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Ecology and Demography of Bicknell's Thrush on East Mountain, East Haven, Vermont: Evaluating Potential Impacts of Wind Turbine Construction

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Abstract. – To establish baseline, preconstruction data for evaluation of the possible effects of wind turbine construction on montane forest bird populations on East Mountain in East Haven, Vermont, we conducted field studies in June and July of 2004. Focusing on Bicknell's Thrush *(Catharus bicknelli)*, our primary research objectives were to: (1) estimate population size and density; (2) estimate demography and survivorship by sex and age class; (3) document reproductive success; and (4) spatially analyze adult thrush home range size, movement patterns and behavioral ecology. Our censusing and nest monitoring encompassed all avian species, while our mist-netting and banding targeted Bicknell's Thrush, Swainson's Thrush *(Catharus ustulatus)*, Yellow-rumped Warbler *(Dendroica coronata)*, and Blackpoll Warbler *(Dendroica striata)*. Overall, we mist-netted and banded 198 individuals of the four target species, a capture rate of 8.9 new birds/100 net hours. We banded 10 male and 8 female Bicknell's Thrushes. We monitored 3 radio-tagged female Bicknell's Thrushes for the duration of the study period and calculated widely varying home ranges of 2.3 – 11.3 ha for each. Four of 7 radio-tagged females were depredated, probably by short-tailed weasels, within 1-5 days of release. We monitored a total of 12 active nests of 5 species; of 11 nests whose outcomes were known, 8 (73%) were successful. Our sample included 4 nests of 3 female Bicknell's Thrushes; 2 of these nests fledged young. We detected a total of 135 individuals of 16 avian species on two census dates, for a mean of 9.6 birds per point count. The suite of species was very similar to that found on other Vermont peaks, with the exception of 3 species typically restricted to lowland spruce-fir forests in the Northeast Kingdom: Black-backed Woodpecker *(Piciodes arcticus)*, Gray Jay *(Perisoreus canadensis)*, and Boreal Chickadee *(Poecile hudsonica)*. We estimate that as many as 18-20 individual male Bicknell's Thrushes and 10-12 females may inhabit the full extent of suitable montane fir-spruce habitat on East Mountain. Our 2004 field work, while limited in scope and duration, provides a solid foundation for future research and monitoring.

Introduction

A proposed wind turbine project on East Mountain in East Haven, Vermont is the first such development targeted for montane spruce-fir forests of Vermont. An existing wind power facility in Searsburg, Vermont also supports this natural community type, but it is less well-developed and occurs at considerably lower elevations. While recent concerns have surfaced over the potential threat to birds from the construction and operation of wind energy projects, most studies have focused on avian mortality from collisions with turbines (see review in Erickson et al. 2001). Few studies have addressed potential risks to local breeding populations, especially at proposed turbine sites in northeastern North America (but see Young et al. 2004). Further, no rigorous impact assessments have been conducted in high elevation habitats of the Northeast. The region's montane forests constitute a unique, limited habitat that supports a distinctive assemblage of breeding birds. The combination of chronic airborne pollution, fragmentation from human development, and impending climate change make this restricted habitat one of the most threatened forest types in eastern North America (e.g., Johnson et al. 1992, Rimmer et al. 2001, Lambert et al. *in press*). The proposed East Haven Wind Farm project presents a unique opportunity to assess potential impacts from construction activities and turbine operation on East Mountain's montane forest breeding bird community.

Bicknell's Thrush *(Catharus bicknelli)* is an obligate montane forest specialist and one of the most rare, range-restricted breeding species in eastern North America. Considered the Neotropical migrant species of highest conservation concern in the northeastern United States (Pashley et al. 2000, Rimmer et al. 2001), Bicknell's Thrush is classified as globally "vulnerable" by the International Union for the Conservation of Nature (BirdLife International 2000). In Vermont, the species is listed as "Special Concern". Concerns for the conservation status of Bicknell's Thrush by the Vermont Fish and Wildlife Department, combined with a paucity of knowledge about its susceptibility to wind turbine development, suggested that Bicknell's Thrush would be an appropriate focal species for a detailed risk assessment of the proposed EHWF. While the species' ecology and demography have been well-studied on Vermont ski areas (Rimmer et al. 2004), little information is available from existing or proposed wind turbine sites.

Previous field work conducted by the Vermont Institute of Natural Science (VINS) and by Curry and Kerlinger, LLC documented the occurrence of Bicknell's Thrush in the proposed EHWF project area (C.C. Rimmer, unpubl. data; Lambert et al. 2001; Kerlinger and Dowdell 2003). While the mountainwide population has not been either censused or estimated, VINS field staff mist-netted and banded six males on the ridgeline in June of 2000 (C.C. Rimmer, unpubl. data), while Kerlinger and Dowdell (2003) estimated seven "territories" on the basis of individuals detected during point counts in June of 2003. These findings provide a crude abundance index but reveal little about the total population size, demographics, or breeding status of Bicknell's Thrush on East Mountain. Such data are necessary to assess impacts of the proposed development on Bicknell's Thrush and can be obtained only through intensive field study. VINS contracted with VFWD during June and July of 2004 to begin a 3 to 4-year risk assessment study. This report presents our preliminary findings.

Study Area and Methods

A team of three VINS seasonal biologists and two VINS Conservation Biologists met VFWD Biologist Everett Marshall on the East Mountain summit on 14 June 2004 to begin field work. A mobile trailer (Figure 1) served as our headquarters during the following seven weeks, during which time field staff were on site a minimum of five days per week. Field work terminated on 30 July. Our original plans to conduct research on a replicate "control" site such as Seneca or Gore Mountains were postponed until 2005, due to constraints of time and qualified field personnel.

Primary research objectives on East Mountain during 2004 were to collect baseline, pre-construction field data that would enable us to: (1) estimate population size and density of Bicknell's Thrushes, using mark-recapture analyses via mist-netting and distance sampling; (2) estimate thrush demography and survivorship by sex and age class, using mark-recapture analyses; (3) document reproductive success, using nest monitoring; and (4) spatially analyze adult home range size, movement patterns and behavioral ecology, using radio telemetry. Our censusing encompassed all avian species, while our mist-netting and banding targeted Bicknell's Thrush, Swainson's Thrush *(Catharus ustulatus)*, Yellow-rumped Warbler *(Dendroica coronata)*, and Blackpoll Warbler *(Dendroica striata)*.

Mist-netting and Banding. – The first week of field work was dominated by training of field staff, familiarization with the study site, and establishment of a mist-netting regime. Beginning on the evening of 14 June, we operated arrays of 15-25 12- and 6-m mist nets on a daily basis. Nets were often operated simultaneously on two areas of East Mountain, with 1-2 people checking each array every 30-45 minutes. We typically opened nets from dawn through late morning and from late afternoon until dusk during periods of suitable weather. Sampling effort (hours of operation/12 m mist net) was recorded daily. Net locations extended along nearly 1 km of the access road and in several areas of suitable habitat away from the road (Figure 1). Net arrays were usually operated for 2-3 consecutive days at each location before being moved to another location; each discrete netting area was sampled 2-3 times during the 7-week field season. We used both passive and target netting to capture Bicknell's Thrushes. Target netting involved using broadcast elicitations of thrush vocalizations to lure birds into nets; this took place both within and outside of standard net arrays.

