/mountain laurel forests were predated in 2016, while there was an increase in the number of boxes predated in the oak/aspen forests (Figures 5 and 6).

It is assumed that most nest box predation that occurred in 2016 was not done by red squirrels. Red squirrels are a key predator of avian eggs and hatchlings in this area; however, the evidence left in the predated nest boxes was not typical of squirrel predation. Squirrels tend to leave behind nests that clearly have been disturbed, and frequently egg shell remnants are found. In all of the predated boxes except for one, the nests were completely intact and no shells or pieces of hatchlings were found. This points more towards an animal that eats or removes the eggs and hatchlings whole, such as a snake, flying squirrel, weasel, or house wren, and less towards an animal such as a squirrel, mouse or rat, or raccoon, that would leave pieces behind or would disturb the structure of the nest.

Comparing predated and unpredated nests, one hypothesis was proposed that would take into consideration the design of the nest box itself. The length of the roof on a nest box can either aid predators by being too short, or discourage predators when the length is long enough to disallow predators access to the cavity opening. Most of the nest boxes at the Rockwell Sanctuary range from 0.5 inches to 2.5 inches in length. The Cornell Lab of Ornithology Nest Watch program recommends a length of 5 inches to discourage predation³. Evaluating the lengths of predated versus non-predated boxes, there was no statistically difference in the lengths of the roofs, meaning that based on that factor alone, each box was just as likely as another box to be predated ($p = 0.10609$).

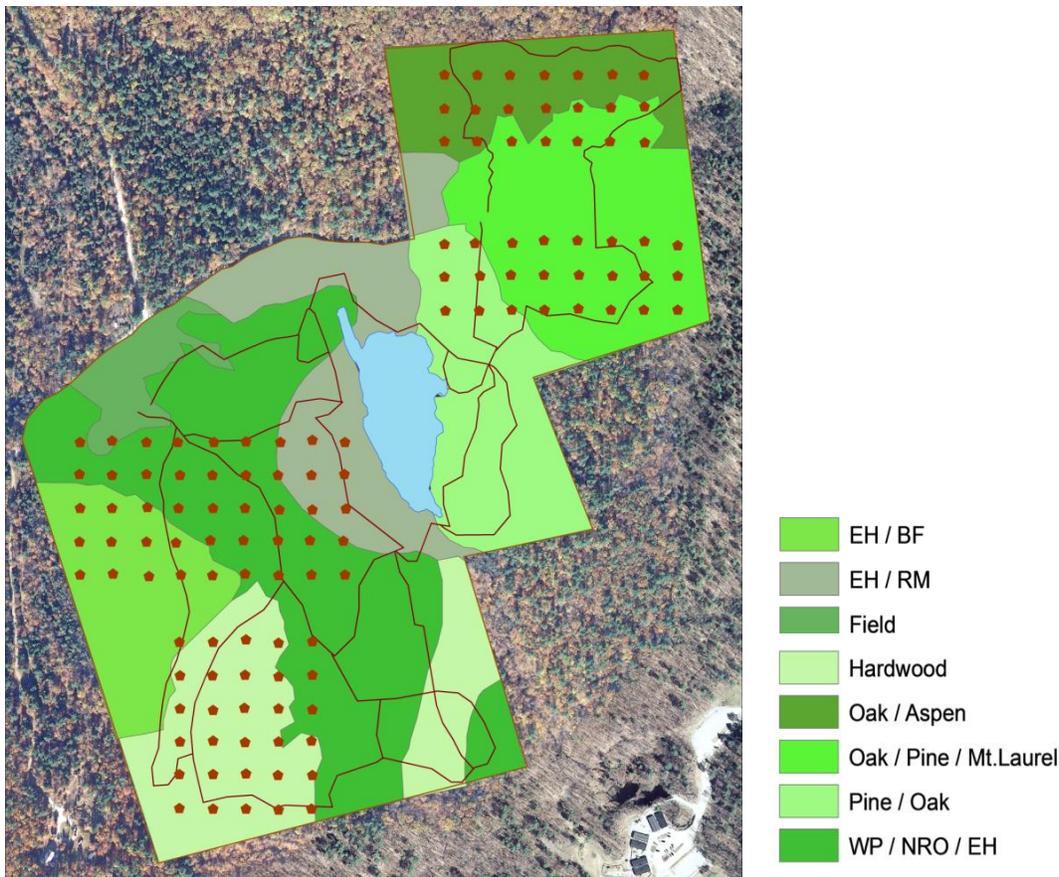


Figure 5. Forest cover type map of the Rockwell Sanctuary at Tin Mountain. Created in 2011 by Logan Cline, this map shows the dominant tree type present throughout the property, in relation to the location of 120 nest boxes. The remaining nest boxes are unmarked, and are placed on the edge of the field, creating a circle surrounding the nature center (unmarked).

