Nest-Patch Characteristics of Bicknell’s Thrush in Regenerating Clearcuts, and Implications for Precommercial Thinning

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Abstract - Catharus bicknelli (Bicknell’s Thrush) is a rare and globally vulnerable songbird often found in regenerating clearcuts in the Canadian maritime provinces and Québec. Previous studies have shown correlations between vegetation characteristics and occurrence and abundance of this species, but no study has described vegetation associated with Bicknell’s Thrush nests in managed forests. From 2007–2010, we investigated nest-habitat selection of Bicknell’s Thrush in the industrial forestry landscape of north-central New Brunswick. We compared vegetation composition and structure in 5-m-radius patches around nests to vegetation in a random control-patch within the home range of each Bicknell’s Thrush. Precommercial thinning (PCT) is a forest-management treatment that may reduce the suitability of habitat for Bicknell’s Thrush, thus we also examined the percent of the landscape treated by this practice around Bicknell’s Thrush nests. We found that Bicknell’s Thrush preferentially selected nest sites with a significantly lower proportion of deciduous trees and higher overall tree density than randomly sampled habitat within their home range. We also found that an average of 44% of the area within 500 m of Bicknell’s Thrush nests was treated by PCT, and most had been treated within 3–5 years of our study. We suggest that small patches of dense, Abies balsamea (Balsam Fir)-dominated forest within a thinned matrix may be sufficient to provide nesting sites for Bicknell’s Thrush; however, it remains unclear if these areas support production of young or if they are population sinks. PCT could have serious negative consequences on Bicknell’s Thrush breeding success and on the long-term survival of the species in Canada; thus, we encourage silviculture treatments that leave unthinned areas for nesting of Bicknell’s Thrush in managed forests.

Introduction

Catharus bicknelli Ridgway (Bicknell’s Thrush) is a rare migratory songbird endemic to northeastern North America that breeds in high-elevation or foggy coastal areas dominated by dense, stunted Abies balsamea (L.) Mill. (Balsam Fir) (Rimmer et al. 2001). Bicknell’s Thrush is globally listed as vulnerable (IUCN 2013), and is federally listed as threatened in Canada (COSEWIC 2009). At the northern periphery of its breeding range (New Brunswick, Québec, Nova Scotia, Canada; Maine, US), Bicknell’s Thrush is also found in industrial forestland (COSEWIC 2009). Bicknell’s Thrush breeding habitat is found at lower elevations here than elsewhere.

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in its New England breeding range (although still high elevation for this region) and it is composed of younger trees, usually with a high proportion of *Betula papyrifera* Marsh. (White Birch), particularly in New Brunswick (Chisholm and Leonard 2008, Nixon et al. 2001, Ouellet 1993). In managed forests in New Brunswick, the spatial distribution of young forest is related primarily to patterns of clearcutting, after which there is rapid and dense regeneration of Balsam Fir and White Birch.

Nixon et al. (2001) studied abundance and occurrence of Bicknell’s Thrush in regenerating clearcuts in the highlands of New Brunswick, and found that survey points where they detected Bicknell’s Thrush were dominated by White Birch at a stem density similar to that found at unoccupied points. Bicknell’s Thrush is strongly associated with high stem-density and dominance of Balsam Fir in New England and Québec (Aubry et al 2011, Connolly et al 2002, Rimmer et al. 2001). It is unclear whether these regional differences are biologically significant for breeding Bicknell’s Thrush, i.e., whether subtle differences in vegetation association are related to differences in breeding success or survival. At the northern edge of its range in New Brunswick, Canada, Bicknell’s Thrush nest density is 16 pairs per 100 ha (Nixon et al. 2001), whereas at the southern part of the breeding range on Mt. Mansfield, VT, nest density is about 104 pairs per 100 ha (Rimmer et al. 1996), suggesting that productivity or survival of individuals in New Brunswick may be lower than in Vermont or that the second-growth habitat in New Brunswick is marginal.

