# Chapter Five

## The Population History of Bicknell's Thrush and Veery

### Introduction

The population history of Bicknell's Thrush and Veery are tied to the biogeographic effects of repeated Pleistocene glaciation. Much of northeastern North America was ice covered as recently as 14 to 13 thousand years ago and it was re-populated by its current flora and fauna in recent geologic times (Pielou 1991). Because Bicknell's Thrush and Veery have very different habitat preferences they likely had widely separated ranges at the glacial maximum and had very different recolonization patterns in the Northeast. Such differences in habitat and range expansion suggest that these birds may have had different population histories and may show different patterns of genetic variation and gene flow between them. The Bicknell's Thrush's habitat is sub-alpine boreal conifers, thus it must have inhabited regions at or near the edge of glacial ice during Pleistocene glaciations. Thus it is plausible that Bicknell's Thrush had a distribution shifted just a few hundred kilometers to the south of its current breeding range. As such the post-glacial range expansion of Bicknell's Thrush may not have involved an especially long-distance range shift. On the other hand, the Veery's association with hardwood forest implies its range was far to the south of its current position. The Veery probably had a much narrower geographic distribution due to the limited distribution of appropriate vegetation at glacial maxima (e.g. Delcourt and Delcourt 1987), and would have lived a few thousand kilometers south of the bulk of its current range. Thus it appears reasonable to postulate a glacial population bottleneck, and rapid population expansion during the Veery's reoccupation of the north after ice retreated. It is also plausible that the Veery went through multiple founder events along its expanding post-glacial range front (Hewitt 1996).

Aspects of population history that may be inferred from coalescence patterns of genealogical trees derived from molecular data include effective population size (Kuhner *et al.* 1995), population growth (Kuhner *et al.* 1998b), and gene flow, including its rate and net direction (Beerli 1999). Patterns of population history may also be guessed at by examination of more standard measures of population genetic diversity and neutrality indices (Tajima 1989; Templeton 1998). I have used the population genetic analysis programs Arlequin (Schneider *et al.* 1997), Fluctuate (Kuhner *et al.* 1998a), and Migrate (Beerli 1997) on my mtDNA sequence data from Veery and Bicknell's Thrush to examine whether the Veery shows the hallmarks of a bottlenecked population and long-distance range expansion in contrast to Bicknell's Thrush.

## Methods

I used Arlequin, developed at the University of Geneva (Schneider *et al.* 1997), to determine a variety of metrics from the data of both species and to test whether the sequences showed signs of exposure to natural selection. Arlequin is a broadly applicable population-genetics program that calculates an array of population-genetic parameters for a variety of molecular data types including mtDNA sequences. These include measures of genetic diversity, and tests for neutrality of genetic variation (Schneider *et al.* 1997). The metrics I obtained included gene diversity (*h*), which is roughly equivalent to heterozygosity for diploid data, nucleotide diversity ($\pi$), the per site variation among the sequences, and the mean pairwise differences among the sequences. I also used the Arlequin  to calculate values of Tajima's D statistic to test the assumption of sequence neutrality (Tajima 1989). Lack of response to natural selection is a valuable trait for determining population genetic parameters because the only force presumably acting on neutral sequences should be random genetic drift, thus reflecting the true patterns of gene flow and drift rather than recent selection.

I defined the samples from each mountain range as sub-populations for gene flow analyses. The metrics calculated by Arlequin shown in Table 5.1 are indicative of the amount of variation contained in each sub-population and allow inferences about the long-term size of populations due to the positive relationship between population size and maintenance of genetic variation. Since many of the parameters estimated by Arlequin assume a population that is not growing or experiencing gene flow, I also used the programs Migrate and Fluctuate from the University of Washington's LaMarc package that attempt to determine if these phenomena were acting on the populations I studied.

I used Fluctuate to measure effective population ($N_{ef}$) and population growth (g, Kuhner *et al.* 1998b), and Migrate to estimate bi-directional gene flow among mountain ranges (Beerli and Felsenstein 1999). Fluctuate and Migrate construct gene trees, in essence genealogies, to determine patterns of coalescence in the data. These programs were developed by Joseph Felsenstein's research group and use maximum likelihood techniques to estimate population genetic parameters from genealogies of haplotypes employing a coalescent approach (Kingman 1980; Kingman 1982). Estimates derived from coalescence methods are sensitive to gene tree topology; thus it is important to find the correct intraspecific phylogeny to use these methods (Smouse 1998). Maximum likelihood estimation of parameters using Metropolis-Hastings Markov Chain analysis attempts to answer these objections by using data re-sampling and examination of large numbers of trees to obtain maximum likelihood estimates of effective population, population growth, and migration rate (Kuhner *et al.* 1998b; Beerli and Felsenstein 1999). These programs first establish an initial estimate of $\theta$ ($2N_{ef}\,\mu$) where $\mu$ represents the mutation rate per site per generation and $N_{ef}$ the effective number of breeding females (because mtDNA is maternally inherited) by constructing a genealogical tree from the sequence data. This estimate of effective population and mutation rate is then used as a reference to construct further genealogical trees with maximum likelihood estimation. Each maximum likelihood tree is derived via a Markov Chain process using the posterior probability of the initial genealogy in comparison to the probability of each newly constructed genealogy in the chain. Several Markov Chains are run to produce maximum likelihood estimates, from the best genealogies, of the parameters $g$, the exponential growth rate; $\theta$, in essence the effective female population at a given mutation rate (Kuhner *et al.* 1998b); and the effective migration rate 4*Nm* (Beerli and Felsenstein 1999).

I executed runs with Fluctuate on the complete DNA sequence data for each species. I ran five short Markov Chains recording 400 genealogies per chain and achieved final maximum likelihood estimates of $g$ and $\theta$ with two long Markov Chains recording 2000 genealogies in each chain.

I made pairwise comparisons among all pairs of sub-populations with Migrate to obtain estimates of bi-directional gene flow among sub-populations. To obtain gene flow estimates I ran 10 short chains in Migrate of 25,000 steps recording 500 genealogies, and three long chains of 2,500,000 steps recording 50,000 genealogies.

## Results

### *Genetic Diversity*

**Bicknell's Thrush**

Overall, Bicknell's Thrush shows higher levels of gene diversity, nucleotide diversity, and mean pairwise difference than does Veery (Table 5.1A), in spite of the Veery's higher number of variable sites and haplotypes. The Catskills exhibit the highest values for all genetic diversity indices including gene diversity, nucleotide diversity; and mean pairwise differences among sequences, the Green Mountains have the lowest gene diversity measure and the White Mountains show the lowest nucleotide diversity and mean pairwise differences.

Tajima's D statistics imply that the Bicknell's Thrush sequences have not been subjected to the effects of natural selection (see Table 4.2A). However note that although the values of Tajima's D statistic are not significant at $P<0.05$, they do approach significance at $P<0.1$ for the total sample and in the Catskills (see Table 4.2A). This trend suggests that these samples may not be strictly neutral to selection or that the population as a whole, and the Catskill sub-population in particular, may not be in strict equilibrium with respect to population growth or random genetic drift.

**Veery**

As noted above, the Veery samples show less genetic diversity than Bicknell's Thrush samples. As with Bicknell's Thrush, the Catskills show the highest values for measures of genetic diversity among sub-populations, but unlike Bicknell's Thrush, the Adirondacks exhibited the lowest values (see Table 5.1B).

Most of the Tajima's D statistics indicate that Veery samples do not vary significantly from neutrality (see Table 4.2B). However for all 40 sequences Tajima's D reaches $P<0.05$. Although it does not reach this level for any single sub-population it trends toward significance at $P<0.1$ for the Green Mountain sub-population (see Table 4.2B). The significance of Tajima's D for the entire Veery sample indicates that the populations may not be in equilibrium with respect to growth or drift, or that selection may be acting on the mitochondrial genome of the Veery at a regional scale (Tajima 1989). The latter conclusion is doubtful given the non-coding nature of the control region and the high level of variability of control region III.

### *Effective Population Size and Estimates of Population Growth*

#### **Bicknell's Thrush**

The maximum likelihood estimate of θ generated by Fluctuate for Bicknell's Thrush was 0.0320 (SD = 0.0032). If one applies a reasonable estimate of the mitochondrial mutation rate (μ) of ca. $1 \times 10^{-8}$ substitutions per site per generation (Baker and Marshall 1997) this value of $2N_{ef}\mu$ translates to an effective female population ($N_{ef}$) of 800,000 (95% confidence interval around the estimate of theta, 640,000 to 960,000) in the region I sampled. At a faster mutation rate the $N_{ef}$ would be smaller (e.g., at $1 \times 10^{-6}$ it would be 64,000 to 96,000). The estimate of g (Kuhner *et al.* 1998a) was 790.15, indicative of slow growth or a stable population. To dramatize this, consider that at this growth rate the effective population is predicted to grow, assuming a mutation rate of $1 \times 10^{-8}$ (as defined above), by 60 individuals in 100 generations (approximately 100 years).

#### **Veery**

The Veery displays an estimate of θ, 0.2852, almost nine times higher than in Bicknell's Thrush. This translates into an $N_{ef}$ of 7,000,000 (95% confidence interval of theta, $5.6 \times 10^6$ to $8.7 \times 10^6$) in northeastern New York State, Vermont and New Hampshire assuming $\mu = 1 \times 10^{-8}$ substitutions per site per generation. The growth rate estimator g = 2598.14 suggests approximately three times more rapid population growth than in Bicknell's Thrush. The predicted growth over the next 100 generations would be almost 1900 individuals.

### *Gene Flow*

#### **Bicknell's Thrush**

Estimates of gene flow based on Markov Chain Monte Carlo maximum likelihood estimation via Migrate are shown in Figure 5.1A. This shows that all Bicknell's Thrush populations are connected by $N_m \geq 1.0$, that is at least one individual per generation brings its genes into another sub-population. When $N_m$ reaches or exceeds 1.0 migrant per generation a population has sufficient gene flow to counteract random genetic drift. Migrate also allows inference on the direction of gene flow (Figure 5.1A). Note that there is at least some gene flow indicated from the Catskills and Green Mountains to all other sub-populations and that the amount of gene flow inferred is highest between the Catskills and Adirondacks.

#### **Veery**

Figure 5.1B shows gene flow estimates for the Veery. As with Bicknell's Thrush, all estimates of $N_m$ exceed or are equivalent to 1.0. Migrate suggests an essentially infinite amount of gene flow between the Green and White Mountains ($5.5 \times 10^6$), reflecting the predominance of haplotype A in all sub-populations and a lack of population subdivision. Not only is the abundant haplotype A almost evenly distributed across all mountain ranges, the three other haplotypes found in more than one bird (B, C and D) occurred in more than one region (see Figure 4.4). Although the inferred gene flow from the Green to White Mountains appears far out of line, it is well to remember a value of *Nm* in excess of one is indicative of panmixia and that levels in excess of four imply essentially infinite gene flow and thus are not qualitatively different from any higher number. This result indicates how artificial it is to define sub-populations for this widespread species. The next highest levels of gene flow, according to Migrate, appear to be from the Catskills to the Adirondacks and from the White to the Green Mountains. The direction of gene flow is from the Green Mountains to all other regions and to the Adirondacks from all other regions. The Catskills and White Mountains show a mix of gene flow direction.

## Discussion

### *Comparing the Population Genetics of Veery and Bicknell's Thrush in Northeastern Mountain Ranges*

It is noteworthy that Catskills samples of both Veery and Bicknell's Thrush differ from samples from other ranges in their greater sequence diversity. The Catskills sub-populations exhibit the highest levels of gene diversity (*h*), nucleotide diversity ($\pi$), and mean pairwise sequence difference (see Chapter 4 and Table 5.1). The Catskills sub-populations also showed the highest haplotype diversity in both species, five in Bicknell's Thrush, and five in Veery (the Green Mountains also had five Veery haplotypes). I would be more skeptical of this pattern if it were not shown by both species. This may reflect the age of settlement of the Catskills sub-population as rare haplotypes are better represented in older populations (Templeton 1998).