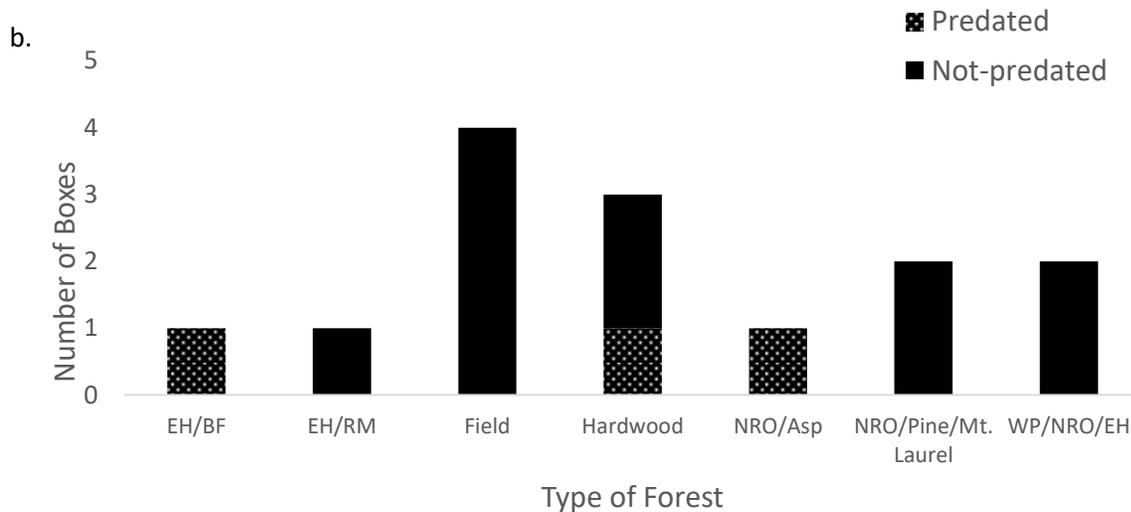
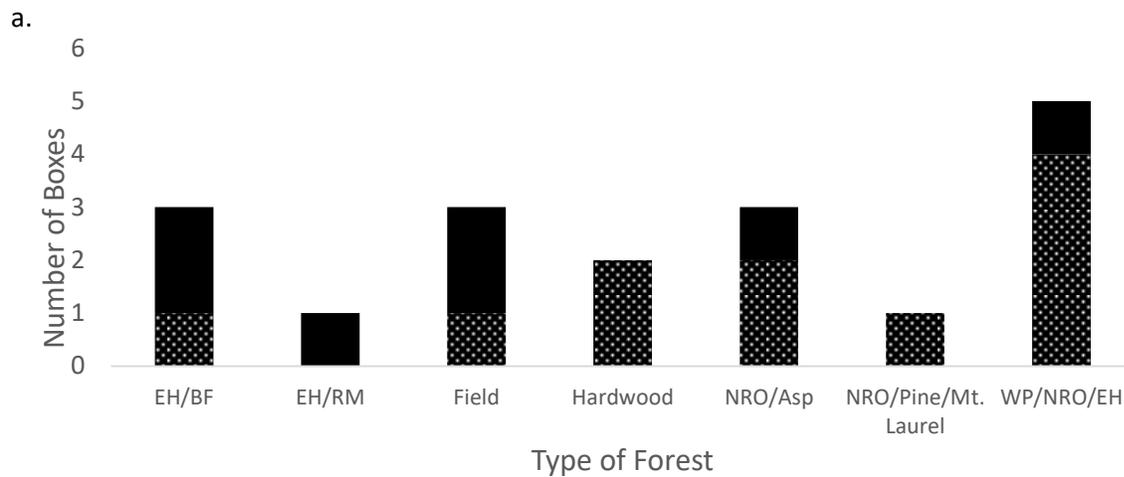


Figure 6 a. and b. a: A comparison of successful and non-successful nest boxes by forest cover type in 2016. b: A comparison of successful and non-successful nest boxes by forest cover type in 2015.

Mysteriously, no BCCH, or any other avian species, are using the boxes in the oak/pine/mt. laurel forests and in the pine/oak forests in the nest box grouping towards the northeast end of the property. Banded and unbanded BCCH have been spotted in that forest area during point counts and nest box checks, but have yet to show any interest in those boxes. This could be in part due to the typical breeding habitat for these species. BCCH are generally found in deciduous and mixed deciduous/coniferous forests, often near the edges, showing a liking for areas with large canopies of old trees. Thus, areas of heavy mountain laurel do not provide enough nesting cavities for BCCH, leading to the notion that BCCH may feed in these areas, but are not likely to breed. BCCH can also be found in disturbed areas, as long as there are adequate cavities provided by larger vegetation or artificial nest boxes; hence their affinity for nesting in the field².