Management recommendations for species at risk often use density or abundance to indicate habitat quality; however, habitat-selection studies (such as nest-site selection) can identify features of particular importance for a given species. Nest microhabitat, the specific assemblage of biotic and abiotic features immediately around the nest, is strongly linked to patterns of nest predation, which is a major factor in birds’ reproductive success (Martin 1998, Rangel-Salazar et al 2008). Nest-site vegetation associations of Bicknell’s Thrush have been studied in Vermont and Québec (summarized by Rimmer et al. 2001), but the composition and management history reported in these studies differed from the industrial forestlands in New Brunswick where Bicknell’s Thrush occurs. More information on habitat selection of Bicknell’s Thrush in New Brunswick’s industrial forests, particularly in terms of nest-site selection, is needed to inform management practices.

In New Brunswick, Bicknell’s Thrush is found mostly in regenerating clearcuts that are at the target tree-density for a management practice known as precommercial thinning (PCT). PCT involves manually reducing the stem density of regenerating stands approximately 10–15 years after clearcutting, or from 40,000 stems/ha down to ≈6000 stems/ha, in order to promote the growth of residual trees. Chisholm and Leonard (2008) found that Bicknell’s Thrush was most abundant in the pre-thinned stands—those that had been clear-cut 11–13 years before, and were of sufficient stem density and height to undergo PCT. Because of safety concerns, foresters avoid areas with large dead snags, boulders, steep grades, or standing water during the thinning process. This practice results in many small, unthinned patches throughout thinned forest stands. Bicknell’s Thrush has been found to use patches as small as 0.1 ha on Vermont ski areas (Rimmer et al. 2004) and may also
use these unthinned patches for nesting. Bicknell’s Thrushes are not edge-averse (Aubry et al. 2011), and may nest in small patches of forest or within 50 m of a forest edge (Rimmer et al. 2001). Demonstration of successful Bicknell’s Thrush nesting in these fragments may provide an important tool for forest management because forest managers could ensure that unthinned patches are retained in forests where Bicknell’s Thrushes have been detected.

The goals of this study were to: 1) describe characteristics of Bicknell’s Thrush nest patches in regenerating clearcuts in New Brunswick; and 2) to determine if Bicknell’s Thrush nests in stands after PCT treatment.

**Field-site Description**

We located and monitored Bicknell’s Thrushes and nests in the Christmas Mountains region of Northumberland County, in north-central New Brunswick, Canada (47º15'47.1''N, 66º32'56.62''W). For our study stands, we chose forest patches on Crown land leased to UPM-Kymmene Miramichi, Inc., that were accessible by gravel logging-road. Active silviculture operations occurred in 2007, but UPM-Kymmene Miramichi, Inc. ended its lease of the land, and by 2008, only minimal logging or other silvicultural treatments occurred in this region from 2008–10. Our focal stands were of similar management history, age, elevation, and tree-species composition; all stands were 10–15 years post salvage-harvest or clearcut, at least 600 m in elevation, and dominated by Balsam Fir and White Birch. All sampled stands were on public land, and we chose them based on published accounts of Bicknell’s Thrush occurrence in this region (Chisholm and Leonard 2008, Nixon et al. 2001) and initial surveys for Bicknell’s Thrush in 2007. To determine the impact of tree-thinning on nesting, we selected 6 focal stands that were at a sufficient stem density to be treated by PCT and where Bicknell’s Thrush was detected in 2007. Of these 6 stands, 3 were scheduled for PCT after the 2007 breeding season.

**Methods**

From June to July 2007–2010, we used 2 techniques to find active Bicknell’s Thrush nests. We used arrays of eight to fourteen 12-m-long mistnets (34- or 36-mm mesh) to catch Bicknell’s Thrushes, and we fitted female thrushes with 0.75-g radio-transmitters (model BD-2, Holohil Systems, Inc., Carp, ON, Canada) using a string harness (Rappole and Tipton 1991) during incubation so that we could locate nests (Goetz et al. 2003, Powell et al. 2005). We banded all individuals of both sexes using uniquely numbered metal leg bands and a unique series of 3 plastic color-bands. The University of New Brunswick’s Animal Care Committee reviewed and approved all protocols. We also made systematic searches of stands to find nests, focusing near areas with Bicknell’s Thrush activity, e.g., singing and calling.