All mist-netted individuals of the four target species were banded and processed inside the trailer (Figure 1). Most birds were released from this site, although incubating and brooding females were returned to the point of capture for release. All captured birds were banded with a U.S. Fish and Wildlife Service aluminum leg band, a unique combination of 3 plastic color leg bands. Age was determined using plumage criteria, while sex of individuals in breeding condition was determined by the presence of a cloacal protuberance or brood patch (Pyle 1997). We further aged Bicknell's and Swainson's thrushes as second-year (SY) or after second-year (ASY) by outer rectrix shape (Collier and Wallace 1989) and/or the presence of terminal buffy streaks or spots on any greater coverts (Pyle 1997). The following additional data were recorded: (1) body weight to the nearest 0.1 g, (2) subcutaneous (beneath the skin) fat class, (3) unflattened wing length to the nearest 0.5 g, (4) tail length to the nearest 0.5 g, (5) tarsus (lower portion of the leg above the foot) length to the nearest 0.01 mm, (6) exposed bill length to the nearest 0.01 mm, (7) bill length from anterior (front) edge of nostrils to tip to nearest 0.01 mm, bill width and depth from anterior edge of nostrils to tip, (8) extent of flight feather or body molt, (9) time of banding, and (10) capture site.

To examine mercury concentrations in Bicknell's Thrush, we collected a 30-50 µl blood sample from the cutaneous ulnar (brachial) vein of each newly-captured adult in a heparinized capillary tube. Samples were immediately frozen until contamination analyses were conducted. We collected both fifth secondary wing feathers from most birds by clipping the calamus (quill) close to its insertion point; these were stored in glassine envelopes prior to Hg analyses. Both blood and feather samples were analyzed by element-specific cold vapor atomic absorption at Texas A&M Trace Element Research Laboratory, College Station, Texas. We compared data from 2004 to those collected from 6 male Bicknell's Thrushes on East Mountain in June of 2001.

Radiotelemetry. – We placed 1.2 g radio transmitters (Holohil Systems model BD-2) with a battery life of 60 days on all captured adult female thrushes, using a backpack harness attachment (Rappole and Tipton 1991). We relocated radio-tagged individuals at least once daily with Wildlife Materials TXR-1000 receivers and 3-element, hand-held Yagi antennas, using homing techniques (White and Garrot 1990). Homing locations were determined by quietly approaching individuals to visually pinpoint their location and/or by identifying vocalizing individuals. Locations were plotted on handheld GPS units, and observers ranked point accuracy

on a 0-3 scale (0 = exact [bird seen or heard], 1 = <10m, 2 = 11-25m, 3 = >25m radius). We were unable to radio-track any male thrushes, due to the unavailability of an adequate supply of transmitters from Holohil Systems.

For analysis of telemetry data, we defined a breeding home range as the area used by an individual female from the date of capture until termination of her nest in each season. We determined home range size and location using the non-parametric kernel method (Worton 1989) calculated with ArcView 3.2 (ESRI 1999) and Animal Movement Analyst 2.04 (Hooge and Eichenlaub 1997). We used a fixed kernel with the smoothing factor determined by least-squares cross-validation (Seaman and Powell 1996, Seaman et al. 1999). We calculated the 95% (area the bird actually used), 75%, and 50% contours (core area of activity) for individuals with a minimum of 30 locations (Seaman et al. 1999). Locations of individuals known to be incubating or brooding on nests were included in our home range calculations.

Nest Monitoring. – We located nests of all species by systematic searches, by observing parental behavior, and by opportunistic flushing of incubating or brooding females. Bicknell's Thrush nests were found via telemetry of radio tagged females. The chronology and status of all active nests were monitored every 1 – 4 days either directly or, when possible, remotely via binoculars, or by radio telemetry monitoring of females. Nests that fledged at least one young were considered successful. Observations of fledging, fledglings near nests, parents carrying food nearby, or an empty nest cup with depressed edge and excrement were considered evidence of a successful nest. Depredation was assumed when the eggs or nestlings (when too young to fledge) disappeared.

Vegetation sampling – We sampled nest characteristics and vegetation around all Bicknell's Thrush and Blackpoll Warbler nests, using methods modified from the Breeding Biology Research and Monitoring Database Program (BBIRD; Martin et al. 1997). Nests were characterized after their termination, according to standard criteria. This sampling was non-destructive and conducted after the termination of each nest.

Censusing – we conducted standardized, unlimited-distance point counts at seven points along the East Mt. access road (Figure 1). Each point was separated by $\geq$ 150 m distance. On 25 June and 2 July, a series of counts of all species was conducted, beginning shortly after dawn. Censusing began shortly (<1 min.) after arriving at a station. A single observer (C. Rimmer) conducted both series, censusing each point in the same sequence on each date, and recording all birds seen and heard during a 10-min sampling period, which was divided into 3 time intervals: 3, 2, and 5 mins. Each bird was counted only once, during the time period in which it was first encountered, and placed into one of two distance categories; within or beyond 50 m. To reduce duplicate records, individual birds were mapped on standardized field cards, and known or presumed movements were noted. Different symbols were used to record the status of birds encountered (i.e., singing male, pair observed, calling bird, etc.). All birds seen or heard were each counted as 1 individual unless a family group or active nest was encountered, in which case they were scored as a breeding pair, or 2 individuals. In summarizing data for analysis, we used the mean count for each species over all points on both series as the station (point) estimate for the year.

Results

Demographics. – We operated mist nets on 31 days between 14 June and 30 July, accumulating 2,229.5 net-hours (one 12-m net open for one hour = one net-hour), with a mean of 71.9 $\pm$ 57.4 SD net-hours per day (range = 2.0 – 236.5). Overall, we mist-netted and banded 198 individuals of the four target species (Tables 1-4), a capture rate of 8.9 new birds/100 net hours. We obtained a total of 89 recaptures of 54 banded individuals among the four species. Recapture rates (# recaptured individuals/# banded individuals) were highest in Bicknell's Thrush (57%) and lowest in Yellow-rumped Warbler (15%). Yellow-rumped Warblers ranked first in abundance in new (n = 96) and total (n = 113) mist net captures (Table 3), followed by Swainson's Thrush (n = 42 new, 65 total; Table 2), Blackpoll Warbler (n = 37, 61; Table 4), and Bicknell's Thrush (n = 23, 48; Table 1). The relative abundance of each species paralleled that documented in the point counts (Table 5; see below).