It is also notable that the Catskills appear to show the genetic imprint of being the first settled region in the northeast for both species. A gradient from more variable to less variable populations appears to be a signature of range expansion (Templeton *et al.* 1995). It seems likely based on models of vegetation range expansion from palynological and macrofossil analyses that the Catskills were amenable to Bicknell's Thrush between 14,000 to 13,000 years before present (YBP) (Delcourt and Delcourt 1987). I also suggest that the species arrived thereafter in the Green Mountains 12,000 to 11,000 YBP, the Adirondacks 11,000 to 10,000 YBP, and the White Mountains 10,000 to 9,000 YBP. I base this hypothesis on the pattern of genetic diversity and the historical pattern of range expansion in beech (*Fagus grandifolia*), maple (*Acer* spp.), and hemlock (*Tsuga canadensis*) combined with the retreat of spruce (*Picea* spp.) and fir (*Abies* spp.) (Delcourt and Delcourt 1987). For instance, Davis *et al.* (1980) showed that balsam fir (*Abies balsamea*), an important element of current Bicknell's Thrush habitat (Sabo 1980), appeared in abundance in the White Mountain pollen record ca.9000 YBP. For much of the period from ca.12,000 YBP to 9000 YBP it is likely that Bicknell's Thrush habitat was more widespread and at lower elevations than it is in the present. The retreat to the current distribution along mountain ridges and summits probably took place 8000 to 7000 YBP during the hypsithermal interval (Pielou 1991). It has been demonstrated that white pine (*Pinus strobus*) and hemlock ranged upward to 1000 m in the White Mountains during this period (Davis *et al.* 1980), implying that suitable Bicknell's Thrush habitat was above this elevation at the time.

Similarly, the Veery probably arrived in the Catskills 11,000 to 10,000 YBP, the Green Mountains very soon thereafter, and the Adirondacks and White Mountains 8000 to 7000 YBP. This is based on the patterns of range expansion of beech, maple, oak (*Quercus* spp.), and hemlock (Delcourt and Delcourt 1987; Davis *et al.* 1980).

Patterns of gene flow between the Catskills and other ranges also appear explicable for similar reasons. The direction of gene flow is largely away from the Catskills in the Migrate analysis, indicating the status of the Catskills as a source of genetic variation in other mountain ranges. A notable exception is net gene flow from the Green Mountains in the Veery, and from the White Mountains in Bicknell's Thrush. The former seems biologically reasonable since it is likely that during its post-glacial range expansion the Veery may have reached the southern Green Mountains from the Hudson Lowlands very soon after reaching the Catskill region, thus making detection of a difference in net gene flow between the Catskills and Green Mountains unlikely. These mountain ranges are only 160 kilometers apart and the Veery probably re-settled the lowlands adjacent to them fairly rapidly leading to scant differences in re-settlement time and thus a seemingly inconsistent direction of gene flow between them. The net gene flow from the White Mountains to the Catskills in the Bicknell's Thrush, with its more insular distribution, is less likely to be based on biology than a sampling artifact, perhaps attributable to the makeup of the founder population in northern New Hampshire. Large estimates of gene flow were generated between the Catskills and Adirondacks for both thrushes. Given the close geographic proximity of the ranges and their positions in a north to south line it is not surprising that the migratory Bicknell's Thrush's and Veery's respective sub-populations should exchange genes regularly across the modest barriers of the Mohawk Valley and intervening low ranges.

It seems probable that the Catskill sub-population of Bicknell's Thrush initially built up to high numbers, enabling it to retain much genetic diversity even after a long-term slow decline set in as the interglacial climate warmed. Alternatively, the current level of gene flow with other mountain ranges is sufficiently high to retain the original level of genetic diversity achieved upon colonization. This explanation seems less likely than the former when one considers the direction of gene flow inferred by 'Migrate'. It is plausible that both mechanisms contribute to the relatively high levels of genetic diversity evinced by Catskills samples of both species.

### *Comparing Bicknell's Thrush to Veery*

The salient difference between Veery and Bicknell's Thrush is the paradoxically higher genetic diversity of Bicknell's Thrush, given its lower number of haplotypes overall, and its small, slowly growing population. Results from 'Fluctuate' reveal a Bicknell's Thrush population far smaller than Veery that is increasing slowly if at all. 'Fluctuate' estimates a very high population for Bicknell's Thrush (ca. 800,000), relative to current field estimates of 25,000 to 50,000 (Rimmer *et al.* 2001). The high and positive Tajima's D (1.8247) in Bicknell's Thrush seems to indicate a population that has declined or one that is stable but not at drift equilibrium. Only the Catskill sub-population produced a comparably high level of Tajima's D. Given that this sub-population has almost certainly declined since the interglacial temperature maximum ca. 8000 YBP, a high Tajima's D may reflect this decline.

By contrast, in spite of low measures of genetic diversity, the Veery shows all the earmarks of a rapidly growing population, exhibiting many apparently young and scarce haplotypes along with a seemingly older and abundant core haplotype. A similar pattern has been documented for the widespread and common Greenfinch (*Carduelis chloris*) of Europe, attributed by Merilä *et al.* (1997) to growth out of southern European bottlenecked populations in glacial refugia. Hewitt (1996) has also pointed out that genetic diversity might be lost at an expanding range front as a species occupies new territory due to the establishment of many small founder populations at the forefront of the expansion. The significant negative value of Tajima's D (-1.8373) probably indicates a rapid demographic expansion rather than the effect of selection on the control region (Hartl and Clark 1997).

These data appear to reflect the contrasting population histories of these thrush species. The Bicknell's Thrush's range was much closer to the glacial front at its maximum advance and this species has likely always maintained a much smaller, more stable population with greater levels of genetic diversification than Veery (i.e. fewer but more widely diverging haplotypes). They have also been present in the northeast north of the maximum glacial advance at least two to three thousand years longer than Veery (see above). On the other hand, the Veery shows signs of having spent time in a small, bottlenecked population in a restricted refugium or refugia well south of the current southern boundary of its modern range. Although one cannot pinpoint the location of this refugium, the vegetation maps in Delcourt and Delcourt (1987) suggest that it may have been in the Mississippi Delta region. The rapid demographic expansion has nearly obliterated much indication of the pattern of range expansion in the Veery. However the genetic diversity gradient from the Catskills and Green Mountains to the Adirondacks and White Mountains and the direction of the gene flow indicated in Figure 5.1 sensibly suggest that settlement occurred later in northeastern New York and northern New Hampshire.

## Summary

The higher levels of genetic diversity for both Bicknell's Thrush and Veery seen in the Catskill samples sensibly suggest that the Catskills have indeed been longer occupied than the more northerly Adirondack, Green and White mountains. The differing patterns of genetic diversity, and coalescence estimates of population growth and population size point to small populations showing little growth in Bicknell's Thrush versus much larger populations that have grown much faster in the Veery. This result is consistent with presumptive bottlenecking combined with a fairly rapid population increase and post-glacial range expansion in the Veery. Bicknell's Thrush seems to have had a stable population with fairly high levels of dispersal to maintain genetic diversity. The high value of Tajima's D in the Catskill Mountains may indicate a population decline in Bicknell's Thrush at the southern edge of its range. The comparable gene flow results between the $\Phi_{ST}$ based estimates of Chapter Four and the coalescence-based method used in this chapter emphasize the apparent mobility of Bicknell's Thrush among mountain ranges.

Conservation of Bicknell's Thrush should focus on habitat preservation and the husbanding of its largest source populations (e.g. Mt. Mansfield, Vermont; Mt. Washington, New Hampshire), as well as a major effort to preserve the limited wintering habitat on Hispaniola (C. Rimmer, pers. comm.). The Veery appears to be in less danger than Bicknell's Thrush, but it has gone through an extended decline over the last three decades (Price *et al.* 1995), apparently due to habitat fragmentation and habitat loss on its South American wintering range (Moskoff 1995). If these trends continue the Veery's apparent lack of genetic diversity attributable to Pleistocene population bottlenecks may limit its ability to adapt to global change in the near future.

|  | Diversity Indices |  |  |
|---|---|---|---|
|  | Gene Diversity (*h*) | Nucleotide Diversity ($\pi$) | Mean Pairwise Difference |
| A. Bicknell's Thrush |  |  |  |
| Total | 0.7010 | 0.005995 | 2.35 |
| Adirondack | 0.6889 | 0.006122 | 2.40 |
| Catskill | 0.8000 | 0.006546 | 2.53 |
| Green Mt. | 0.5256 | 0.005155 | 2.00 |
| White Mt. | 0.6889 | 0.004138 | 1.62 |
| B. Veery |  |  |  |
| Total | 0.6026 | 0.001699 | 0.67 |
| Adirondack | 0.3778 | 0.001023 | 0.40 |
| Catskill | 0.7556 | 0.002444 | 0.96 |
| Green Mt. | 0.6667 | 0.001538 | 0.60 |
| White Mt. | 0.6444 | 0.001913 | 0.76 |

**Table 5.1. Measures of genetic diversity in Bicknell's Thrush and Veery for the complete sample and among sub-populations.**