We monitored activity at nests by visual inspections every 2–3 days, or by remote video-camera recordings. We installed semi-permanent video-camera mounts as far from the next as possible (3–5 m), while still being able to see the rim of the
nest. This arrangement allowed us to set up and remove video cameras quickly, limiting disturbance of the nest. The camera mount was waterproof and camouflaged. We used Sony DCR-SR45 hard-drive-disk camcorders, with extended batteries, to record the nests continuously for six to seven hours. After each nest fledged or failed, we recorded tree density, tree species, and tree diameter in a 5-m-radius circle (78.5 m²) centered on each nest. We chose 5-m-radius patches to be consistent with other descriptions of Bicknell’s Thrush nest-patch vegetation and the Breeding Biology Research and Monitoring Database (Martin et al. 1997). Congruent with the protocol of Nixon et al. (2001), we defined trees as any woody stem at least 50 cm tall; thus, we measured diameter at 10 cm above the ground instead of at breast height to accommodate the many small trees. We assigned trees to one of 3 diameter categories: <2.5 cm (small), 2.5–5 cm (medium), >5 cm (large). We collected the same vegetation measurements at a non-nest point, located 100 m in a random cardinal direction from each nest. If the randomly chosen control-patch was in a road or a different stand, we selected another random compass direction to keep all patches within the same stand, and thus, the same historical management regime. Assuming non-nest patches were within the home range of a female Bicknell’s Thrush (Rimmer et al. 2001), they represented sites in which Bicknell’s Thrush might occur but which were not chosen as nest sites during our study. Average female home-range size varies between 2.33 ha in Vermont (Rimmer et al. 2001) to 13.9 ha in Quebec (Aubry et al. 2011). Thus, our control patches were well within a female’s territory based on either estimate of home range size, and our focal patches accounted for less than 1% of the area that a female might use.

We combined tree-counts at each patch (nest and control) into biologically meaningful variables based on a priori knowledge of vegetation associations of Bicknell’s Thrush: tree density (trees/m²); proportion Balsam Fir in each size class; proportion deciduous trees (including White Birch, Prunus pennsylvanica L.f. [Pin Cherry], and Sorbus americana Marsh. [(Mountain-ash]); total number of snags; and density of large trees. Proportion data were arcsin-transformed (Quinn and Keough 2002). We compared nest patches and non-nest patches using generalized linear modelling with binomial-error structure (Crawley 2007) to determine which characteristics were associated with nests, and compared the full model with all habitat variables to reduced models using Akaike’s information criterion (AIC) to determine the most appropriate model. All statistics were calculated using the software package R (R Development Core Team 2011). Where applicable, we report measurements as means ± standard error.

To determine use of stands treated by PCT, we searched for nests in stands before and after treatments (search area ≈50 ha). In 2008, when we did not find any nests within stands treated by PCT, we examined three buffer zones (100 m, 500 m and 1 km) surrounding Bicknell’s Thrush nests to determine how much PCT-treated forest was nearby. These buffers approximated the area of a female Bicknell’s Thrush home range in Vermont, a cluster of home ranges (typical of the breeding system of this species), and the average annual dispersal distance of a female Bicknell’s Thrush, respectively (Rimmer et al. 2001). Using ArcGIS
we calculated the area of thinned forest within each buffer.

Results

We found 12 Bicknell’s Thrush nests (3, 6, 2, and 2 during 2007–2010, respectively). We confirmed all nests as Bicknell’s Thrush nests, and not nests of the very similar *Catharus ustulatus* (Nuttall) (Swainson’s Thrush), by either radio-telemetry of the female, or by examination of color digital video-recordings from cameras temporarily set up at the nest. We found 11 nests in unthinned stands and 1 in a strip-cut stand. Mean (± SE) tree-species composition at Bicknell’s Thrush nest patches was: 64.9 ± 18.7% Balsam Fir, 22.3 ± 5.8 % White Birch, 9.1 ± 2.8 % dead trees (snags), 2.7 ±1.1% Mountain-ash, and <1% *Picea* spp. (spruce) and Pin Cherry combined. Percent deciduous trees and percent White Birch were positively correlated ($r = 0.88$) because White Birch was the dominant deciduous species in our study area; therefore, we retained only percent deciduous trees in our model because it represented more trees in the patch. The most abundant tree species in Bicknell’s Thrush nest patches was Balsam Fir, with all other species combined occupying less than 50% of the total number of trees in the patch (Fig. 1).