The distribution of captures among known-age SY (yearling, or second-year) and ASY (> 2 year-old, or after second-year) birds ranged from 13% SY individuals in Bicknell's Thrush to 48% in Swainson's Thrush (Tables 1-4). Among the 10 male Bicknell's Thrushes we banded, 2 were SY individuals, while only 1 of the 8 banded females was a SY bird. Hatching-year (HY) samples were composed of banded nestlings (Bicknell's Thrush only) and free-flying juveniles. After-hatching year (AHY) birds were adults that could not be reliably aged as SY or ASY individuals. Males predominated among adults of known sex in the banded samples of all four species, ranging from 56% in Blackpoll Warbler and Bicknell's Thrush to 63% in Swainson's Thrush (Tables 1-4).

Female movements and home ranges. – We captured 8 female Bicknell's Thrushes and placed radio transmitters on 7 of these. One bird was captured in mid-July with a regressing brood patch, indicating that she had likely completed nesting; this individual was not radio-tagged. Of the 7 birds that received transmitters, three were taken by mammalian predators. Two were killed and cached within 24 hours of being released on 24 June. One of these was cached deep within boulder talus along the access road less than 25 m from her release point near the net where she had been captured. We were unable to retrieve this bird's transmitter, which signaled from this location through 30 July. The second female was recovered about 100 m from the first (both had been captured in the same net and released at the same point) from beneath a mass of tree roots and rocks; her body had been mostly eaten. A third female appeared to behave and move normally for 4 days, although we did not locate her nest, but she was recovered dead on 21 June, wedged deep under a rotting log. She had not been eaten, nor was she visibly damaged, but we believe that she was depredated. The pattern of predation and caching of these 3 birds strongly suggested depredation by a member of the mustelid family, several species of which commonly cache partially consumed or uneaten prey (Powell 1982). A positive sighting of a short-tailed weasel *(Mustela erminea)* by S. Faccio on 25 June, as it crossed the road close to the sites of the two first depredated females, affirms our belief that this species was the likely predator of all 3 females. Fall trapping on the East Mountain ridgeline by W. Kilpatrick and C. Woods (pers. comm.) yielded additional confirmations of the presence of short-tailed weasel in the study area, as well as long-tailed weasel *(Mustela frenata)* and fisher *(Martes pennanti)*.

We monitored 3 radio-tagged females for the duration of the study period and plotted home ranges for each (Figure 2, Table 5). Two females (#917 and #698) were associated with known nests, while the third (#949), although captured in breeding condition, was never documented to have an active nest. We suspect that she failed shortly before being captured, although it is equally possible that she abandoned her nest immediately after release. Female #917 was banded on 14 June and tracked to her nest two days later. She abandoned this nest on or about 28 June and built a second nest 22 m away, which fledged on 20 or 21 July. Her 95% Kernel home range during the 7-week tracking period was 2.3 ha in size (Figure 2, Table 5). She frequently crossed the access road and was recaptured four times in mist nets. Female #698 was banded on 14 June, and radio-tracked to her nest on 17 June. During the period in which her nest was active (fledging occurred on 7 July), she maintained a large 95% Kernel home range of 8.7 ha (Figure 2, Table 5), often being recorded on the nest as she incubated or brooded. Immediately after fledging, she moved her brood of 2 young west across the road, then nearly a kilometer north along the ridgeline to an area north of the road, where she remained until her transmitter battery expired on 23 July. This home range was slightly larger than the one she occupied while nesting, 10.5 ha in size (Figure 2, Table 5).

Female #949 was banded on 23 June. Over the following month, she moved over an area of 11.3 ha east of the access road below the summit ridgeline (Figure 2). During the final week of July, she had relocated about 250 m to the northwest, just south of the trailer, where she remained on a relatively small home range of 3.5 ha until field operations ceased on 30 July (Figure 2). Two additional females were radio-tracked for fewer than 5 days each, and neither provided adequate data to track movements or calculate home ranges.

Nest monitoring. – We monitored a total of 12 active nests of 5 species on East Mountain in 2004 (Figure 3, Table 6). Inclement weather and our late start hampered nest-searching efforts. Of the 11 nests whose outcomes were known, 8 (73%) were successful. We located a number of abandoned or recently depredated nests, but these were not counted in our totals.

We located 4 nests of 3 female Bicknell's Thrushes (Table 7), one of which renested after abandoning her initial nest for unknown reasons. All were found by following radio-tagged females. Female #917 built her initial nest 4.5 m above ground in a balsam fir *(Abies balsamea)* in a dense stand of pole-sized fir. It contained 4 eggs on 15 June, and she was observed, either directly or via telemetry, incubating the clutch on several dates through 28 June. On 1 July, she was confirmed incubating on a second nest, also 4.5 m high in a fir. The nest was too high to enable us to check contents without risking disturbance, but on 15 July, we confirmed with a mirror that the nest contained 2-3 nestlings. Fledging occurred on 20 or 21 July, and the female was located with at least 2 fledglings 30-40 m from the nest on 21 July. We do not know why this female's first nest was abandoned, but we collected the 4 intact eggs on 2 July. Both nests were within 17 m of the access road and within 90 m of a proposed turbine site (Figure 3).

Female #698 built a nest 1.5 m high in a fairly open, fir-dominated stand 13.3 m north from the easternmost summit building of the abandoned radar facility (Figure 3, Table 7). The nest contained 4 eggs on 16 June. Two eggs hatched on 24 June, and the remaining two never hatched. The two nestlings were banded on 2 July, and fledging occurred on 6 or 7 July.

We found the nest of female #751 on 28 June via systematically searching a dense stand of young fir and spruce. The nest was located 3.0 m high in a red spruce *(Picea rubrens)* and contained 3 recently-hatched young. We passively captured and radio-tagged the female that evening. She was brooding the chicks at midday on 29 June and was foraging nearby on the 30th. On 1 July, female #751 was recaptured shortly after dawn in a mist net across the access road > 250 m from her nest. She appeared weak in the net and was immediately released without processing. Four hours later she was retrieved dead near the release location, apparently having succumbed to exposure. A midday check of her nest revealed that the 3 unfeathered chicks were also dead and that they appeared to have died the previous day, as some decomposition was evident. We do not know if the female's abandonment of the nest caused her chicks' death, or if their death on or before 30 June led to her abandonment.

We found active nests of only one other target species, Blackpoll Warbler. Of 4 nests monitored on East Mountain (Figure 3), 3 were successful in fledging young, with a mean fledging date of 5 July. A fourth nest was abandoned shortly after the female completed a late clutch of 4 eggs on 6 July. These 4 nests were situated at heights of 0.5 – 1.5 m above ground in fir (n = 2) or red spruce saplings (n = 2) near small forest openings. Three of the nests were located 19, 30, and 75 m from proposed turbine sites (Figure 3).