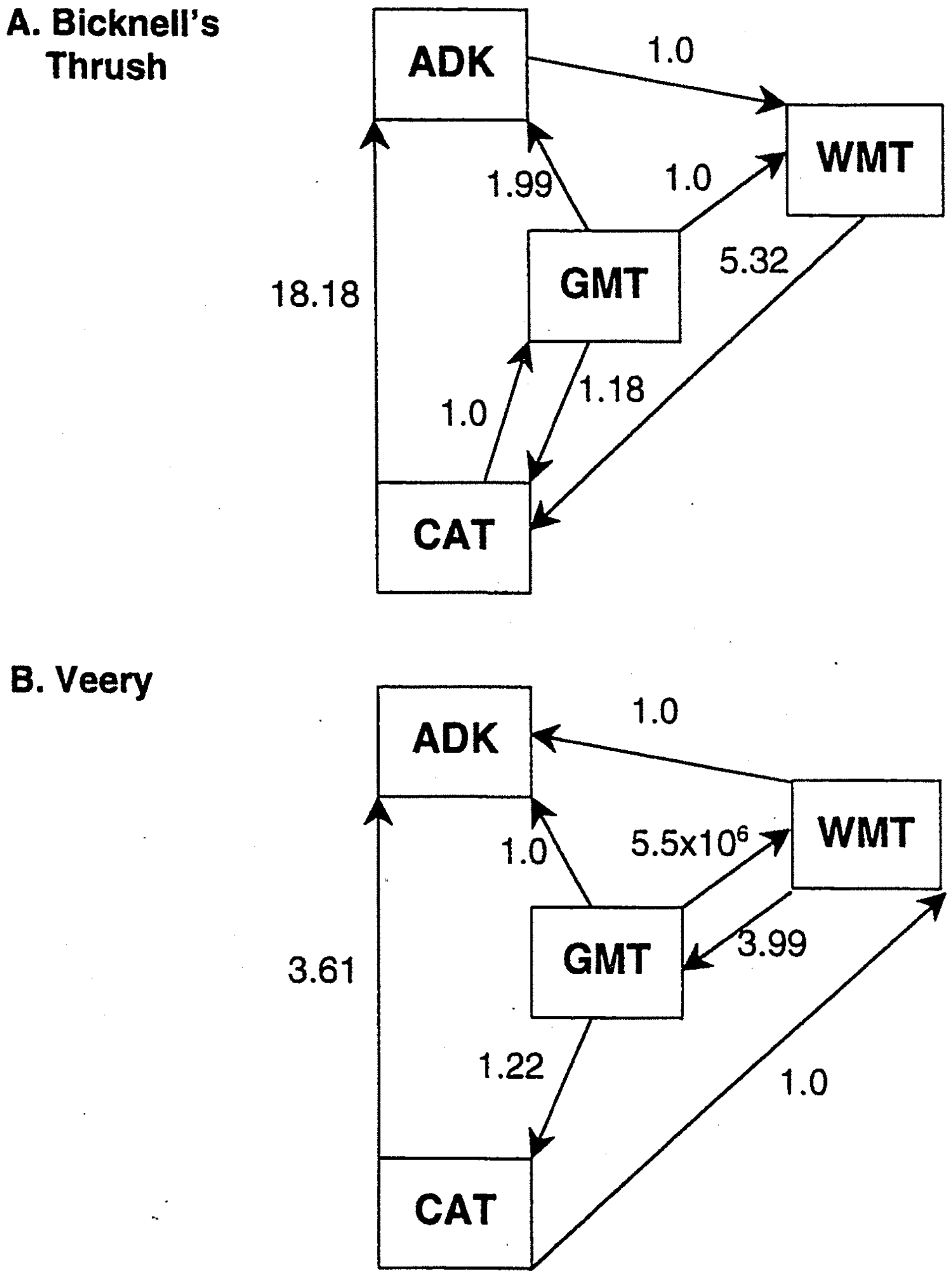

**Figure 5.1. Patterns and rates of gene flow among mountain ranges for Bicknell's Thrush (A) and Veery (B).** The boxes represent mountain ranges roughly in relation to geographical position (ADK=Adirondacks, CAT=Catskills, GMT=Green Mts., WMT=White Mts.). Lines among boxes represent gene flow with arrow heads indicating the predominant direction of genetic exchange, and the numbers representing the calculated number of breeding individuals exchanged per generation ($4N_m$) by the program Migrate (Beerli and Felsenstein 1999).

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# Appendix I

## Thrushes Sampled in this Study

Complete band numbers, location information, and morphometric data for Bicknell's Thrushes, Veeries and Gray-cheeked Thrushes captured in this study.

Date format includes Roman numeral to represent month;
Age codes: SY=Second (calendar) Year, AHY=After Hatch Year;
Sex codes: M=Male, F=Female, U=Unknown sex

## Bicknell's Thrush

| Band Number | Locality | Latitude, Longitude | Elevation (m) | Date | Age-Sex | Wing (mm) | Tail (mm) | Culmen (mm) | Tarsus (mm) | Mass (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| *ADIRONDACK MOUNTAINS, NY* | | | | | | | | | | |
| 1161-17732 | Whiteface Mt. | 44°22', 73°53' | 1250-1300 | 30 VI 1993 | SY-M | 91 | 73 | 8.6 | 28.2 | 28.8 |
| 1161-17733 | Whiteface Mt. | 44°22', 73°53' | 1250-1300 | 30 VI 1993 | AHY-M | 95 | 72 | 8.5 | 27.0 | 30.0 |
| 1161-17734 | Whiteface Mt. | 44°22', 73°53' | 1250-1300 | 1 VII 1993 | SY-M | 92 | 68 | 8.9 | 27.6 | 27.1 |
| 1161-17735 | Whiteface Mt. | 44°22', 73°53' | 1250-1300 | 7 VII 1993 | AHY-M | 92 | 74 | 9.8 | 29.6 | 29.0 |
| 1161-17748 | Phelps Mt. | 44°00', 73°50' | 1200-1250 | 22 VI 1994 | AHY-M | 95 | 72 | 9.1 | 27.6 | 26.5 |
| 1161-17749 | Phelps Mt. | 44°00', 73°50' | 1200-1250 | 22 VI 1994 | AHY-M | 97 | 74 | 9.5 | 28.8 | 30.0 |
| 1161-17750 | Phelps Mt. | 44°00', 73°50' | 1200-1250 | 22 VI 1994 | AHY-M | 96 | 72 | 9.6 | 28.5 | 29.0 |
| 1161-17751 | Phelps Mt. | 44°00', 73°50' | 1200-1250 | 22 VI 1994 | AHY-M | 95 | 73 | 9.5 | 28.2 | 29.0 |
| 1161-17755 | Wright Peak | 44°08', 73°58' | 950 | 31 V 1995 | AHY-M | 95 | 71 | 9.5 | 28.2 | 26.2 |
| 1161-17756 | Wright Peak | 44°08', 73°58' | 950 | 31 V 1995 | AHY-M | 94 | 70 | 9.0 | 27.5 | 27.2 |
| 1161-17757 | Cascade Mt. | 44°13', 73°51' | 1170 | 1 VI 1995 | AHY-M | 94 | 70 | 9.5 | 27.5 | 26.0 |
| 1161-17758 | Cascade Mt. | 44°13', 73°51' | 1170 | 1 VI 1995 | AHY-M | 93 | 67 | 8.5 | 27.5 | 27.5 |
| 1161-17759 | Hurricane Mt. | 44°10', 73°40' | 1100 | 2 VI 1995 | AHY-M | 95 | 72 | 8.9 | 27.0 | 26.4 |
| *CATSKILL MOUNTAINS, NY* | | | | | | | | | | |
| 1161-17718 | Hunter Mt. | 42°10', 74°15' | 1210 | 9 VI 1993 | SY-M | 88 | 64 | 8.3 | 27.0 | 24.7 |
| 1161-17719 | Slide Mt. | 42°00', 74°25' | 1180-1210 | 11 VI 1993 | AHY-M | 96 | 70 | 9.2 | 27.0 | 29.2 |
| 1161-17720 | Slide Mt. | 42°00', 74°25' | 1180-1210 | 14 VI 1993 | AHY-F | 88 | 65 | 9.9 | 26.5 | 29.5 |
| 1161-17726 | Black Dome | 42°15', 74°07' | 1180 | 26 VI 1993 | AHY-M | 91 | 66 | 9.7 | 28.5 | 26.9 |
| 1161-17727 | Black Dome | 42°15', 74°07' | 1180 | 26 VI 1993 | SY-M | 88 | 67 | 9.3 | 28.6 | 27.0 |

## Bicknell's Thrush, continued

| Band Number | Locality | Latitude, Longitude | Elevation (m) | Date | Age-Sex | Wing (mm) | Tail (mm) | Culmen (mm) | Tarsus (mm) | Mass (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| *CATSKILL MOUNTAINS, NY,* continued | | | | | | | | | | |
| 1161-17728 | Plateau Mt. | 42°07', 74°12' | 1130-1150 | 27 VI 1993 | AHY-M | 95 | 75 | 8.9 | 30.1 | 31.9 |
| 1161-17729 | Plateau Mt. | 42°07', 74°12' | 1130-1150 | 27 VI 1993 | SY-M | 89 | 67 | 8.9 | 28.9 | 29.0 |
| 1161-17730 | Plateau Mt. | 42°07', 74°12' | 1130-1150 | 27 VI 1993 | AHY-M | 90 | 71 | 9.4 | 28.9 | 24.7 |
| 1161-17731 | Plateau Mt. | 42°07', 74°12' | 1130-1150 | 27 VI 1993 | AHY-M | 89 | 74 | 9.5 | 30.0 | 28.5 |
| 1161-17737 | Blackhead | 42°10', 74°00' | 1180 | 5 VI 1994 | AHY-M | 95 | 69 | 9.0 | 29.2 | 27.9 |
| 1161-17738 | Blackhead | 42°10', 74°00' | 1180 | 5 VI 1994 | AHY-M | 96 | 72 | 9.1 | 29.5 | 30.0 |
| 1161-17739 | Plateau Mt. | 42°07', 74°12' | 1130-1150 | 8 VI 1994 | AHY-M | 90 | 66 | 9.8 | 30.2 | 29.2 |
| 1161-17740 | Plateau Mt. | 42°07', 74°12' | 1130-1150 | 8 VI 1994 | AHY-M | 92 | 67 | 9.9 | 30.0 | 30.9 |
| 1161-17741 | Plateau Mt. | 42°07', 74°12' | 1130-1150 | 8 VI 1994 | AHY-M | 92 | 65 | 8.6 | 28.5 | 27.6 |
| 1161-17752 | Blackhead | 42°10', 74°00' | 1180 | 25 V 1995 | AHY-U | 93 | 68 | 9.1 | 29.9 | 25.6 |
| 1161-17753 | Blackhead | 42°10', 74°00' | 1180 | 25 V 1995 | AHY-M | 93 | 69 | 9.3 | 29.0 | – |
| 1161-17754 | Black Dome | 42°15', 74°07' | 1180 | 25 V 1995 | SY-M | 93 | 71 | 9.3 | 27.4 | 29.1 |
| *GREEN MOUNTAINS, VT* | | | | | | | | | | |
| 1161-17715 | Mt. Mansfield | 44°30', 72°50' | 1090-1150 | 3 VI 1993 | AHY-M | 95 | 69 | 8.9 | 29.8 | 28.0 |
| 1161-17716 | Mt. Mansfield | 44°30', 72°50' | 1090-1150 | 4 VI 1993 | AHY-M | 89 | 65 | 9.6 | 28.3 | 26.7 |
| 1161-17717 | Mt. Mansfield | 44°30', 72°50' | 1090-1150 | 5 VI 1993 | AHY-F | 92 | 68 | 8.9 | 28.2 | 30.3 |
| 1161-17722 | Shrewsbury Pk. | 42°32', 72°50' | 1060-1090 | 17 VI 1993 | AHY-F | 87 | 66 | 8.4 | 24.5 | 29.5 |
| 1161-17723 | Shrewsbury Pk. | 42°32', 72°50' | 1060-1090 | 17 VI 1993 | AHY-M | 94 | 72 | 9.2 | 27.9 | 28.9 |
| 1161-17724 | Shrewsbury Pk. | 42°32', 72°50' | 1060-1090 | 19 VI 1993 | AHY-M | 97 | 73 | 9.5 | 27.3 | 29.1 |