However, overlaying the BCCH point count map and the nest box map, it is interesting to note that while BCCH are regularly seen or heard in areas of mountain laurel during point count surveys, their frequency of occurrence is not nearly as high as in other habitat types (refer to Figure 2 for reference).

Resights and Recaptures:

Using point count data starting in January 2015, a total of 115 BCCH have been heard or seen during the yearly surveys and have been identified as either banded or unbanded. Far more have been heard, but their banding status was undeterminable. Of those, 51 BCCH were banded and the remaining 64 BCCH were not banded. Using the Lincoln-Petersen estimator for population size, it was estimated that there are approximately 406 BCCH at the Tin Mountain Rockwell Sanctuary. However, this formula does not take into consideration the size of the property, the consistency, or lack thereof, of data recording, and individual effort, thus likely overestimating the number of BCCH residing on the sanctuary. While the formula uses the number of marked individuals, the total number of marked and unmarked individuals, and the number of marked individuals seen, it does not factor in behavioral differences, such as adjusting for the likelihood that some individuals are more likely to be resighted than others.

Nonetheless, using the resighting data is a necessity. It is possible to examine habitat use of the BCCH at Tin Mountain by analyzing their resight locations (Figure 7).

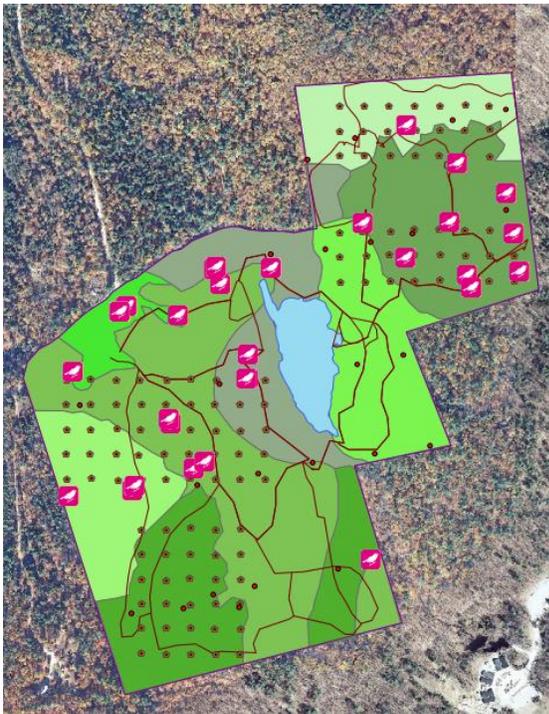


Figure 7. Map of the Tin Mountain Rockwell Sanctuary displaying where banded BCCH have been resighted during point counts from January 2015 through July 2016.

Combining our knowledge from Figures 2 and 6, it is evident that although BCCH are consistently being resighted in areas of heavy mountain laurel, they rarely are found to be nesting there. Areas of heavy northern red oak, pine, and mountain laurel on the south side of Bald Hill Road, in particular, have not had a single nest in the past 2 years. This is noteworthy as BCCH have been consistently seen and heard in that area during point counts and nest box checks. This gap between foraging and nest locations likely occurs as a consequence of the type of vegetation found in this part of the property. BCCH generally are found during breeding in areas of mixed deciduous/coniferous woodlands, and are generally more common near the edges of forests, often in areas that contain old trees with a large

amount of canopy cover². This breeding characteristic provides a simple explanation; the area in question simply does not contain the most advantageous habitat for BCCH.

It is also possible to factor in resights from feeder observations. Two feeders were set up at the nature center; one outside the library, and one outside the intern cabin. Since January, 2015, BCCH have been resighted at a feeder 520 times. The vast majority of these resights were of banded BCCH (481 of the 520 resights), but only 89 banded BCCH, out of the 180 total, have been seen at a feeder since banding. Combining the number of birds resighted in the field and at the feeders, a total of 96 differently banded BCCH have been seen via resights after the initial banding. Factoring this in, the Lincoln-Petersen estimator predicts a population size of about 373 BCCH (calculated by uses 96 as the number of marked individuals observed, and adding together the number of unbanded individuals seen in the field and at the feeder as the number of unmarked individuals seen).

Regarding recaptures, 32 different banded BCCH have been trapped by potter trap or mist net since color banding began, with a capture rate of 1.7 captures per banded BCCH. Of these, 14 have been recaptured at least twice, with a mean capture number of 2.7 captures per individual among those 14 birds.

Using the banding and recapture records, a banding trend can be observed. Many more banded BCCH are recaptured throughout the fall, winter, and spring than during the summer. However, a large number of new BCCH are banded in the summer, largely due to the number of nestlings being banded each year (Figure 8). Excluding the nestlings, far more BCCH are banded during the same period as the majority of the recaptures, indicating not only that these months are when BCCH become easier to catch, but also demonstrating an increase in banding and catching efforts (summer is generally when additional activities are required, resulting in a decreased amount of time spent trapping).