A significant discovery in 2004 was an active nest of a Black-backed Woodpecker *(Picoides arcticus)*. This species of Special Concern in Vermont had previously been documented to nest only in low elevation spruce-fir forests, primarily in the Nulhegan and Victory Basins (Laughlin and Kibbe 1985, Weinhagen 1998). The nest cavity, situated 7.5 m above ground in a large balsam fir southeast of the summit ridge (Figure 3), was discovered on 23 June, with a persistently begging juvenile visible in the entry hole. The nest fledged on 24 June. We suspect that at least one other pair of Black-backed Woodpeckers was resident on East Mountain, as we mist-netted a male and female with well-developed brood patches > 1 km west of the nest site on two separate dates. To our knowledge, this nest constitutes the first documentation of Black-backed Woodpecker breeding in montane forests of Vermont.

Mercury blood concentrations: We collected blood and feather samples from 15 Bicknell's Thrushes (10 males 5 females) on East Mountain in 2004. We compared blood Hg concentrations from these birds to those from 5 males sampled in 2000, as well as to birds sampled at nearby Burke Mountain in 2000-2004 and at established study sites on Mt. Mansfield and Stratton Mountain in 1999-2004. The mean blood Hg concentration of all birds sampled on East Mountain was higher than the population mean on Mansfield or Stratton, but lower than birds from Burke Mountain (Table 8, Figure 4). Although small samples sizes preclude meaningful statistical tests, the East Mountain 5 thrushes sampled in 2000 had markedly higher mean blood Hg concentrations than the 15 birds sampled in 2004. Feather samples await Hg analysis at Texas A&M University.

Censusing. – Censusing was hampered by our late start date of 14 June, fully two weeks later than originally planned, and by inclement weather. We were unable to conduct our first point count series until 25 June, thus missing the window of peak Bicknell's Thrush vocalizing, which occurs during the first three weeks of June (Rimmer et al. 1996). Consequently, we located only 2 birds on the first series and none on the second series conducted on 2 July (Table 5). This

provided a gross underestimate of the number of males known to occur from netting and general observations within the typical point count detection radius of approximately 100 meters. The 10 males banded were all captured within detection limits of census points, and it is likely that most of these would have been detected if the point counts had been conducted earlier in June. The two lowest elevation points (Figure 1) may have been below the area of habitat regularly occupied by Bicknell's Thrush. We did not mist-net below the elevation of point #3 (987 m), nor did we record any vocalizing Bicknell's Thrushes below that elevation.

We detected a total of 135 individuals of 16 avian species on the two census dates, for a mean of 9.6 birds per point count (Table 9). The suite of species was very similar to that found on other Vermont peaks (e.g., Faccio and Rimmer 2004), with the exception of 3 species typically restricted to lowland spruce-fir forests in the Northeast Kingdom: Black-backed Woodpecker, Gray Jay *(Perisoreus canadensis)*, and Boreal Chickadee *(Poecile hudsonica)*. Although we only encountered Gray Jays on one occasion, during the 2 July point count at Point #7, we regularly encountered Black-backed Woodpeckers and Boreal Chickadees throughout June and July. Among species more typical of montane fir forests in Vermont, several occurred in higher relative abundance than on Green Mountain peaks like Mansfield and Stratton, while others were recorded in lower numbers. Both Winter Wren *(Troglodytes troglodytes)* and Swainson's Thrush were very common on East Mountain point counts in 2004, while Blackpoll Warbler and White-throated Sparrow *(Zonotrichia ablicollis)* were recorded in numbers below those averaged at two montane forest sites on Mt. Mansfield from 1991-2003 (Faccio and Rimmer 2004). We detected only one red squirrel (*Tamiasciurus hudsonicus)* during East Mountain point counts, as this species was very scarce on East Mountain throughout the summer.

Discussion

Demographics. – It is premature to provide any substantive analysis of Bicknell's Thrush demographics on East Mountain, based on only a single year of study. Our capture of 10 males and 8 females suggests a more equal sex ratio than the 1.8:1.0 male:female ratio documented on Mansfield and Stratton (Rimmer et al. 2001). We suspect that some of the East Mountain females may have terminated breeding attempts before being captured, as evidenced by the near-simultaneous capture of 3 individuals in the same mist net on 23 June. Females typically occupy non-overlapping home ranges (Rimmer et al. 2001), and it seems likely that one or more of these birds was wandering after abandoning its nest or losing it to predation. Two radio-tagged females followed for a minimum of 5 days never settled on nests. While we cannot discount the possibility that our handling and radio-tagging may have caused them to abandon, we have very rarely documented such abandonments on our long-term Mansfield or Stratton study sites.

The preponderance of ASY birds (80% of males, 88% of females) in the 2004 sample of banded Bicknell's Thrushes on East Mountain suggests an age structure similar to that on Mansfield and Stratton (Rimmer et al. 2001). Of known-age female breeders from 85 nests in 1994-1999, ASY birds outnumbered SY females 73 to 12 (86% to 14%). Of 25 males with known paternity from 1998 and 1999 nests on Mansfield and Stratton, only 2 (8%) were SY birds, while this age-class constituted almost 25% of the entire banded male population. Among banded adults on Stratton in 2004, 17 of 20 (85%) males were ASY, while 7 of 10 (70%) females were in this age-class. An additional field season of data collection will be needed to provide a

more robust index of the demographic structure of East Mountain's Bicknell's Thrush population.

We were surprised not to recapture any of 6 male Bicknell's Thrushes that had been mist-netted and banded on the East Mountain ridgeline in June of 2000. We regularly operated mist nets in the areas in which all 6 individuals had been captured in 2000. In general, both males and females are site-faithful to breeding sites, as indicated by demographic studies yielding repeated mist net recaptures over successive years (Rimmer et al. 2001). Survivorship is relatively high for a migratory passerine, with estimates of 65% and annual recapture probabilities of 75-100% on Mansfield and Stratton (Rimmer et al. 2004). It is likely that our netting failed to capture all thrushes that were present on East Mountain in 2004, as time constraints prevented us from thoroughly surveying several areas of suitable habitat.

Female movements and home ranges. – Our small sample of radio-tracked females limits meaningful conclusions about home range sizes and movements. The mean home range of female #917 (2.32 ha) was almost identical in size to that of females on Stratton (Rimmer et al. 2001), while the 8.74 ha breeding home range of female #698 was much larger. A larger sample of both females and males will be necessary to establish robust baseline data against which to measure possible changes in home range sizes, locations, or configurations, as well as in general movement patterns following turbine construction. The documentation of a separate post-fledging home range by female 698 suggests that possible effects of turbines should be examined during the post-breeding period.

Mercury blood concentrations – Our Hg data from East and Burke mountains, while based on a small sample of birds, suggest that Northeast Kingdom sites may experience higher deposition of atmospheric-borne Hg than sites in the Green Mountains. Previous analyses have shown a significant correlation between regional leaf litter Hg deposition patterns and Bicknell's Thrush blood Hg concentrations (Rimmer et al. *in press*). Without an established threshold of methylmercury (MeHg) toxicity in Bicknell's Thrush, we can not gauge the possible impacts of the blood Hg concentrations we documented on East Mountain in 2004. The higher Hg levels in males conform to results from other Vermont populations and may reflect dietary differences and/or depuration of Hg by females in eggs (Rimmer et al. *in press*).