## Bicknell's Thrush, continued

| Band Number | Locality | Latitude, Longitude | Elevation (m) | Date | Age-Sex | Wing (mm) | Tail (mm) | Culmen (mm) | Tarsus (mm) | Mass (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| *GREEN MOUNTAINS, VT*, continued | | | | | | | | | | |
| 1161-17725 | Shrewsbury Pk. | 42°32', 72°50' | 1060-1090 | 19 VI 1993 | AHY-M | 94 | 72 | 9.7 | 26.8 | 28.2 |
| 1161-17736 | Stratton Mt. | 43°00', 72°50' | 1200 | 29 V 1994 | AHY-M | 90 | 67 | 9.1 | 27.4 | 28.1 |
| 1471-47932 | Mt. Mansfield | 44°30', 72°50' | 1090-1150 | 1 VI 1994 | AHY-F | 94 | 60 | 10.5 | 28.7 | 28.8 |
| 1471-47901 | Mt. Mansfield | 44°30', 72°50' | 1090-1150 | 2 VI 1994 | ASY-M | 95 | 61 | 9.6 | 29.4 | 27.7 |
| 1471-47916 | Mt. Mansfield | 44°30', 72°50' | 1090-1150 | 2 VI 1994 | AHY-U | 90 | 65 | 9.6 | 28.4 | 28.6 |
| 1471-47937 | Mt. Mansfield | 44°30', 72°50' | 1090-1150 | 2 VI 1994 | AHY-M | 97 | 67 | 9.5 | 27.0 | 29.4 |
| 1471-47938 | Mt. Mansfield | 44°30', 72°50' | 1090-1150 | 3 VI 1994 | SY-M | 93 | 68 | 8.9 | 29.5 | 28.8 |
| 1471-47904 | Mt. Mansfield | 44°30', 72°50' | 1090-1150 | 3 VI 1994 | ASY-M | 91 | 66 | 9.2 | 27.9 | 26.8 |
| 1161-17742 | Shrewsbury Pk. | 42°32', 72°50' | 1060-1090 | 10 VI 1994 | SY-M | 90 | 65 | 9.2 | 29.4 | 26.5 |
| 1481-27602 | Haystack Mt. | 42°55', 72°55' | 1050 | 5 VII 1994 | AHY-M | 91 | 70 | 8.1 | 29.2 | 25.2 |
| 1481-27603 | Haystack Mt. | 42°55', 72°55' | 1050 | 5 VII 1994 | AHY-F | 86 | 65 | 9.4 | 28.5 | 29.5 |
| *WHITE MOUNTAINS, NH* | | | | | | | | | | |
| 1161-17743 | Mt. Jefferson | 44°10', 71°10' | 950-1200 | 14 VI 1994 | AHY-M | 94 | 70 | 8.5 | 26.5 | 28.2 |
| 1161-17744 | Mt. Jefferson | 44°10', 71°10' | 950-1200 | 14 VI 1994 | AHY-M | 92 | 68 | 9.2 | 28.3 | 28.5 |
| 1161-17745 | Mt. Jefferson | 44°10', 71°10' | 950-1200 | 14 VI 1994 | AHY-M | 96 | 68 | 9.2 | 27.5 | 29.1 |
| 1161-17746 | Mt. Washington | 44°10', 71°10' | 1320-1400 | 15 VI 1994 | AHY-M | 96 | 72 | 8.9 | 26.2 | 27.5 |
| 1161-17747 | Mt. Washington | 44°10', 71°10' | 1320-1400 | 15 VI 1994 | AHY-M | 90 | 67 | 9.5 | 27.9 | 27.9 |
| 1161-17760 | Mt. Jefferson | 44°10', 71°10' | 950-1200 | 7 VI 1995 | AHY-M | 92 | 68 | 9.0 | 26.3 | 24.9 |
| 1161-17761 | Mt. Jefferson | 44°10', 71°10' | 950-1200 | 7 VI 1995 | AHY-U | 94 | 69 | 9.2 | 31.0 | 27.1 |

## Bicknell's Thrush, continued

| Band Number | Locality | Latitude, Longitude | Elevation (m) | Date | Age-Sex | Wing (mm) | Tail (mm) | Culmen (mm) | Tarsus (mm) | Mass (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| *WHITE MOUNTAINS, NH*, continued | | | | | | | | | | |
| 1161-17762 | Mt. Jefferson | 44°10', 71°10' | 950-1200 | 8 VI 1995 | AHY-M | 95 | 73 | 9.5 | 26.6 | 28.1 |
| 1161-17763 | Mt. Jefferson | 44°10', 71°10' | 950-1200 | 8 VI 1995 | AHY-F | 88 | 65 | 9.9 | 26.7 | 26.8 |
| 1161-17764 | Mt. Jefferson | 44°10', 71°10' | 950-1200 | 8 VI 1995 | AHY-M | 95 | 72 | 9.6 | 28.1 | 27.9 |
| 1161-17765 | Mt. Osceola | 44°00', 71°30' | 1060 | 10 VI 1995 | SY-M | 92 | 66 | 9.1 | 29.0 | 27.4 |

**Veery**

| Band Number | Locality | Latitude, Longitude | Elevation (m) | Date | Age-Sex | Wing (mm) | Tail (mm) | Culmen (mm) | Tarsus (mm) | Mass (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| *ADIRONDACK MOUNTAINS, NY* | | | | | | | | | | |
| 1161-17793 | Lincoln Pd., Elizabethtown | 44°00', 73°30' | 390-450 | 17 VI 1997 | AHY-M | 98 | 75 | 9.2 | 27.8 | 33.2 |
| 1161-17794 | Lincoln Pd., Elizabethtown | 44°00', 73°30' | 390-450 | 17 VI 1997 | AHY-M | 100 | 74 | 8.8 | 26.8 | 31.5 |
| 1161-17795 | Lincoln Pd., Elizabethtown | 44°00', 73°30' | 390-450 | 17 VI 1997 | AHY-M | 97 | 70 | 9.4 | 29.4 | 31.0 |
| 1161-17796 | Lincoln Pd., Elizabethtown | 44°00', 73°30' | 390-450 | 17 VI 1997 | AHY-M | 101 | 74 | 9.7 | 29.0 | 32.4 |
| 1161-17797 | High Falls Gorge, Wilmington | 44°20', 73°50' | 390-450 | 18 VI 1997 | SY-U | 99 | 71 | 8.4 | 28.4 | 31.0 |
| 1161-17798 | Wilmington Notch Campground, Wilmington | 44°20', 73°50' | 390-450 | 18 VI 1997 | SY-M | 96 | 68 | 9.2 | 28.2 | 31.2 |
| 1161-17799 | Hearn Swamp, Forestdale Rd., Black Brook | 44°20', 73°40' | 450 | 19 VI 1997 | AHY-M | 101 | 74 | 9.6 | 28.5 | 31.5 |
| 1431-98210 | Taylor Pond Campground, Black Brook | 44°20', 73°40' | 450 | 30 VI 1997 | SY-M | 98 | 74 | 9.8 | 29.5 | 30.5 |

**Veery, continued**

| Band Number | Locality | Latitude, Longitude | Elevation (m) | Date | Age-Sex | Wing (mm) | Tail (mm) | Culmen (mm) | Tarsus (mm) | Mass (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| *ADIRONDACK MOUNTAINS, NY*, continued | | | | | | | | | | |
| 1431-98211 | Hearn Swamp, Forestdale Rd., Black Brook | 44°20', 73°50' | 450 | 30 VI 1997 | AHY-M | 101 | 72 | 8.9 | 28.8 | 31.4 |
| 1431-98212 | Hearn Swamp, Forestdale Rd., Black Brook | 44°20', 73°50' | 450 | 30 VI 1997 | SY-U | 97 | 72 | 9.1 | 28.3 | 30.0 |
| *CATSKILL MOUNTAINS, NY* | | | | | | | | | | |
| 1161-17770 | Mink Hollow, Hunter | 42°00', 74°00' | 680-695 | 24 V 1997 | SY-M | 97 | 70 | 8.9 | 25.2 | 30.0 |
| 1161-17771 | Mink Hollow, Hunter | 42°00', 74°00' | 680-695 | 24 V 1997 | AHY-U | 100 | 73 | 10.5 | 27.3 | 32.2 |
| 1161-17772 | Mink Hollow, Hunter | 42°00', 74°00' | 680-695 | 24 V 1997 | AHY-M | 102 | 77 | 8.5 | 27.5 | 31.6 |
| 1161-17773 | Mink Hollow, Hunter | 42°00', 74°00' | 680-695 | 24 V 1997 | AHY-M | 98 | 76 | 8.6 | 28.6 | 31.8 |
| 1161-17774 | Stony Clove, Hunter | 42°00', 74°10' | 575 | 26 V 1997 | AHY-M | 100 | 75 | 8.2 | 29.8 | 31.9 |
| 1161-17775 | Stony Clove, Hunter | 42°00', 74°10' | 575 | 27 V 1997 | AHY-M | 101 | 75 | 8.8 | 27.5 | 31.5 |

**Veery, continued**

| Band Number | Locality | Latitude, Longitude | Elevation (m) | Date | Age-Sex | Wing (mm) | Tail (mm) | Culmen (mm) | Tarsus (mm) | Mass (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| *CATSKILL MOUNTAINS, NY,* continued | | | | | | | | | | |
| 1161-17776 | Stony Clove, Hunter | 42°00', 74°10' | 575 | 27 V 1997 | SY-M | 99 | 74 | 9.7 | 28.5 | 29.6 |
| 1161-17777 | McKenley Hollow, Big Indian | 42°00', 74°20' | 545 | 27 V 1997 | SY-M | 100 | 76 | 10.0 | 28.5 | 29.8 |
| 1161-17778 | McKenley Hollow, Big Indian | 42°00', 74°20' | 545 | 27 V 1997 | AHY-M | 100 | 76 | 8.9 | 27.0 | 30.6 |
| 1161-17779 | Dutcher Notch Trail, Roundtop | 42°10', 74°00' | 360 | 28 V 1997 | SY-M | 95 | 70 | 8.9 | 28.5 | 31.1 |
| *GREEN MOUNTAINS, VT* | | | | | | | | | | |
| 1161-17780 | Searsburg Res., Searsburg | 42°50', 72°50' | 540 | 31 V 1997 | SY-M | 100 | 73 | 10.1 | 29.7 | 30.6 |
| 1161-17781 | Harbour Rd., Woodford | 42°50', 73°00' | 425-450 | 2 VI 1997 | AHY-M | 102 | 76 | 9.0 | 27.2 | 29.0 |
| 1161-17782 | Roaring Brook, Stamford | 42°46', 73°05' | 515 | 3 VI 1997 | AHY-M | 100 | 75 | 8.6 | 26.5 | 30.1 |
| 1161-17783 | Burgess Rd., Woodford | 42°50', 73°10' | 425-450 | 3 VI 1997 | AHY-M | 99 | 73 | 9.2 | 27.4 | 29.9 |
| 1161-17784 | Burgess Rd., Woodford | 42°50', 73°10' | 425-450 | 3 VI 1997 | AHY-M | 97 | 73 | 9.0 | 28.0 | 33.0 |

**Veery, continued**

| Band Number | Locality | Latitude, Longitude | Elevation (m) | Date | Age-Sex | Wing (mm) | Tail (mm) | Culmen (mm) | Tarsus (mm) | Mass (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| *GREEN MOUNTAINS, VT*, continued | | | | | | | | | | |
| 1161-17785 | Plymsbury Unit, Coolidge S.F., Plymouth | 43°30', 72°40' | 410-485 | 10 VI 1997 | AHY-M | 101 | 72 | 9.4 | 28.5 | 34.2 |
| 1161-17786 | Plymsbury Unit, Coolidge S.F., Plymouth | 43°30', 72°40' | 410-485 | 10 VI 1997 | AHY-M | 99 | 75 | 9.0 | 29.1 | 32.2 |
| 1161-17787 | Plymsbury Unit, Coolidge S.F., Plymouth | 43°30', 72°40' | 410-485 | 10 VI 1997 | SY-M | 98 | 69 | 9.1 | 29.2 | 32.1 |
| 1161-17788 | Little River S.P., Waterbury | 44°20', 72°40' | 410-425 | 15 VI 1997 | AHY-U | 96 | 76 | 8.4 | 27.1 | 31.1 |
| 1161-17789 | Little River S.P., Waterbury | 44°20', 72°40' | 410-425 | 15 VI 1997 | AHY-M | 97 | 74 | 8.4 | 28.2 | 32.0 |
| 1161-17790 | Little River S.P., Waterbury | 44°20', 72°40' | 410-425 | 15 VI 1997 | AHY-M | 100 | 74 | 10.1 | 29.8 | 32.1 |
| 1161-17791 | Little River S.P., Waterbury | 44°20', 72°40' | 410-425 | 15 VI 1997 | AHY-M | 97 | 74 | 9.2 | 26.9 | 30.3 |
| 1161-17792 | Little River S.P., Waterbury | 44°20', 72°40' | 410-425 | 16 VI 1997 | AHY-U | 100 | 77 | 9.4 | 26.5 | 30.0 |