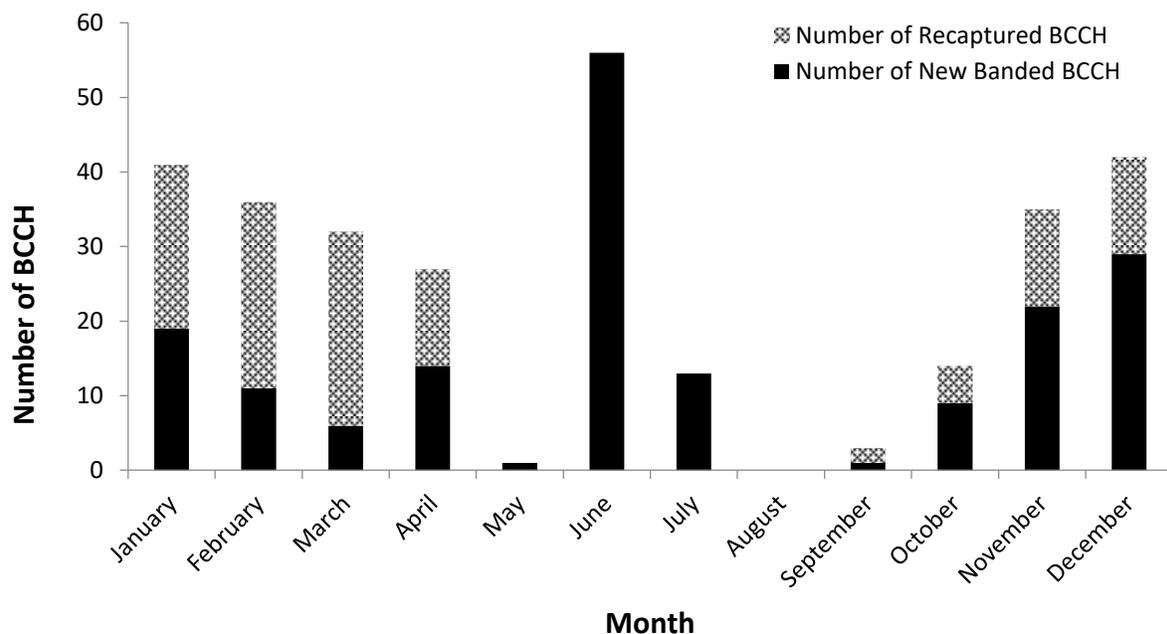


Figure 8. The number of BCCH banded and recaptured by month, beginning in 2012. Concentrated efforts did not start until October, 2014.

Recommendations for future years

In order to more appropriately estimate the population size of BCCH at the Rockwell Sanctuary, it is absolutely vital that BCCH are marked as banded or unbanded during point counts. Taking into consideration that it is not always possible due to distance from the point count station and the amount of foliage, it becomes extremely important that when a BCCH is seen, the recorder marks down that either it could not be seen, was banded, or unbanded. This allows for a more accurate count of banded and unbanded BCCH seen in the field, which would adjust the Lincoln-Petersen estimator for population size.

Additionally, nest box guards or baffles need to be installed on the nest boxes before the next breeding season. Predation was at an extremely high level in 2016, suggesting that the predator or predators learned that nest boxes provide easy access to food. This idea of nest boxes as a search image has been well documented in raccoons, and it is suspected that many other animals have the ability to distinguish this as well. There are several different types of baffles, or predator guards, which can be used. It is recommended that since the predator is not known after one season, a cone or cylindrical baffle is placed, as well as a metal cavity guard. It will also be important to use a trail camera on any occupied nest boxes 2017 to determine the predation type in order to allow for any appropriate adjustments in baffle types. Furthermore, lengthening the roofs on the nest boxes could prove valuable in preventing predators from gaining access to the nesting BCCH.

Finally, it is worth repeating that no banded BCCH nestlings have been resighted after fledging. If time allows in the future, it might be valuable to spend some time searching for BCCH off property. Most of the surrounding areas are heavily forested, providing the appropriate habitat for dispersing juvenile BCCH. It would be interesting to determine where the fledging BCCH go when leaving the property.

References

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²Foote, Jennifer R., Daniel J. Mennill, Laurene M. Ratcliffe and Susan M. Smith. 2010.. Black-capped Chickadee (*Poecile atricapillus*), *The Birds of North America* (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: <https://birdsna-org.bnaproxy.birds.cornell.edu/Species-Account/bna/species/bkcchi>.

³"All About Birdhouses." *NestWatch*. Cornell Lab of Ornithology. <http://nestwatch.org/learn/all-about-birdhouses/dealing-with-predators/>

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