The best model describing Bicknell’s Thrush nest patches compared to non-nest patches retained only two vegetation variables: total tree density in the patch (model estimate = 0.38 ± 0.19, $P = 0.049$) and proportion deciduous trees in the patch (estimate = -4.15 ± 2.04, $P = 0.042$). Mean (± SE) total tree density was 6.37

![Figure 1. A bar plot of percent vegetation composition of the 5-m-radius control ($n = 12$) and nest patches ($n = 12$) of Bicknell’s Thrush in the Christmas Mountains, NB, Canada showing the top categories (>99% of the patch): deciduous trees (primarily White Birch, with small amounts of Mountain-ash and Pin Cherry), Balsam Fir, and snags. The only other tree species present but not shown here was *Picea* spp. (Spruce), which accounted for <1% of all trees counted. Vertical lines show standard error.](image)
± 0.8 stems per m² at Bicknell’s Thrush nests and 4.41 ± 0.8 stems per m² at control patches. The proportion of deciduous trees at Bicknell’s Thrush nests was about half that in control patches (25.46 ± 6.15% and 48.04 ± 8.34%, respectively; Fig. 1). Although this variable was not retained in the final model, there were more snags at Bicknell’s Thrush nests than in control patches (mean = 35 ± 12 snags at nests and 10 ± 5 snags at control patches, respectively; P = 0.97; Fig. 1).

PCT stands in our study were not treated equally because of a change in operating practices of UPM-Kymmene, Inc.; only one stand was fully thinned. The 2 other experimental stands were 70% thinned and strip-cut, respectively (Fig. 2). Control stands remained unthinned, as planned. We detected Bicknell’s Thrush in unthinned stands during both years, suggesting nests were present both years (although we only documented nesting in 2007).

We detected Bicknell’s Thrushes singing throughout the 2008 breeding season in one experimental stand that received a complete PCT treatment after the 2007 breeding season. We found no nests within this stand, despite 18.5 hours of intensive searching in 2008. However, we found a Bicknell’s Thrush nest in an adjacent, small unthinned stand (Fig. 3). The female at this nest was the same individual that had nested in the experimental stand in 2007, prior to PCT.

One stand was approximately 70% thinned prior to the 2008 breeding season; however, a large area of the stand was left unthinned (due to a steep grade). During ≈60 h of surveys in this stand, we did not detect Bicknell’s Thrush vocalizations in the thinned area (where birds had been detected in 2007). In the unthinned area, we consistently observed Bicknell’s Thrushes singing and calling throughout the breeding season. We captured 4 individuals upslope, 2 of which were recaptures from 2007, and we found 1 nest in the unthinned section.

In the fall of 2007, one experimental stand was cut in strips approximately 2 m wide, spaced at 2- to 4-m intervals throughout the stand, leaving dense strips of trees between cut strips (Fig. 2C). This process allowed forestry operators to walk into the stand to thin out the remaining strips using hand-held thinning saws. In 2008, we detected Bicknell’s Thrushes singing in this stand and we found an active Bicknell’s Thrush nest on the edge of a cut strip. We also heard Bicknell’s Thrushes vocalizing in an adjacent stand that had been thinned in 2004 and was the same age and had the species composition as the experimental stand.

We used the locations of nests found in 2007 and 2008 to analyze nest location relative to PCT (n = 6, not including re-nests of the same females). On average, 44% (range = 29–76%) of the area within 500 m of each nest patch had been treated by PCT since 1994 (13–14 years before our study). Within 100 m, only 2 nest patches contained thinned forest (29 and 42% thinned, respectively). Eighty percent of the all thinned stands within 1 km of each nest had been treated within 3–4 years prior to our study.