## Veery, continued

| Band Number | Locality | Latitude, Longitude | Elevation (m) | Date | Age-Sex | Wing (mm) | Tail (mm) | Culmen (mm) | Tarsus (mm) | Mass (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| *WHITE MOUNTAINS, NH* | | | | | | | | | | |
| 1161-17800 | Mossilauke e. shoulder, Rt. 118, Woodstock | 43°50', 71°40' | 450-515 | 22 VI 1997 | AHY-M | 97 | 73 | 9.2 | 28.2 | 29.9 |
| 1431-98201 | Jackman Brook, Rt. 118, Woodstock | 44°00', 71°40' | 450-515 | 22 VI 1997 | AHY-M | 100 | 73 | 9.2 | 29.2 | 33.1 |
| 1431-98202 | Tripoli Rd., Thornton | 43°50', 71°30' | 425-485 | 23 VI 1997 | AHY-M | 100 | 77 | 8.6 | 28.4 | 31.8 |
| 1431-98203 | Tripoli Rd., Thornton | 43°50', 71°30' | 425-485 | 23 VI 1997 | SY-M | 95 | 70 | 9.3 | 28.3 | 30.1 |
| 1431-98204 | Tripoli Rd., Thornton | 43°50', 71°30' | 425-485 | 23 VI 1997 | AHY-M | 98 | 74 | 8.8 | 29.3 | 30.0 |
| 1431-98205 | s. of Zealand Campground, Ammonoosuc R., Carroll | 44°10', 71°30' | 450 | 24 VI 1997 | SY-M | 95 | 72 | 9.2 | 26.5 | 26.2 |
| 1431-98206 | s. of Zealand Campground, Ammonoosuc R., Carroll | 44°10', 71°30' | 450 | 24 VI 1997 | AHY-M | 100 | 73 | 9.9 | 28.4 | 30.0 |

## Veery, continued

| Band Number | Locality | Latitude, Longitude | Elevation (m) | Date | Age-Sex | Wing (mm) | Tail (mm) | Culmen (mm) | Tarsus (mm) | Mass (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| *WHITE MOUNTAINS, NH*, continued | | | | | | | | | | |
| 1431-98207 | Gale River trailhead, Bethlehem | 44°10', 71°40' | 450 | 24 VI 1997 | SY-M | 100 | 77 | 8.5 | 29.3 | 31.8 |
| 1431-98208 | Bear Notch, Bartlett | 44°00', 71°10' | 425 | 24 VI 1997 | AHY-M | 102 | 79 | 8.9 | 28.5 | 33.0 |
| 1431-98209 | Bear Notch, Bartlett | 44°00', 71°10' | 425 | 24 VI 1997 | SY-M | 97 | 74 | 9.0 | 28.2 | 30.0 |

## Gray-cheeked Thrush

| Band Number | Locality | Latitude, Longitude | Elevation (m) | Date | Age-Sex | Wing (mm) | Tail (mm) | Culmen (mm) | Tarsus (mm) | Mass (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| *LABRADOR* | | | | | | | | | | |
| 1161-17766 | Miron River, Trans Labrador Hwy | 53°15', 66°00' | 500-550 | 25 VI 1995 | AHY-M | 107 | 75 | 10.8 | 29.7 | 35.0 |
| 1161-17767 | Miron River, Trans Labrador Hwy | 53°15', 66°00' | 500-550 | 27 VI 1995 | AHY-M | 107 | 79 | 11.0 | 26.7 | 34.1 |
| *NEWFOUNDLAND* | | | | | | | | | | |
| 1161-17768 | east shore, Pistolet Bay, N. Peninsula | 51°29', 55°39' | 50 | 23 VI 1996 | SY-M | 102 | 74 | 9.0 | 28.6 | 32.9 |
| 1161-17769 | Viking Trail, Sainte Lunaire, N. Peninsula | 51°28', 55°35' | 50 | 23 VI 1996 | SY-M | 100 | 73 | 9.9 | 29.5 | 29.8 |

# Appendix II

## Control Region III Sequences of *Catharus* thrushes

Aligned 395 bp sequence from control region III of Bicknell's Thrush, Veery, Gray-cheeked Thrush, Hermit Thrush, and Swainson's Thrush.

Sample ID codes are derived from a single letter locality designation [G=Green Mt; C=Catskill Mt; A=Adirondack Mt; W=White Mt (for Bicknell's and Veery); L=Labrador; N=Newfoundland (for Gray-cheeked)], a single letter species code (B=Bicknell's Thrush; V=Veery; G=Gray-cheeked Thrush; H=Hermit Thrush; S=Swainson's Thrush), a three digit (four in Swainson's) numerical code for each bird, and the single letter within-species haplotype code.

ery,

n Mt;
abrador;
ll's
Thrush)
letter

## Bicknell's Thrush

```
                  10         20         30         40         50
                   |          |          |          |
CB718a  GATGCACTTT GACCCCATTC ACGAGGGGGA GGCTATTTAC CTCTTAAGTA
CB719c  .......... .......... .......... .......... ..........
CB720d  .......... .......... .......... ..?....... ..........
CB727b  .......... .......... .......... .......... ..........
CB728f  ?......... .......... .......... .......... ..........
CB730b  .......... .......... .......... .......... ..?.......
CB737b  .......... .......... .......... .......... ..........
CB741a  ?????..... .......... .......... .......... ..........
CB753b  ?????..... .......... .......... .......... ..........
CB754a  ?......... .......... .......... .......... ..........
GB602a  .......... .......... .......... ..?....... ..........
GB603b  ..?....... .......... .......... .......... ..?.......
GB715a  .......... .......... .......... .......... ..........
GB717g  .......... .......... .......... .......... ..........
GB724a  .......... .......... .......... ..?....... ?.........
GB725a  ....??.?.. .......... .......... ..??...... ..........
GB736a  .......... .......... .......... .......... ..........
GB901b  .......... .......... .......... .......... ..........
GB904d  .......... .......... .......... .......... ..........
GB916a  .......... .......... .......... .......... ..........
GB932a  .......... .......... .......... .......... ..........
GB937a  .......... .......... .......... .......... ..........
GB938a  .......... .......... .......... .......... ..........
AB732e  .......... .......... .......... .......... ..........
AB733a  ......?... .......... .......... ..?....... ..........
AB734a  .......... .......... .......... .......... ..........
AB735a  .......... .......... .......... .......... ..........
AB748a  .......... .......... .......... .......... ..........
AB749e  ?????..... .......... .......... .......... ..........
AB755b  ?????..... .......... .......... .......... ..........
AB757b  ?????..... .......... .......... .......... ..........
AB758b  ?......... .......... .......... .......... ..........
AB759a  ?????..... .......... .......... .......... ..........
WB743b  ..?....... .......... .......... .......... ..........
WB744b  ?......... .......... .......... .......... ..........
WB745b  ?......... .......... .......... .......... ..........
WB746c  ?......... .......... .......... .......... ..........
WB747a  .......... .......... .......... .......... ..........
WB760c  .......... .......... .......... .......... ..........
WB761c  ?????..... .......... .......... .......... ..........
WB762b  ??????.... .......... .......... .......... ..........
WB764a  .......... .......... .......... .......... ..........
WB765b  ..?....... .......... .......... .......... ..........
```

```
                    60         70         80         90        100
                     |          |          |          |
CB718a  TGCAGATAGT GTAATGGTCA CCGCACATAT TTAGATTGTT TCCCCTTTCT
CB719c  .......... .......... .......... .......... ..........
CB720d  .......... .......... .......... .......... ..........
CB727b  .......... .......... .......... .......... ..........
CB728f  .......... .......... .......... .......... ..........
CB730b  .......... .......... .......... .......... ..........
CB737b  .......... .......... .......... .......... ..........
CB741a  .......... .......... .......... .......... ..........
CB753b  .......... .......... .......... .......... ..........
CB754a  .......... .......... .......... .......... ..........
GB602a  .......... .......... .......... .......... ........?.
GB603b  .......... .......... .......... .......... ..........
GB715a  .......... .......... .......... .......... ..........
GB717g  .......... .......... .......... .......... ..........
GB724a  .......... .......... .......... .......... ..........
GB725a  .......... .......... .......... .......... ..........
GB736a  .......... .......... .......... .......... ..........
GB901b  .......... .......... .......... .......... ..........
GB904d  .......... .......... .......... .......... ..........
GB916a  .......... .......... .......... .......... ..........
GB932a  .......... .......... .......... .......... ..........
GB937a  .......... .......... .......... .......... ..........
GB938a  .......... .......... .......... .......... ..........
AB732e  .......... .......... .......... .......... ..........
AB733a  .......... .......... .......... .......... ........?.
AB734a  .......... .......... .......... .......... ..........
AB735a  .......... .......... .......... .......... ..........
AB748a  .......... .......... .......... .......... ..........
AB749e  .......... .......... .......... .......... ..........
AB755b  .......... .......... .......... .......... ..........
AB757b  .......... .......... .......... .......... ..........
AB758b  .......... .......... .......... .......... ..........
AB759a  .......... .......... .......... .......... ..........
WB743b  .......... .......... .......... .......... ..........
WB744b  .......... .......... .......... .......... ..........
WB745b  .......... .......... .......... .......... ..........
WB746c  .......... .......... .......... .......... ..........
WB747a  .......... .......... .......... .......... ..........
WB760c  .......... .......... .......... .......... ..........
WB761c  .......... .......... .......... .......... ..........
WB762b  .......... .......... .......... .......... ..........
WB764a  .......... .......... .......... .......... ..........
WB765b  .......... .......... .......... .......... ..........
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**Bicknell's Thrush** (continued)

```
               110        120        130        140        150
                 |          |          |          |
CB718a  AGGAATTTCC ATCTAAACCC CTAAAAATCA TCATTTTTTT CGTTCGTTTA
CB719c  .......... .......... .......... .......... ..........
CB720d  .......... .......... .......... .......... ..........
CB727b  .......... .......... .......... .......... ..........
CB728f  .......... .......... .......... .......... ..........
CB730b  .......... .......... .......... .......... ..........
CB737b  .......... .......... .......... .......... ..........
CB741a  .......... .......... .......... .......... ..........
CB753b  .......... .......... .......... .......... ..........
CB754a  .......... .......... .......... .......... ..........
GB602a  .......... .......... .......... .......... ..........
GB603b  .......... .......... .......... .......... ..........
GB715a  .......... .......... .......... .......... ..........
GB717g  .......... .......... .C........ .......... ..........
GB724a  .......... .......... .......... .......... ..........
GB725a  .......... .......... .......... .......... ..........
GB736a  .......... .......... .......... .......... ..........
GB901b  .......... .......... .......... .......... ..........
GB904d  .......... .......... .......... .......... ..........
GB916a  .......... .......... .......... .......... ..........
GB932a  .......... .......... .......... .......... ..........
GB937a  .......... .......... .......... .......... ..........
GB938a  .......... .......... .......... .......... ..........
AB732e  .......... .......... .......... .......... ..........
AB733a  .......... ..?....... .......... .......... ..........
AB734a  .......... .......... .......... .......... ..........
AB735a  .......... .......... .......... .......... ..........
AB748a  .......... .......... .......... .......... ..........
AB749e  .......... .......... .......... .......... ..........
AB755b  .......... .......... .......... .......... ..........
AB757b  .......... .......... .......... .......... ..........
AB758b  .......... .......... .......... .......... ..........
AB759a  .......... .......... .......... .......... ..........
WB743b  .......... .......... .......... .......... ..........
WB744b  .......... .......... .......... .......... ..........
WB745b  .......... .......... .......... .......... ..........
WB746c  .......... .......... .......... .......... ..........
WB747a  .......... .......... .......... .......... ..........
WB760c  .......... .......... .......... .......... ..........
WB761c  .......... .......... .......... .......... ..........
WB762b  .......... .......... .......... .......... ..........
WB764a  .......... .......... .......... .......... ..........
WB765b  .......... .......... .......... .......... ..........
```

**Bicknell's Thrush** (continued)