The markedly lower blood Hg concentrations of the 2004 East Mountain birds versus those sampled in 2000 is puzzling, in that no significant between-year differences exist among Stratton Mountain and Mt. Mansfield birds (Rimmer et al. *in press*). We documented a similarly lower blood Hg concentration (0.084 ppm) in one Burke Mountain adult sampled in 2004, compared to a mean of 0.163 $\pm$ 0.054 SD in 4 birds sampled in 2000-2002. Whether these results are artifacts of small sample sizes or reflect possible between-year differences in atmospheric deposition patterns and/or MeHg bioavailability are unknown. Variability due to analytical processing is an unlikely source of variation (R. Taylor, personal communication). We can only speculate that the relatively high blood Hg concentrations in the 5 males from 2000 and the apparent absence of these birds from the study area in 2004 might have resulted in part from the toxic effects of their MeHg burdens. Although adverse effects of MeHg toxicity on behavior and survivorship in wild birds are well-documented (e.g. Evers et al 2003), we emphasize that we have no empirical data to support this possibility. While it is possible that radio-tagged females might have been

impaired by high MeHg burdens, increasing their susceptibility to predators shortly after release or lowering their ability to withstand mist net capture, we again stress that our data are inadequate to support this. We believe that the phenomenon of Hg concentrations in East Mountain birds, and more generally in the Northeast Kingdom metapopulation of Bicknell's Thrush, warrants further investigation.

Censusing – It is premature to fully characterize the bird community structure on East Mountain after only one year of study, especially in that our censusing was conducted outside the optimal survey timeframe. We believe that at least two years of baseline preconstruction data collection will be necessary to provide a meaningful analysis. However, our focus on Bicknell's Thrush enables a more accurate estimate of the population within the area in which we conducted mist-netting and censusing. We conservatively estimate that 12 males Bicknell's Thrushes inhabited this area, and we believe that as many as 18-20 individual males might inhabit the full extent of suitable montane fir-spruce habitat on the mountain. We encountered at least 3-4 vocalizing birds during opportunistic surveys in areas east and northwest of the road, and we believe that there may be other suitable habitat patches that were not visited by project staff. It is more difficult to accurately estimate the female population. Assuming that all 8 birds we captured were local breeders, it seems reasonable to suspect that 10-12 females may inhabit the entire mountain, given the species' sex ratio of 1.8 males per females on Mansfield and Stratton (Rimmer et al. 2001). A more robust overall population estimate of males and females will be a primary goal of future field work on East Mountain.

We suspect that Black-backed Woodpeckers and Boreal Chickadees are regular breeders on East Mountain, and we believe that Gray Jays may also nest in the montane forests. All three species were detected during 2003 surveys by Kerlinger and Dowdell (2003). The boreal component of East Mountain's avifauna lends a distinctive feature to the mountain, one that typically is characteristic only of lowland spruce-fir forests in Vermont (Thompson and Sorenson 2000). We believe that more extensive surveys of East Mountain, especially if conducted earlier in the avian breeding season, will likely confirm local nesting by these and other boreal species not encountered in 2004.

Conclusions from 2004 and future plans. – Despite constraints of adequate field time and project staff availability in 2004, we established a solid baseline of bird population data on East Mountain. This included: (1) preliminary demographic profiles of 4 target species; (2) detailed information on home ranges of 3 female Bicknell's Thrushes; (4) georeferenced locations of 12 nests of 5 species; (5) reproductive success and productivity data on 3 Bicknell's Thrush and 4 Blackpoll Warbler nests, (6) data on Hg blood concentrations in Bicknell's Thrush; and (7) preliminary census data on avian community structure and relative abundance. We believe that a second full field season of data collection will be necessary to establish a more rigorous, preconstruction data set on the ecology and demography of Bicknell's Thrush and other montane forest species.

Our 2004 field work on East Mountain, while limited in scope and duration, provides a solid foundation for future research and monitoring. Project staff are familiar with the mountain's terrain and habitats, a well-established infrastructure of point counts and mistnet sites has been established, and a marked population of individual birds exists for mark-recapture analyses and

between-year comparisons. Our primary concern entering 2005 involves the loss of 4 females from the 2004 breeding population. While at least 3 of these birds might have been depredated regardless of our intervention via radio-tagging, we are uncertain of the demographic effect that their absence from the 2005 study population will create. Our previous research on Mansfield and Stratton has shown that radio-tagged males and females are occasionally depredated by both weasels and Sharp-shinned Hawks *(Accipiter striatus)*, as we have found thrush remains in weasel caches and hawk nests (Rimmer et al. 2001). The loss of these 4 birds will have to be statistically accounted for in mark-recapture analyses of adult survivorship and return rates. Our plans for 2005 include the following:

1) Radio telemetry of male Bicknell's Thrush – we will radio-tag all adult males and monitor them throughout the season to collect information on home ranges and movements. These will be critical to establish baseline preconstruction data on male home range size and configuration, movement patterns, and seasonal changes in these. We will continue to follow females with radio telemetry.
2) Expanded census protocols – we will conduct point counts at least ten days earlier than in 2004, to coincide with peak periods of avian territorial behavior and Bicknell's Thrush vocalizing. We will implement a distance sampling protocol on several dates to collect more quantitative census data on Bicknell's Thrush, in order to obtain breeding population density estimates.
3) Geographic expansion of studies – we will expand the geographic scope of Bicknell's Thrush surveys and mist-netting efforts in 2005 more areas of suitable habitat) on East Mountain. Although we will continue to focus studies in areas of the proposed turbine locations (i.e. along the access road) during 2005, we will attempt to more fully survey other areas of potentially suitable thrush habitat on East Mountain.
4) Establishment of a control site – although full-blown replicate studies at a nearby control site will not be logistically feasible, we plan to conduct point counts for all species and distance sampling for Bicknell's Thrush on either Seneca or Gore mountain in 2005. If time permits, we will conduct targeted mist-netting for Bicknell's Thrush, so as to obtain body condition indices (e.g. weight and subcutaneous fat scores, corticosterone levels, blood and feather Hg concentrations) and morphometrics for comparison to East Mountain.
5) Corticosterone sampling – Many recent studies have focused on stress as a marker for an animal's well-being in its natural habitat (e.g., Wingfield 1997). One potential indicator of a compromised physiological state in birds is the hormone corticosterone. Baseline levels of blood corticosterone have been used to assess behavioral and physiological changes resulting from increased energy demands. Elevated corticosterone concentrations have been shown to indicate declining physiological condition due to deteriorating habitat quality (Marra and Holberton 1998) or harsh weather conditions (Romero et al. 2000). Under the assumption that birds might respond to the presence of wind turbines via elevated physiological stress levels, we propose to measure corticosterone concentrations in Bicknell's Thrush on East Mountain. We will sample blood from all captured birds in 2005 and use these as baseline levels against which to measure possible changes following wind turbine construction. We believe that corticosterone sampling may provide a powerful tool for assessing avian physiological condition in response to wind turbine development

on East Mountain. If turbines are not built, we would expect no significant changes between years in corticosterone levels. If turbines affect physiological stress levels, we would expect to document (a) a positive relationship between corticosterone concentrations and individual birds' proximity to turbines, and/or (b) increased early season corticosterone in birds that move away from turbines, with decreased corticosterone concentrations thereafter.