**Discussion**

Bicknell’s Thrush nest-patches were significantly different from non-nest patches in that they had higher tree-density, and fewer deciduous trees. Bicknell’s
Thrush nested in patches superficially similar in appearance to krummholz habitat at very high elevation (>900 m asl) in their New England breeding range (Rimmer et al. 2001), with abundant small Balsam Fir at high stem density. At our study

Figure 2. Forestry treatment types in Bicknell’s Thrush habitat in north-central New Brunswick, Canada. A) Untreated, regenerating clearcut, composed primarily of Balsam Fir; note the large White Birch snags present from the time the original stand was cut. B) Forest after pre-commercial thinning. Note the residual Balsam Fir trees and cut debris left on the ground. C) Strip-cut treatment, in which 2-m-wide strips were cut through dense stands of regenerating Balsam Fir, leaving approximately 2-m-wide strips between each cut. In this treatment, the cut trees were completely removed from the site, in contrast to B. The results of strip-cutting in dense stands are dramatic, and are visible on 2013 Google Earth maps of the region.
sites, Balsam Fir were small because of their young age, rather than from stunting effects of harsh high-elevation climate; thus, Bicknell’s Thrushes likely inhabit only relatively young forests in this region. Forest-age differences could explain

Figure 3. Locations of two nests of the same female Bicknell’s Thrush before (2007) and after pre-commercial thinning (PCT) (2008), shown by solid black dots. Open circles are control patches 100 m away from nest patches within the same stands (shown connected by dashed black lines). This individual bird moved approximately 280 m to an unthinned area (unshaded) after her 2007 nest site from the year before was treated by PCT. All shaded patches above are stands treated by PCT; small numbers indicate year of treatment, i.e., 04 = 2004. Unshaded areas are unthinned forests and roadsides. Thin gray lines are secondary logging roads. Note that unthinned patches are present around stand edges and at roadsides.
why stem density at nest patches in our study was greater than density reported for Bicknell’s Thrush in Vermont (6.4 ± 0.8 trees/m² compared with 2.1 ± 1.4 trees/m², respectively) (Rimmer et al. 2001). Throughout its breeding range, Bicknell’s Thrush uses Balsam Fir as its primary nest substrate (Rimmer et al. 2001); therefore, the abundance of Balsam Fir at our study sites suggests that suitable nest trees are plentiful in this region.

We found evidence that Bicknell’s Thrush selects against deciduous trees for nest patches. In New Brunswick, Nixon et al. (2001) found that White Birch was associated with occupied sites in New Brunswick more often than unoccupied sites (Table 1). In our study, nest patches had only half as many deciduous trees (25% of all trees) as the control non-nest patches (48% of all trees; Fig. 1). Our data illustrate that assessments of vegetation associations differ when measured at points where individual birds are detected (e.g., Nixon et al. 2001) and at the nest (this study) (Table 1). Our data from nest patches add important information to our understanding of vegetation associations used for nesting by Bicknell’s Thrush in a managed forest, and provide information that can be used to assess habitat quality and abundance for Bicknell’s Thrush in this region, and possibly other industrial forestland where Bicknell’s Thrush occurs, such as in Nova Scotia and in Québec. Balsam Fir-dominated forests at high elevation with patches of very high stem density (6.4 ± 0.8 trees/m²) and 25% or less deciduous trees would provide nest habitat similar to that used by Bicknell’s Thrush in this study.

Birds such as Bicknell’s Thrush that nest in young, dense forests, may compensate for changes in forest structure caused by PCT by selecting non-treated

Table 1. Comparison between vegetation associations measured by Nixon et al. (2001) at aural survey points where Bicknell’s Thrushes were detected vocalizing (n = 57 occupied points), and in this study at nest patches (5-m-radius circle centered on the nest), and at non-nest patches located 100 m away from a nest (n = 12 each). Densities represent trees/m². Where possible, all measurements are reported as means ± standard error.