```
                  160         170         180         190         200
                    |           |           |           :
CB718a    TTTTTATCAT  GACATTTTCG  TTTAAAATTG  ACCAAATATT  CTTAGACATC
CB719c    ..........  ..........  ..........  ..........  ..........
CB720d    ..........  ..........  ..........  ..........  .........?
CB727b    ..........  ..........  ..........  ..........  ?.........
CB728f    ..........  ..........  ..........  ..........  ..........
CB730b    ..........  ..........  ..........  ..........  ..........
CB737b    ..........  ..........  ..........  ..........  ..........
CB741a    ..........  ..........  ..........  ..........  ..........
CB753b    ..........  ..........  ..........  ..........  ..........
CB754a    ..........  ..........  ..........  ..........  ..........
GB602a    ..........  ..........  ..........  ..........  ?.........
GB603b    ..........  ..........  ..........  ..........  ..........
GB715a    ..........  ..........  ..........  ..........  ..........
GB717g    ..........  ..........  ..........  ..........  ..........
GB724a    ..........  ..........  ..........  ..........  ..........
GB725a    ..........  ..........  ..........  ..........  ?.........
GB736a    ..........  ..........  ..........  ..........  ..........
GB901b    ..........  ..........  ..........  ..........  ..........
GB904d    ..........  ..........  ..........  ..........  ..........
GB916a    ..........  ..........  ..........  ..........  ..........
GB932a    ..........  ..........  ..........  ..........  ..........
GB937a    ..........  ..........  ..........  ..........  ..........
GB938a    ..........  ..........  ..........  ..........  ..........
AB732e    ..........  ..........  ..........  ..........  ..........
AB733a    ..........  ..........  ..........  ..........  ?........?
AB734a    ..........  ..........  ..........  ..........  ..........
AB735a    ..........  ..........  ..........  ..........  ..........
AB748a    ..........  ..........  ..........  ..........  ..........
AB749e    ..........  ..........  ..........  ..........  ..........
AB755b    ..........  ..........  ..........  ..........  ..........
AB757b    ..........  ..........  ..........  ..........  ..........
AB758b    ..........  ..........  ..........  ..........  ..........
AB759a    ..........  ..........  ..........  ..........  ..........
WB743b    ..........  ..........  ..........  ..........  ..........
WB744b    ..........  ..........  ..........  ..........  ..........
WB745b    ..........  ..........  ..........  ..........  ..........
WB746c    ..........  ..........  ..........  ..........  ..........
WB747a    ..........  ..........  ..........  ..........  ..........
WB760c    ..........  ..........  ..........  ..........  ..........
WB761c    ..........  ..........  ..........  ..........  ..........
WB762b    ..........  ..........  ..........  ..........  ..........
WB764a    ..........  ..........  ..........  ..........  ..........
WB765b    ..........  ..........  ..........  ..........  ..........
```

**Bicknell's Thrush** (continued)

```
               210        220        230        240        250
                 |          |          |          |
CB718a  TCCCTACCTT TAACCAAAGC ATTCATCATC ACAAAACTAA CGAACAAACT
CB719c  .......... .......... .......... .......... ..........
CB720d  .......... .......... .......... ......?... ..........
CB727b  .......... .......... .......... .......... ..........
CB728f  .......... .......... .......... .......... ..........
CB730b  .......... .......... .......... .......... ..........
CB737b  .......... .......... .......... .......... ..........
CB741a  .......... .......... .......... .......... ..........
CB753b  .......... .......... .......... .......... ..........
CB754a  .......... .......... .......... .......... ..........
GB602a  ...?...... .......... .......... .......... ........?.
GB603b  .......... .......... .......... .......... ..........
GB715a  .......... .......... .......... .......... ..........
GB717g  .......... .......... .......... .......... ..........
GB724a  .......... .......... .......... .......... ..........
GB725a  .......... .......... .......... .......... ..........
GB736a  .......... .......... .......... .......... ..........
GB901b  .......... .......... .......... .......... ..........
GB904d  .......... .......... .......... .......... ..........
GB916a  .......... .......... .......... .......... ..........
GB932a  .......... .......... .......... .......... ..........
GB937a  .......... .......... .......... .......... ..........
GB938a  .......... .......... .......... .......... ..........
AB732e  .......... .......... .......... .......... ..........
AB733a  .......... .......... ...?..?... ......?... ..........
AB734a  .......... .......... .......... .......... ..........
AB735a  .......... .......... .......... .......... ..........
AB748a  .......... .......... .......... .......... ..........
AB749e  .......... .......... .......... .......... ..........
AB755b  .......... .......... .......... .......... ..........
AB757b  .......... .......... .......... .......... ..........
AB758b  .......... .......... .......... .......... ..........
AB759a  .......... .......... .......... .......... ..........
WB743b  .......... .......... .......... .......... ..........
WB744b  .......... .......... .......... .......... ..........
WB745b  .......... .......... .......... .......... ..........
WB746c  .......... .......... .......... .......... ..........
WB747a  .......... .......... .......... .......... ..........
WB760c  .......... .......... .......... .......... ..........
WB761c  .......... .......... .......... .......... ..........
WB762b  .......... .......... .......... .......... ..........
WB764a  .......... .......... .......... .......... ..........
WB765b  .......... .......... .......... .......... ..........
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**Bicknell's Thrush** (continued)

```
               260        270        280        290        300
                 ¦          ¦          ¦          ¦          .
CB718a  TCCTCTATTT TCCCCCTATT TATCAGAACC GAAAATACAA CAAACTTTTC
CB719c  ......G... .......... ..C....... .......... ..........
CB720d  ....?..... .......... .......... A......... ..........
CB727b  ......G... .......... .......... .......... ..........
CB728f  .......... .......... C......... A......... ..........
CB730b  ......G... .......... .......... .......... ....?.....
CB737b  ......G... .......... .......... .......... ..........
CB741a  .......... .......... .......... .......... ..........
CB753b  ......G... .......... .......... .......... ..........
CB754a  .......... .......... .......... .......... ..........
GB602a  .......... .......... .......... .......... ..........
GB603b  ......G... .......... ?......... .......... ....?.....
GB715a  .......... .......... .......... .......... ..........
GB717g  .......... .......... C......... A......... ..........
GB724a  .......... .......... .......... .......... ..........
GB725a  .......... .......... .......... .......... ..........
GB736a  .......... .......... .......... .......... ..........
GB901b  ......G... .......... .......... .......... ..........
GB904d  .......... .......... .......... A......... ..........
GB916a  .......... .......... .......... .......... ..........
GB932a  .......... .......... .......... .......... ..........
GB937a  .......... .......... .......... .......... ..........
GB938a  .......... .......... .......... .......... ..........
AB732e  .......... .......... C......... A......... ..........
AB733a  .......... .......... .......... .......... ..........
AB734a  .......... .......... .......... .......... ..........
AB735a  .......... .......... .......... .......... ..........
AB748a  .......... .......... .......... .......... ..........
AB749e  .......... .......... C......... A......... ..........
AB755b  ......G... .......... .......... .......... ..........
AB757b  ......G... .......... .......... .......... ..........
AB758b  ......G... .......... .......... .......... ..........
AB759a  .......... .......... .......... .......... ..........
WB743b  ......G... .......... .......... .......... ..........
WB744b  ......G... .......... .......... .......... ..........
WB745b  ......G... .......... .......... .......... ..........
WB746c  ......G... .......... ..C....... .......... ..........
WB747a  .......... .......... .......... .......... ..........
WB760c  ......G... .......... ..C....... .......... ..........
WB761c  ......G... .......... ..C....... .......... ..........
WB762b  ......G... .......... .......... .......... ..........
WB764a  .......... .......... .......... .......... ..........
WB765b  ......G... .......... .......... .......... ..........
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**Bicknell's Thrush** (continued)

```
                  310        320        330        340        350
                    |          |          |          |
CB718a   CATCTTT--A CACACACACA CAAACAGCAA CCCCCCTGAC AAACCACCCC
CB719c   .......--. .......... .......... .......... ..........
CB720d   .......--. .......... .......... .......... ..........
CB727b   .......--. .......... .......... .......... ..........
CB728f   .......AC. .......... .......... .......... ..........
CB730b   ...?...--. .......... .......... .......... ..........
CB737b   .......--. .......... .......... .......... ..........
CB741a   .......--. .......... .......... .......... ..........
CB753b   .......--. .......... .......... .......... ..........
CB754a   .......--. .......... .......... .......... ..........
GB602a   .......--. .......... .......... .......... ..........
GB603b   ...?...--. .......... .......... .......... ..........
GB715a   .......--. .......... .......... .......... ..........
GB717g   .......--. .......... .......... .......... ..........
GB724a   .......--. .......... .......... .......... ..........
GB725a   .......--. .......... .......... .......... ..........
GB736a   .......--. .......... .......... .......... ..........
GB901b   .......--. .......... .......... .......... ..........
GB904d   .......--. .......... .......... .......... ..........
GB916a   .......--. .......... .......... .......... ..........
GB932a   .......--. .......... .......... .......... ..........
GB937a   .......--. .......... .......... .......... ..........
GB938a   .......--. .......... .......... .......... ..........
AB732e   .......--. .......... .......... .......... ..........
AB733a   .......--. .......... .......... .......... ..........
AB734a   .......--. .......... .......... .......... ..........
AB735a   .......--. .......... .......... .......... ..........
AB748a   .......--. .......... .......... .......... ..........
AB749e   .......--. .......... .......... .......... ..........
AB755b   .......--. .......... .......... .......... ..........
AB757b   .......--. .......... .......... .......... ..........
AB758b   .......--. .......... .......... .......... ..........
AB759a   .......--. .......... .......... .......... ..........
WB743b   .......--. .......... .......... .......... ..........
WB744b   .......--. .......... .......... .......... ..........
WB745b   .......--. .......... .......... .......... ..........
WB746c   .......--. .......... .......... .......... ..........
WB747a   .......--. .......... .......... .......... ..........
WB760c   .......--. .......... .......... .......... ..........
WB761c   .......--. .......... .......... .......... ..........
WB762b   .......--. .......... .......... .......... ..........
WB764a   .......--. .......... .......... .......... ..........
WB765b   .......--. .......... .......... .......... ..........
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**Bicknell's Thrush** (continued)

```
                    360        370        380        390   395
                      |          |          |          |     |
CB718a   AACTAAAACC AAACAAAAAC ACAACGCATG TTCTTGTAGC TTAAC
CB719c   .......... .......... .......... .......... .....
CB720d   .......... .......... .......... .......... .....
CB727b   .......... .......... .......... .......... .....
CB728f   .......... .......... .......... .......... .....
CB730b   ..?....... .......... .......... .......... .....
CB737b   .......... .......... .......... .......... .....
CB741a   .......... .......... .......... .......... .....
CB753b   .......... .......... .......... .......... .....
CB754a   .......... .......... .......... .......... .....
GB602a   .......... .......... .......... .......... .....
GB603b   ..?....... .......... .......... .......... .....
GB715a   .......... .......... .......... .......... .....
GB717g   .......... .......... .......... .......... .....
GB724a   .......... .......... .......... ?????????? ?????
GB725a   .......... .......... .......... .......... .....
GB736a   .......... .......... .......... .......... .....
GB901b   .......... .......... .......... .......... .....
GB904d   .......... .......... .......... .......... .....
GB916a   .......... .......... .......... .......... .....
GB932a   .......... .......... .......... .......... .....
GB937a   .......... .......... .......... .......... .....
GB938a   .......... .......... .......... .......... .....
AB732e   .......... .......... .......... .......... .....
AB733a   ..?....... .......... .......... .......... .....
AB734a   .......... .......... .......... .......... .....
AB735a   .......... .......... .......... .......... .....
AB748a   .......... .......... .......... .......... .....
AB749e   .......... .......... .......... .......... .....
AB755b   .......... .......... .......... .......... .....
AB757b   .......... .......... .......... .......... .....
AB758b   .......... .......... .......... .......... .....
AB759a   .......... .......... .......... .......... .....
WB743b   .......... .......... .......... .......... .....
WB744b   .......... .......... .......... .......... .....
WB745b   .......... .......... .......... .......... .....
WB746c   .......... .......... .......... .......... .....
WB747a   .......... .......... .......... .......... .....
WB760c   .......... .......... .......... .......... .....
WB761c   .......... .......... .......... .......... .....
WB762b   .......... .......... .......... .......... .....
WB764a   .......... .......... .......... .......... .....
WB765b   .......... .......... .......... .......... .....
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**Bicknell's Thrush** (continued)

## Veery