Our modeled GIS vegetation data indicate that East Mountain consists of 189 ha of montane spruce-fir habitat, comprising the largest unit of this habitat type in the Northeast Highlands physiographic region of Vermont (J. D. Lambert, unpublished data). Gore Mountain (122 ha) and Seneca Mountain (97 ha) support montane forest patches that are 55% and 95% smaller, respectively, than East Mountain's. East Mountain thus likely supports the region's largest breeding Bicknell's Thrush population, and it may play an important role in ensuring persistence or recolonization of Bicknell's Thrush on nearby peaks. Recent evidence of extirpations (one involving a subsequent recolonizaton) at three mountains in the Northeast Highlands underscores the uncertain status of Bicknell's Thrush in the region. Since 1993, VINS staff have annually surveyed nearby Burke Mountain with two series of point counts at five permanent stations and with broadcasts of Bicknell's Thrush vocal playbacks along the mountain's entire west ridge. During the 12-year period of surveys from 1993-2004, the Burke Mountain population steadily declined from a high of five vocalizing individuals in 1993 and 1994 to two in 2001, one in 2002, zero in 2003, and one in 2004. The bird encountered in 2002 was a male that had been banded in 1999 and recaptured in 2001 and 2002; the bird in 2004 was an unbanded yearling male. Point count and playback surveys on Brousseau Mountain and Monadnock Mountain, conducted each year since 2000, have shown similar declines and apparent extirpations. These extirpations on peaks at the periphery of the region's core montane forest unit (East Mountain) is reflected on a larger scale across the breeding range of Bicknell's Thrush, with well-documented extirpations on Mt. Greylock in Massachusetts and several sites in the Canadian Maritimes. The key to possible future recolonizations of such habitat patches by Bicknell's Thrush and to maintenance of metapopulation stability may lie in the persistence and continued viability of relatively large, core breeding populations such as East Mountain's. We believe that continued research and monitoring of East Mountain's Bicknell's Thrush breeding population is fully warranted.

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Table 1. Bicknell's Thrush banding data, East Mt., June and July 2004.

Sex	Number of Individuals Captured	Number of Individuals Recaptured	Total Number of Recaptures
Male	10	8	16
Female	8	3	6
Unknown	5	2	3
Total	23	13	25
Age			
HY	5	2	3
SY	3	2	6
ASY	15	9	16
Total	23	13	25

Table 2. Swainson's Thrush banding data, East Mt., June and July 2004.

Sex	Number of Individuals Captured	Number of Individuals Recaptured	Total Number of Recaptures
Male	20	10	15
Female	12	3	7
Unknown	10	1	1
Total	42	14	23
Age			
HY	4	0	0
SY	16	7	9
AHY	5	0	0
ASY	17	7	14
Total	42	14	23

Table 3. Yellow-rumped Warbler banding data, East Mt., June and July 2004.

Sex	Number of Individuals Captured	Number of Individuals Recaptured	Total Number of Recaptures
Male	40	12	14
Female	25	2	3
Unknown	31	0	0
Total	96	14	17
Age			
HY	30	0	0
SY	8	2	2
AHY	27	5	5
ASY	31	7	10
Total	96	14	17

Table 4. Blackpoll Warbler banding data, East Mt., June and July 2004.

Sex	Number of Individuals Captured	Number of Individuals Recaptured	Total Number of Recaptures
Male	18	8	14
Female	14	4	9
Unknown	5	1	1
Total	37	13	24
Age			
HY	5	1	1
SY	6	2	7
AHY	6	3	5
ASY	20	7	11
Total	37	13	24

Table 5. Kernal Home range estimates for 3 radio-tagged Bicknell's Thrush females.

	KHR Utilization Distribution (ha)										
	Early Season[a]			Late Season[b]			Total			Total No. of Fixes	Telemetry Period
ID	95%	75%	50%	95%	75%	50%	95%	75%	50%		
698	8.74	4.97	2.85	10.53	4.76	2.24	19.27	9.73	5.09	29	15 Jun - 22 Jul
949	11.28	4.39	1.85	3.50	1.34	-	14.78	5.73	1.85	36	16 Jun - 30 Jul
917	2.32	1.17	0.62				2.32	1.17	0.62	30	24 Jun - 29 Jul
Mean (SE)	10.01 (1.27)	4.68 (0.29)	2.35 (0.50)	7.02 (3.52)	3.05 (1.71)		12.12 (5.07)	5.54 (2.47)	2.52 (1.33)		

[a] 698 and 917 were tracked throughout their respective active nesting periods, while 949 was never associated with a known nest. See text for details.
[b] 698 moved > 1.0 km from her nest after fledging young on 7 July, while 949 moved > 250 m from her established home range between 21-23 July, remaining in a fairly small area during the following week. We thus calculated separate home ranges for each female during the two discrete periods. See text for details.

Table 6. Nests monitored on East Mountain in 2004.

Species	Number of nests	Number Successful
Hairy Woodpecker	1	?
Black-backed Woodpecker	1	1
Bicknell's Thrush	4	2
Blackpoll warbler	4	3
White-throated Sparrow	2	2
Total	12	8 (9)

Table 7. Characteristics of Bicknell's Thrush nests on East Mt. in 2004.

Female Nest ID	Nest Tree Species	Height above Ground (m)	Height of Nest Tree (m)	DBH (cm)	Distance to Nearest Edge (m)
917A	Balsam fir	4.5	7.0	8.5	5.0
917B	Balsam fir	4.5	7.5	10.0	20.0
698	Balsam fir	1.5	2.5	4.1	10.0
751	Red spruce	3.0	4.0	4.0	5.0
Mean $\pm$ SD		3.4 $\pm$ 1.2	5.3 $\pm$ 2.1	6.7 $\pm$ 2.7	10.0 $\pm$ 6.1

Table 8. Blood mercury concentrations (ppm) in adult Bicknell's Thrushes at four sampling sites in Vermont, 1999-2004.

Sampling unit	Number of birds sampled	mean	SD
Burke (all birds)	5	0.147	0.059
East (all birds)	20	0.107	0.05
Mansfield (all birds)	60	0.096	0.045
Stratton (all birds)	79	0.095	0.049
East 2000 birds	5	0.153	0.079
East 2004 birds (all)	15	0.092	0.025
East males (all)	15	0.115	0.055
East females 2004	5	0.083	0.013
East males 2000	5	0.153	0.079
East males 2004	10	0.096	0.029

Table 9. Point count data from East Mountain, 2004.