<table>
<thead>
<tr>
<th>Habitat variable</th>
<th>Nest patch</th>
<th>Non-nest patches</th>
<th>Nixon et al. 2001</th>
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</thead>
<tbody>
<tr>
<td>% occupied nest-points with higher numbers of deciduous stems than coniferous stems</td>
<td>17</td>
<td>50</td>
<td>89</td>
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<tr>
<td>Most abundant tree species at occupied nest sites</td>
<td>Balsam Fir, White Birch, Mountain-ash</td>
<td>White Birch, Balsam Fir, Pin Cherry</td>
<td>White Birch, Balsam Fir, Pin Cherry</td>
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<td>% White Birch</td>
<td>22.3 ± 5.8</td>
<td>48.0 ± 8.4</td>
<td>45.0 ± 3.1</td>
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<td>% Balsam Fir</td>
<td>64.9 ± 18.7</td>
<td>47.6 ± 7.6</td>
<td>24.0 ± 2.8</td>
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<tr>
<td>% Pin Cherry</td>
<td>0.4 ± 0.22</td>
<td>5.1 ± 2.2</td>
<td>22.4 ± 2.7</td>
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<tr>
<td>% Mountain-ash</td>
<td>2.7 ± 1.11</td>
<td>2.2 ± 0.6</td>
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<tr>
<td>Total tree density</td>
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<td>4.4 ± 0.9</td>
<td>3.8 ± 0.3</td>
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<td>% small trees</td>
<td>64.9 ± 4.4</td>
<td>73.0 ± 6.1</td>
<td>&gt; 70.0</td>
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<td>Density of large trees</td>
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<td>Density of large Balsam Fir</td>
<td>0.5 ± 0.1</td>
<td>0.2 ± 0.1</td>
<td>0.1 ± 0.02</td>
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</tbody>
</table>

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patches for breeding or foraging (Easton and Martin 2002, Hayes et al. 2003). In thinned stands, there are always small forest patches left after thinning (Chisholm and Leonard 2008; E.A. McKinnon, pers. observ.). Because New Brunswick supports extensive even-aged forests, there are often nearby stands of a young age and high density that have not yet been thinned. Our observations of Bicknell’s Thrush nesting in a very small unthinned stand (Fig. 3) and in a strip-cut stand (Fig. 2C) suggest that the species can adapt to PCT treatment by selecting unthinned patches or adjacent unthinned stands for nesting. This finding is also supported by evidence from Chisholm and Leonard (2008) that Bicknell’s Thrush abundance post-PCT is correlated to the area of unthinned patches remaining after treatment. A radio-tracking study of adult Bicknell’s Thrushes suggested that birds are not edge-averse (Aubry et al. 2011), despite their selection of habitat with high stem-density. Thus, retention of small patches of densely wooded habitat may be valuable to preserve nesting habitat for Bicknell’s Thrush when forest managers require PCT to increase tree yield in industrial forest lands. However, although Bicknell’s Thrush nesting in these remnant stands has been demonstrated, productivity has not been studied. All nests we found in unthinned patches were active, but we did not have enough detailed information on nest fates to make conclusions about productivity in relation to nest-patch vegetation or management regimes. Exactly how much unthinned forest would provide sufficient nesting habitat for Bicknell’s Thrush is unclear and likely complicated by the mosaic of forest types, silvicultural treatments, and management history of all the stands in the area.

Populations of Bicknell’s Thrush at our study site in north-central New Brunswick have declined by 11.5% annually since 2002 (Campbell and Stewart 2012). As with many migratory birds, causes of these declines are unknown, but may be at least partially attributable to habitat loss on the Greater Antillean wintering grounds (McFarland et al. 2013). However, a small geographic range and small breeding populations of Bicknell’s Thrush in the Maritimes mean that populations in this region are particularly vulnerable to threats at breeding sites; small island populations in this region have recently been extirpated (COSEWIC 2009). PCT or strip-cutting could have serious negative consequences on breeding Bicknell’s Thrush and for the long-term survival of the species in Canada, thus we encourage silviculture treatments that leave unthinned patches for nesting of Bicknell’s Thrush in managed forests.

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