```
                10         20         30         40         50
                 |          |          |          |
CV773a  GATGCACTTT GACCCCATTC ACGAGGGGGA GGCTATTTAC CTCTTAAGTA
CV770a  ?????.?... .......... .?........ .......... ..........
CV771c  .......... .........T .......... ..?....... ..........
CV772b  .......... .......... .......... ........G. ..........
CV774e  .......... .......... .......... .......... ..........
CV775a  .......... .......... .......... .......... ..........
CV776a  .......... .......... .......... .......... ..........
CV777d  ???????... .......... .......... ...C...... ..........
CV778a  .......... .......... .......... .......... ..........
CV779c  ??........ .........T .......... .......... ..........
GV780a  .......... .......... .......... .......... ..........
GV781i  ?????????. .......... .......... .......... ..........
GV783a  ??........ .......... .......... ..?....... ..........
GV785a  ???????... .......... .......... .......... ..........
GV786j  ?......... .......... .......... .......... ..........
GV787a  .......... .......... .......... .......... ..........
GV788a  .......... .......... .......... .......... ..........
GV790a  .......... .......... .......... .......... ..........
GV791h  .......... .......... .......... ........?. ..........
GV792g  ?......... .......... .......... .......... ..........
AV793b  .......... .......... .......... ........G. ..........
AV794d  ????...... .......... .......... ...C...... ..........
AV795a  ?????..... .......... .......... .......... ..........
AV796a  ?......... .......... .......... .......... ..........
AV797a  .......... .......... .......... .......... ..........
AV798a  .......... .......... .......... .......... ..........
AV799a  .......... .......... .......... .......... ..........
AV210a  ?......... .......... .......... .......... ..........
AV211a  .......... .......... .......... .......... ..........
AV212a  .......... .......... .......... .......... ..........
WV800a  .......... .......... .......... .......... ..........
WV201c  .......... .........T .......... .......... ..........
WV202a  .......... .......... .......... ..?....... ..........
WV203b  .......... .......... .......... ........G. ..........
WV204f  .......... .......... .......... .......... ..........
WV205b  ?????..... .......... .......... ........G. ..........
WV206a  ?......... .......... .......... .......... ..........
WV207a  .......... .......... .......... .......... ..........
WV208a  .......... .......... .......... .......... ..........
WV209a  .......... .......... .......... .......... ..........
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                 60         70         80         90        100
                  |          |          |          |
CV773a   TGCAGATAGT GTAATGGTCA CCGCACATAT TTAGATTGTT TCCCCTTTCT
CV770a   .......... .......... .......... .......... ..........
CV771c   .......... .......... .......... .......... ..........
CV772b   .......... .......... .......... .......... ..........
CV774e   .......... .......... .......... .......... ..........
CV775a   .......... .......... .......... .......... ..........
CV776a   .......... .......... .......... .......... ..........
CV777d   .......... .......... .......... .......... ..........
CV778a   .......... .......... .......... .......... ..........
CV779c   .......... .......... .......... .......... ..........
GV780a   .......... .......... .......... .......... ..........
GV781i   .......... .......... .......... .......... ..........
GV783a   .......... .......... .......... .......... ..........
GV785a   .......... .......... .......... .......... ..........
GV786j   .......... .......... .......... .......... ..........
GV787a   .......... .......... .......... .......... ..........
GV788a   .......... .......... .......... .......... ..........
GV790a   .......... .......... .......... .......... ..........
GV791h   .......... .......... .......... .......... ..........
GV792g   .......... .......... .......... .......... ..........
AV793b   .......... .......... .......... .......... ..........
AV794d   .......... .......... .......... .......... ..........
AV795a   .......... .......... .......... .......... ..........
AV796a   .......... .......... .......... .......... ..........
AV797a   .......... .......... .......... .......... ..........
AV798a   .......... .......... .......... .......... ..........
AV799a   .......... .......... .......... .......... ..........
AV210a   .......... .......... .......... .......... ..........
AV211a   .......... .......... .......... .......... ..........
AV212a   .......... .......... .......... .......... ..........
WV800a   .......... .......... .......... .......... ..........
WV201c   .......... .......... .......... .......... ..........
WV202a   .......... .......... .......... .......... ..........
WV203b   .......... .......... .......... .......... ..........
WV204f   .......... .......... .......... .......... ..........
WV205b   .......... .......... .......... .......... ..........
WV206a   .......... .......... .......... .......... ..........
WV207a   .......... .......... .......... .......... ..........
WV208a   .......... .......... .......... .......... ..........
WV209a   .......... .......... .......... .......... ..........
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**Veery** (continued)

```
               110        120        130        140        150
                 |          |          |          |
CV773a  AGGAATTTCC ATCTAAACCC CTAAAAATCA TCATTTTTTT CGTTCGTTTA
CV770a  .......... .......... .......... .......... ..........
CV771c  .......... .......... .......... .......... ..........
CV772b  .......... .......... .......... .......... ..........
CV774e  .......... .......... .C........ .......... ..........
CV775a  .......... .......... .......... .......... ..........
CV776a  .......... .......... .......... .......... ..........
CV777d  .......... .......... .......... .......... ..........
CV778a  .......... .......... .......... .......... ..........
CV779c  .......... .......... .......... .......... ..........
GV780a  .......... .......... .......... .......... ..........
GV781i  .......... .......... .......... .......... ..........
GV783a  ....?..... .......... .......... .......... ..........
GV785a  .......... .......... .......... .......... ..........
GV786j  .......... .......... .......... .......... ..........
GV787a  .......... .......... .......... .......... ..........
GV788a  .......... .......... .......... .......... ..........
GV790a  .......... .......... .......... .......... ..........
GV791h  .......... .......... .......... .......... ..........
GV792g  .......... .......... .......... .......... ..........
AV793b  .......... .......... .......... .......... ..........
AV794d  .......... .......... .......... .......... ..........
AV795a  .......... .......... .......... .......... ..........
AV796a  .......... .......... .......... .......... ..........
AV797a  .......... .......... .......... .......... ..........
AV798a  .......... .......... .......... .......... ..........
AV799a  .......... .......... .......... .......... ..........
AV210a  .......... .......... .......... .......... ..........
AV211a  .......... .......... .......... .......... ..........
AV212a  .......... .......... .......... .......... ..........
WV800a  .......... .......... .......... .......... ..........
WV201c  .......... .......... .......... .......... ..........
WV202a  .......... .......... .......... .......... ..........
WV203b  .......... .......... .......... .......... ..........
WV204f  .......... .......... .......... .......... ..........
WV205b  .......... .......... .......... .......... ..........
WV206a  .......... .......... .......... .......... ..........
WV207a  .......... .......... .......... .......... ..........
WV208a  .......... .......... .......... .......... ..........
WV209a  .......... .......... .......... .......... ..........
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**Veery** (continued)

```
                 160        170        180        190        200
                   :          :          :          :
CV773a    TTTTTATCAT GACATTTTCG TTTAAAATTA ACCAAATATT CTTAGACATC
CV770a    .......... .......... .......... .......... ..........
CV771c    .......... .......... .......... .......... ..........
CV772b    .......... .......... .......... .......... ..........
CV774e    .......... .......... .......... .......... ..........
CV775a    .......... .......... .......... .......... ..........
CV776a    .......... .......... .......... .......... ..........
CV777d    .......... .......... .......... .......... ..........
CV778a    .......... .......... .......... .......... ..........
CV779c    .......... .......... .......... .......... ..........
GV780a    .......... .......... .......... .......... ?.........
GV781i    .......... .......... .......... .......... ..........
GV783a    .......... .......... .......... .......... ..........
GV785a    .......... .......... .......... .......... ..........
GV786j    .......... .......... .......... .......... ..........
GV787a    .......... .......... .......... .......... ..........
GV788a    .......... .......... .......... .......... ..........
GV790a    .......... .......... .......... .......... ..........
GV791h    .......... .......... .......... .......... ..........
GV792g    .......... .......... .......... .......... ..........
AV793b    .......... .......... .......... .......... ..........
AV794d    .......... .......... .......... .......... ..........
AV795a    .......... .......... .......... .......... ..........
AV796a    .......... .......... .......... .......... ..........
AV797a    .......... .......... .......... .......... ..........
AV798a    .......... .......... .......... .......... ..........
AV799a    .......... .......... .......... .......... ..........
AV210a    .......... .......... .......... .......... ..........
AV211a    .......... .......... .......... .......... ..........
AV212a    .......... .......... .......... .......... ..........
WV800a    .......... .......... .......... .......... ..........
WV201c    .......... .......... .......... .......... ..........
WV202a    .......... .......... .......... .......... ..........
WV203b    .......... .......... .......... .......... ..........
WV204f    .......... .......... .......... .......... ..........
WV205b    .......... .......... .......... .......... ..........
WV206a    .......... .......... .......... .......... ..........
WV207a    .......... .......... .......... .......... ..........
WV208a    .......... .......... .......... .......... ..........
WV209a    .......... .......... .......... .......... ..........
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**Veery** (continued)

```
                 210        220        230        240        250
                   |          |          |          |
CV773a  TCCCTACCTT TAACCAAAGC ATTCATCATC ACAAAACTAA CGAACAAACT
CV770a  .......... .......... .......... .......... ..........
CV771c  .......... .......... .......... .......... ..........
CV772b  .......... .......... .......... .......... ..........
CV774e  .......... .......... .......... .......... ..........
CV775a  .......... .......... .......... .......... ..........
CV776a  .......... .......... .......... .......... ..........
CV777d  .......... .......... .......... .......... ..........
CV778a  .......... .......... .......... .......... ..........
CV779c  .......... .......... .......... .......... ..........
GV780a  .......... .......... .......... .......... ..........
GV781i  .......... .......... .......... .......... ..........
GV783a  .......... .......... .......... .......... ..........
GV785a  .......... .......... .......... .......... ..........
GV786j  .......... .......... .......... .......... ..........
GV787a  .......... .......... .......... .......... ..........
GV788a  .......... .......... .......... .......... ..........
GV790a  .......... .......... .......... .......... ..........
GV791h  ....?..... .......... .......... .......... ..........
GV792g  .......... .......... .......... .......... ..........
AV793b  .......... .......... .......... .......... ..........
AV794d  .......... .......... .......... .......... ..........
AV795a  .......... .......... .......... .......... ..........
AV796a  .......... .......... .......... .......... ..........
AV797a  .......... .......... .......... .......... ..........
AV798a  .......... .......... .......... .......... ..........
AV799a  .......... .......... .......... .......... ..........
AV210a  .......... .......... .......... .......... ..........
AV211a  .......... .......... .......... .......... ..........
AV212a  .......... .......... .......... .......... ..........
WV800a  .......... .......... .......... .......... ..........
WV201c  .......... .......... .......... .......... ..........
WV202a  .......... .......... .......... .......... ..........
WV203b  .......... .......... .......... .......... ..........
WV204f  .......... .......... .......... .......... ..........
WV205b  .......... .......... .......... .......... ..........
WV206a  .......... .......... .......... .......... ..........
WV207a  .......... .......... .......... .......... ..........
WV208a  .......... .......... .......... .......... ..........
WV209a  .......... .......... .......... .......... ..........
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**Veery** (continued)