Species	Total Count by Date		Total Individuals	Max Count	Mean	Mean # Birds/Point
	25-Jun-04	02-Jul-04				
Red Squirrel[a]		1	1	1	0.50	0.071
Black-backed Woodpecker		2	2	2	1.00	0.143
Yellow-bellied Flycatcher	2	3	5	3	2.50	0.357
Gray Jay		2	2	2	1.00	0.143
Black-capped Chickadee	1	1	2	1	1.00	0.143
Winter Wren	7	13	20	13	10.00	1.429
Golden-crowned Kinglet	2		2	2	1.00	0.143
Ruby-crowned Kinglet	1	1	2	1	1.00	0.143
Bicknell's Thrush	2		2	2	1.00	0.143
Swainson's Thrush	12	13	25	13	12.50	1.786
American Robin	1	1	2	1	1.00	0.143
Nashville Warbler	3	4	7	4	3.50	0.500
Magnolia Warbler	2		2	2	1.00	0.143
Yellow-rumped Warbler	14	16	30	16	15.00	2.143
Blackpoll Warbler	4	3	7	4	3.50	0.500
White-throated Sparrow	7	5	12	7	6.00	0.857
Dark-eyed Junco	6	6	12	6	6.00	0.857
Total Individuals	64	71	134	79	67.50	9.643
Species Richness	14	13	16	16	13.5	

[a] Not included in totals.

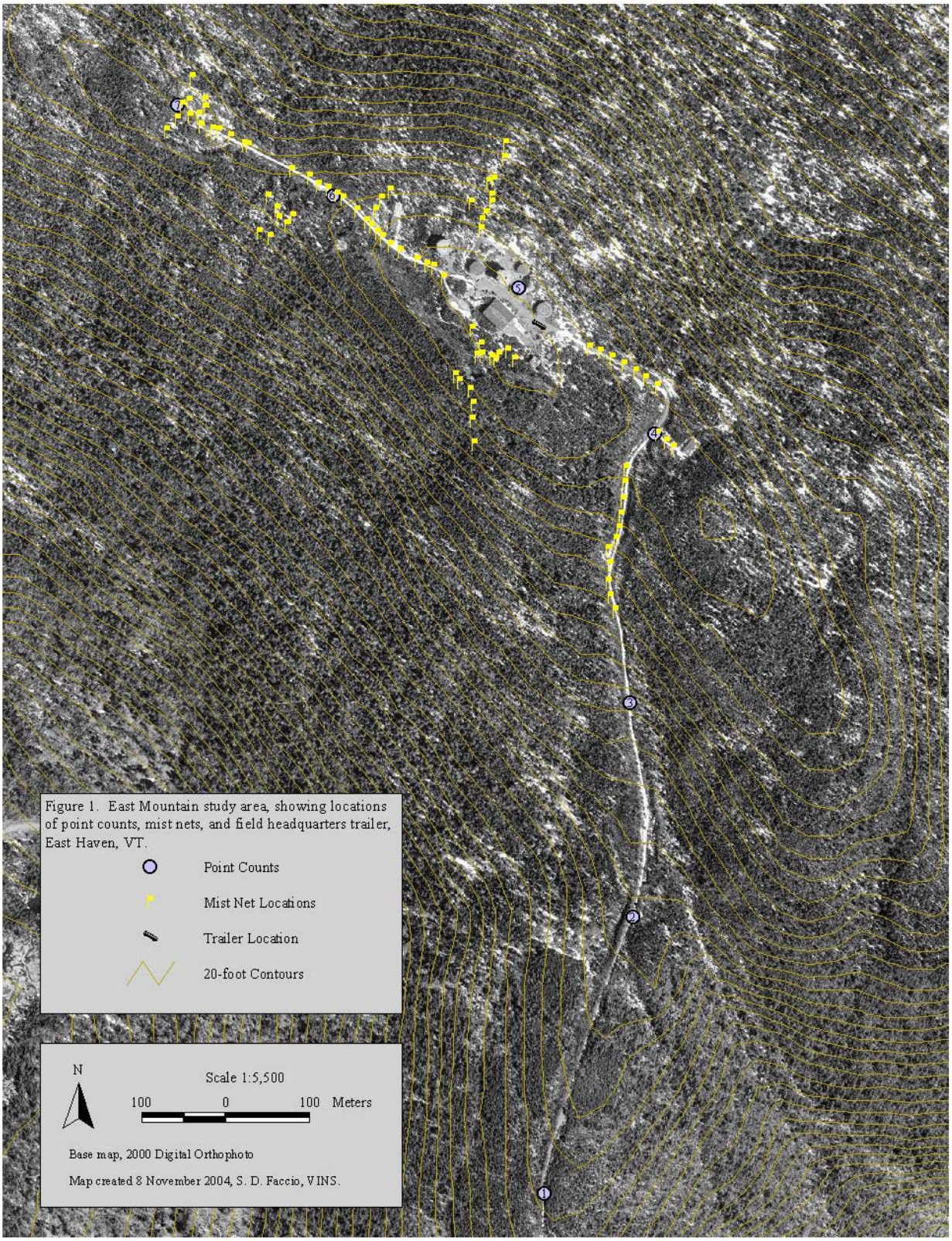
Figure 1. East Mountain study area, showing locations of point counts, mist nets, and field headquarters trailer, East Haven, VT.
Point Counts
Mist Net Locations
Trailer Location
20-foot Contours
N
Scale 1:5,500
100 0 100 Meters
Base map, 2000 Digital Orthophoto
Map created 8 November 2004, S. D. Faccio, VINS.