```
                260        270        280        290        300
                  |          |          |          |
CV773a  TCCTCTATTT TCCCCCTATT TATCAGAACC GAAAATACAA CAAACTTCTC
CV770a  .......... .......... .......... .......... ..........
CV771c  ....?..... .......... .......... .......... ..........
CV772b  .......... .......... .......... .......... ..........
CV774e  .......... .......... .......... .......... ..........
CV775a  .......... .......... .......... .......... ..........
CV776a  .......... .......... .......... ?......... ..........
CV777d  .......... .......... .......... .......... ..........
CV778a  .......... .......... .......... .......... ..........
CV779c  .......... .......... .......... .......... .?..?.....
GV780a  .......... .......... .......... .......... ....?.....
GV781i  .......... .......... .......... .......... ..........
GV783a  .......... .......... .......... .......... ..........
GV785a  .......... .......... .......... .......... ..........
GV786j  .......... .......... .......... .......... ..........
GV787a  .......... .......... .......... .......... ..........
GV788a  .......... .......... .......... .......... ..........
GV790a  .......... .......... .......... .......... ..........
GV791h  ..?....... .......... .....A.... .......... ..........
GV792g  .......... .......... ..C....... .......... ..........
AV793b  .......... .......... .......... .......... ..........
AV794d  .......... .......... .......... .......... ..........
AV795a  .......... .......... .......... .......... ..........
AV796a  .......... .......... .......... .......... ..........
AV797a  .......... .......... .......... .......... ..........
AV798a  .......... .......... .......... .......... ..........
AV799a  .......... .......... .......... .......... ..........
AV210a  .......... .......... .......... .......... ..........
AV211a  .......... .......... .......... .......... ..........
AV212a  .......... .......... .......... .......... ..........
WV800a  .......... .......... .......... .......... ..........
WV201c  .......... .......... .......... .......... ..........
WV202a  ....?..... .......... .......... .......... ..........
WV203b  .......... .......... .......... .......... ..........
WV204f  C......... .......... .......... .......... ..........
WV205b  .......... .......... .......... .......... ..........
WV206a  .......... .......... .......... .......... ..........
WV207a  .......... .......... .......... .......... ..........
WV208a  .......... .......... .......... .......... ..........
WV209a  .......... .......... .......... .......... ..........
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**Veery** (continued)

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                 310        320        330        340        350
                   |          |          |          |
CV773a    CATCTTT--A CACACACACA CAAACAGCAA CCCCCCTGAC AAACTACCCC
CV770a    .......--. .......... .......... .......... ..........
CV771c    .......--. .......... .......... .......... ..........
CV772b    .......--. .......... .......... .......... ..........
CV774e    .......--. .......... .......... .......... ..........
CV775a    .......--. .......... .......... .......... ..........
CV776a    .......--. .......... .......... .......... ..........
CV777d    .......--. .......... .......... .......... ..........
CV778a    .......--. .......... .......... .......... ..........
CV779c    ...?...--. .......... .......... .......... ..........
GV780a    .......--. .......... .......... .......... ..........
GV781i    .......--. .......... .......... T......... ..........
GV783a    .......--. .......... .......... .......... ..........
GV785a    .......--. .......... .......... .......... ..........
GV786j    .......--. .......... .......... .......... ..........
GV787a    .......--. .......... .......... .......... ..........
GV788a    .......--. .......... .......... .......... ..........
GV790a    .......--. .......... .......... .......... ..........
GV791h    .......--. .......... .......... .......... ...?......
GV792g    .......--. .......... .......... .......... ..........
AV793b    .......--. .......... .......... .......... ..........
AV794d    .......--. .......... .......... .......... ..........
AV795a    .......--. .......... .......... .......... ..........
AV796a    .......--. .......... .......... .......... ..........
AV797a    .......--. .......... .......... .......... ..........
AV798a    .......--. .......... .......... .......... ..........
AV799a    .......--. .......... .......... .......... ..........
AV210a    .......--. .......... .......... .......... ..........
AV211a    .......--. .......... .......... .......... ..........
AV212a    .......--. .......... .......... .......... ..........
WV800a    .......--. .......... .......... .......... ..........
WV201c    .......--. .......... .......... .......... ..........
WV202a    ...?...--. .......... .......... .......... ..........
WV203b    .......--. .......... .......... .......... ..........
WV204f    .......--. .......... .......... .......... ..........
WV205b    .......--. .......... .......... .......... ..........
WV206a    .......--. .......... .......... .......... ..........
WV207a    .......--. .......... .......... .......... ..........
WV208a    .......--. .......... .......... .......... ..........
WV209a    .......--. .......... .......... .......... ..........
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**Veery** (continued)

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                 360        370        380        390   395
                   |          |          |          |     |
CV773a   AACTAAAACC AAACAAAAAC ACAACGCATG TTCTTGTAGC TTAAC
CV770a   .......... .......... .......... .......... .....
CV773c   .......... .......... .......... .......... .....
CV772b   .......... .......... .......... .......... .....
CV774e   .......... .......... .......... .......... .....
CV775a   .......... .......... .......... .......... .....
CV776a   .......... .......... .......... .......... .....
CV777d   .......... .......... .......... .......... .....
CV778a   .......... .......... .......... .......... .....
CV779c   .......... .......... .......... .......... .....
GV780a   .......... .......... .......... .......... .....
GV781i   .......... .......... .......... .......... .....
GV783a   .......... .......... .......... .......... .....
GV785a   .......... .......... .......... .......... .....
GV786j   ..T....... .......... .......... .......... .....
GV787a   .......... .......... .......... .......... .....
GV788a   .......... .......... .......... .......... .....
GV790a   .......... .?........ .......... .......... .....
GV791h   .......... .......... .......... .......... .....
GV792g   .......... .......... .......... .......... .....
AV793b   .......... .......... .......... .......... .....
AV794d   .......... .......... .......... .......... .....
AV795a   .......... .......... .......... .......... .....
AV796a   .......... .......... .......... .......... .....
AV797a   .......... .......... .......... .......... .....
AV798a   .......... .......... .......... .......... .....
AV799a   .......... .......... .......... .......... .....
AV210a   .......... .......... .......... .......... .....
AV211a   .......... .......... .......... .......... .....
AV212a   .......... .......... .......... .......... .....
WV800a   .......... .......... .......... .......... .....
WV201c   .......... .......... .......... .......... .....
WV202a   ..?....... .......... .......... .......... .....
WV203b   .......... .......... .......... .......... .....
WV204f   .......... .......... .......... .......... .....
WV205b   .......... .......... .......... .......... .....
WV206a   .......... .......... .......... .......... .....
WV207a   .......... .......... .......... .......... .....
WV208a   .......... .......... .......... .......... .....
WV209a   .......... .......... .......... .......... .....
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**Veery** (continued)

## Gray-cheeked Thrush, Hermit Thrush, Swainson's Thrush

```
                 10         20         30         40         50
                  |          |          |          |
NG744a   GATGCACTTT GACCCCATTC ACGAGGGGGA GGCTATTTAC CTCTTAAGTA
NG769a   .......... .......... .......... .......... ..........
LG766a   .......... .......... .......... .......... ..........
LG767b   .G........ .......... .?........ .......... ..........
H214a    ?????????? .......... .......... .......... ..........
H213b    ?????????? .......... .......... .......... ..........
S9001a   .......... .......... .......... .......... ..........
S4002a   .......... .......... .......... .......... ..........

                 60         70         80         90        100
                  |          |          |          |
NG744a   TGCAGATAGT GTAATGGTCA CCGCACATAT TTAGATTGTT TCCCCTTTCT
NG769a   .......... .......... .......... .......... ..........
LG766a   .......... .......... .......... .......... ..........
LG767b   .......... .......... .......... .......... ..........
H214a    ........A. .C........ ...G...... .......... ..........
H213b    ........A. .C........ ...G...... .......... ..........
S9001a   ........A. .C........ ...G...... .......... ..........
S4002a   ........A. .C........ ...G...... .......... ..........

                110        120        130        140        150
                  |          |          |
NG744a   AGGAACTTCC ATCTAAACCC CTAAAAATCA TCATTTTTTT CGTTCGTTTA
NG769a   .......... .......... .......... .......... ..........
LG766a   .......... .......... .......... .......... ..........
LG767b   .......... .......... .......... .......... ..........
H214a    .......... .......... .C........ .........- .A........
H213b    .......... .......... .C........ .........- .A........
S9001a   .......... .........A .C........ .......... TA........
S4002a   .......... .........A .C........ .......... TA........

                160        170        180        190        200
                  |          |          |          |
NG744a   TTTTTATCAT GACATTTTCG TTTAAAATTA ACCAAATATT CTTAGACATC
NG769a   .......... .......... .......... .......... ..........
LG766a   .......... .......... .......... .......... ..........
LG767b   .......... .......... .......... .......... ?.........
H214a    .......... .T........ .......... ..T....... T.A.T.....
H213b    .......... .T........ .......... ..T....... T.A.T.....
S9001a   .......... .........A .AC....... G.T....... T.A.T.....
S4002a   .......... .........A .AC....... G.T....... T.A.T.....
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               210        220        230        240        250
                 |          |          |          |
NG744a  TCCCTACCTT TAACCAAAGC ATTCATCATC ACAAAACTAA CGAACAAACT
NG769a  .......... .......... .......... .......... ..........
LG766a  .......... .......... .......... .......... ..........
LG767b  .......... .......... .......... .......... ..........
H214a   .........A .......... .CC....... ....G..... .A........
H213b   .........A .......... .CC....... ....G..... .A........
S9001a  .........C .......... ....G.T... .TT.C.T.T. .A........
S4002a  .........C .......... ....G.T... .TT.C.T.T. .A........

               260        270        280        290        300
                 |          |          |          |
NG744a  TTCTCTATTT TCCCCCTATT TATCAGAACC GAAAATACAA CAAACTTCTC
NG769a  .......... .......... .......... .......... ..........
LG766a  .......... .......... .......... .......... ..........
LG767b  .......... .......... .......... .......... ..........
H214a   .......... ....T..... A.CT.....T .....C.... ..........
H213b   .......... ....T..... A.CT.A...T .....C.... ..........
S9001a  .......... .......... A.A..-...T A......... ....A-...T
S4002a  .......... .......... A.A..-...T A......... ....A-...T

               310        320        330        340        350
                 |          |          |          |
NG744a  CATCTTT--A CACACACACA CAAACAGCAA TCCCCCTGAC AAACCACCCC
NG769a  .......--. .......... .......... .......... ..........
LG766a  .......--. .......... .......... .......... ..........
LG767b  .......--. ....T..... .......... .......... ..........
H214a   ....C.C--. .......... ......A... .T........ ..........
H213b   ....C.C--. .......... ......A... .T........ ..........
S9001a  T.C..CCAC. .....GT... .......T.. .T........ ...T......
S4002a  T.C..CCAC. .....GT... .......T.. .T........ ...T......

               360        370        380        390   395
                 |          |          |          |
NG744a  AACTAAAACC AAACAAAAAC ACAACGCATG TTCTTGTAGC TTAAC
NG769a  .......... .......... .......... .......... .....
LG766a  .......... .?........ .......... .......... .....
LG767b  .......... .......... .......... .......... .....
H214a   .......... .......... ....T..... .C........ .....
H213b   .......... .......... ....T..... .C........ .....
S9001a  .......... .......... .....A.... .C.C...... ....T
S9001a  .......... .......... .....A.... .C.C...... ....T
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**Gray-cheeked Thrush, Hermit Thrush, Swainson's Thrush** (continued)