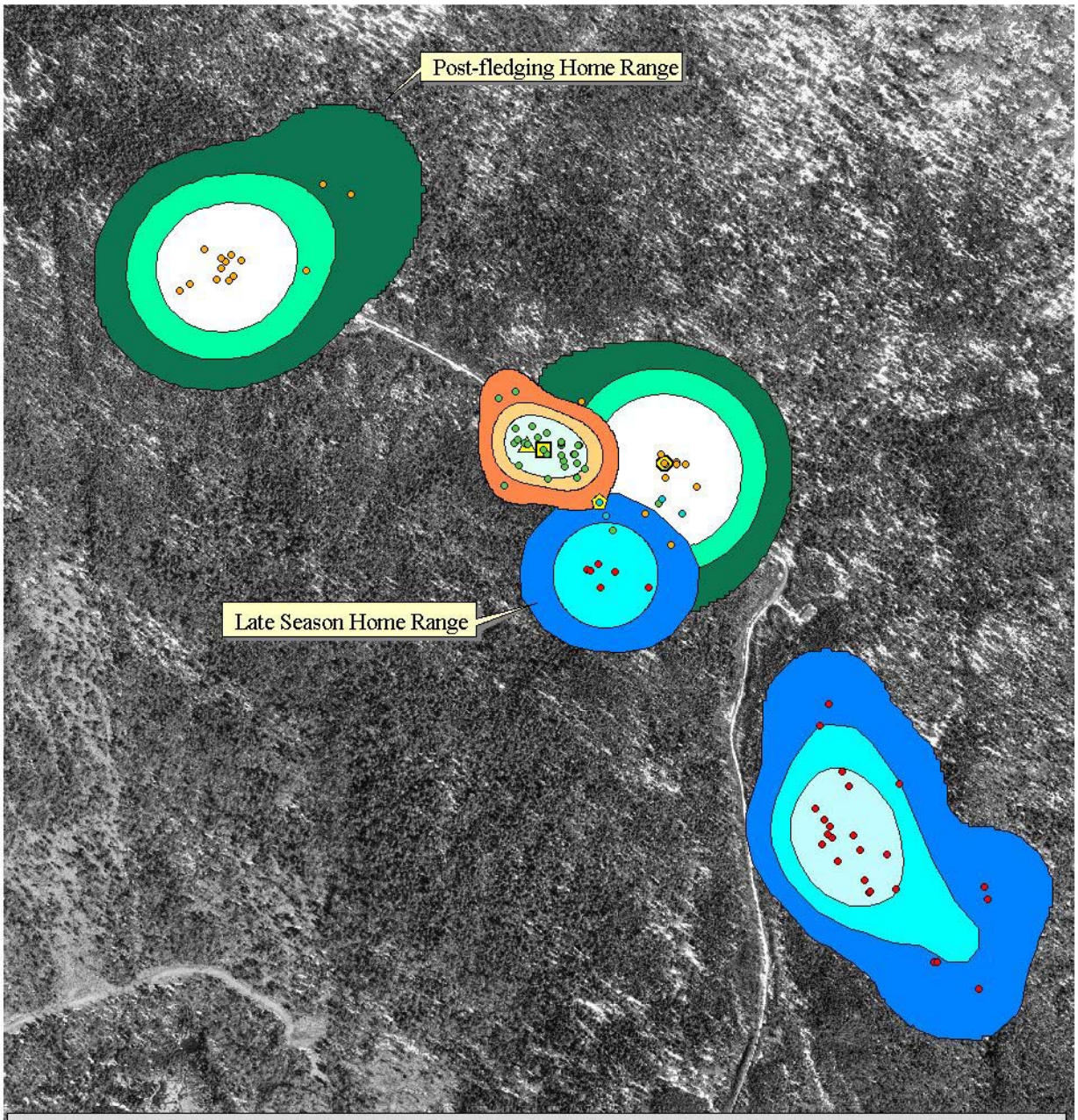

Figure 2. Radio telemetry locations, nests, and Kernal home range estimates for Bicknell's Thrush, East Mountain, East Haven, VT.

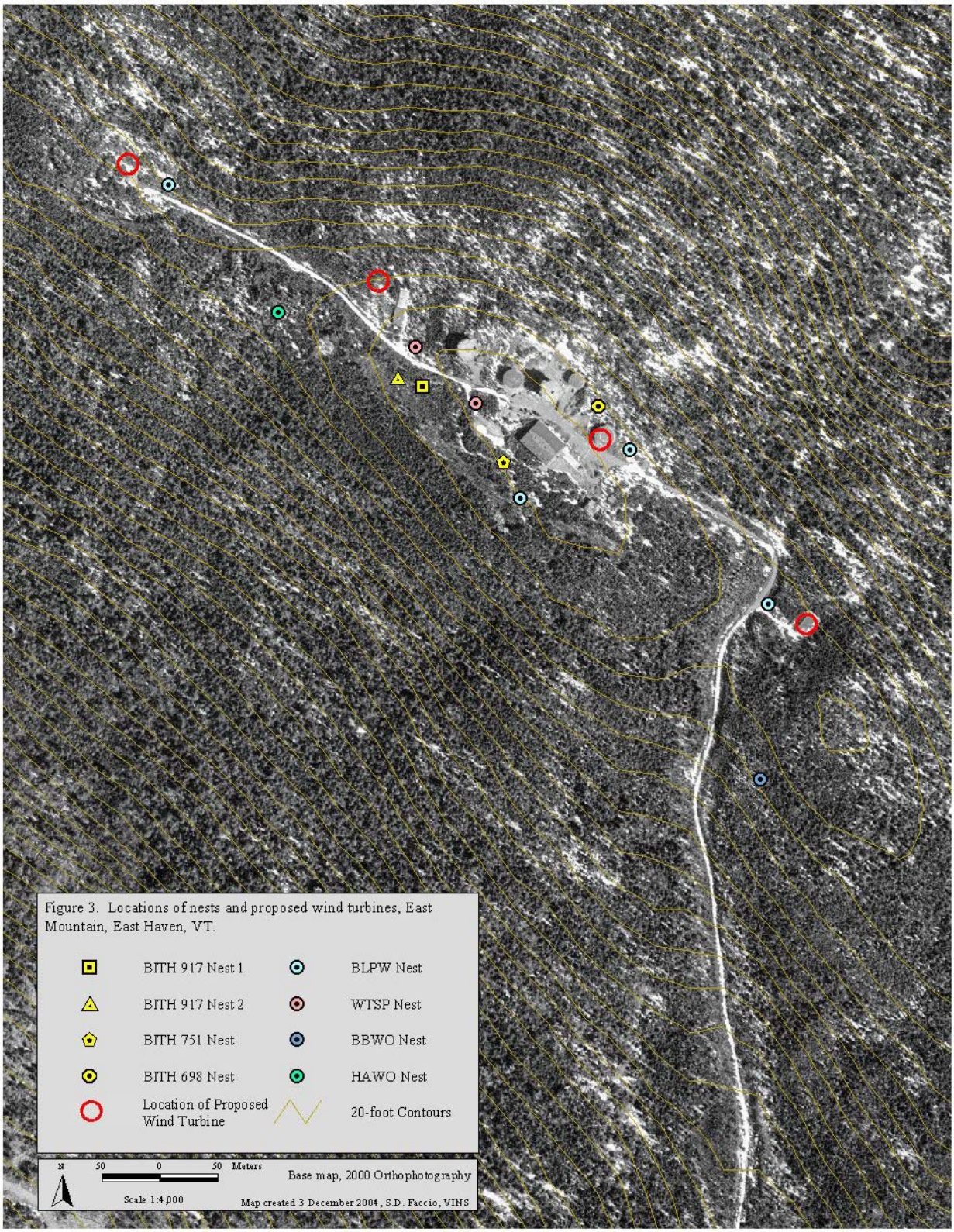
Figure 3. Locations of nests and proposed wind turbines, East Mountain, East Haven, VT.
BITH 917 Nest 1
BITH 917 Nest 2
BITH 751 Nest
BITH 698 Nest
Location of Proposed Wind Turbine
BLPW Nest
WTSP Nest
BBWO Nest
HAWO Nest
20-foot Contours
N
50 0 50 Meters
Scale 1:4,000
Base map, 2000 Orthophotography
Map created 3 December 2004, S.D. Faccio, VINS

Figure 4. Blood mercury concentrations (ppm) in Bicknell's Thushes sampled on Burke Mountain, East Mountain, Mt. Mansfield, and Stratton Mountain, Vermont. See text for details.