CHAPTER SIX

The Boreal Landbird Component of Migrant Bird Communities in Eastern North America

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Abstract. The vast and remote boreal forest supports nearly 50% of North America's bird species, some of which appear to be in decline and the majority of which are not well monitored. In this study, we provide evidence based on a geographic information system (GIS) analysis of >300,000 banding records that (particularly in fall) the migrations of birds that breed in the boreal forest region from Alaska to the Canadian Maritimes are not simple north–south movements. Rather, they take the form of a large-scale funneling southeast across the Great Lakes and/or southwest along the Appalachians. Boreal birds of some 50 species make up 50% or more of the migrants caught at banding stations located within and near an area of the mid-Appalachian mountains that is about 350 km across. For example, at the Powdermill Avian Research Center in the mountains of southwestern Pennsylvania, 32 species of boreal songbirds comprised 50% of fall captures over a 15-year period. At Allegheny Front Migration Observatory, in the mountains of northeastern West Virginia, 35 species of boreal songbirds comprised 62% of captures over the same period. We propose that the apparent funneling of migrants from across an expansive boreal breeding area through a comparatively narrow "neck" creates an exceptional opportunity for data from coordinated fall migration banding to be used in the monitoring of many species for which other methods are inadequate. Furthermore, it suggests that states within the mid-Appalachian region have a high responsibility for the conservation of boreal landbird migrants.

Key Words: boreal birds, eastern North America, migration monitoring network, migratory funneling, population monitoring, Powdermill Avian Research Center.

The boreal forest is one of the world's largest intact forest ecosystems, spanning 6,000 kilometers (3,500 miles) across Alaska and Canada and 20 degrees of latitude (50°–70°N). Nearly half of all North American birds rely on the boreal forest, especially during the breeding season. More than 1.5 billion landbirds are estimated to breed in the boreal forest region, some of which may be in serious decline (Blancher and Wells 1995, National Audubon Society 2002, Sauer et al. 2007).

In understanding more about populations of these birds, researchers have historically looked to the Breeding Bird Survey (BBS), various breeding bird atlases, and Christmas Bird Count (CBC)

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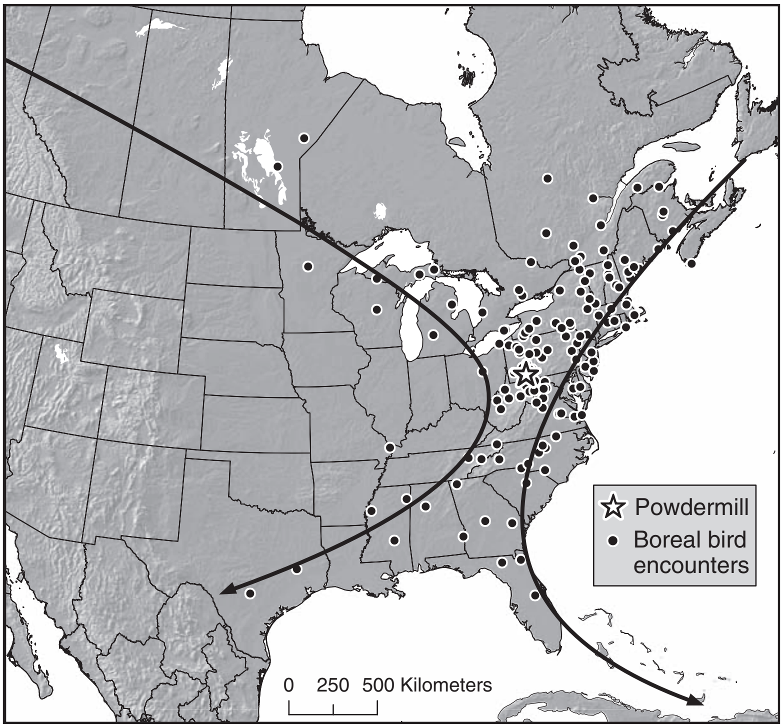

Figure 6.1. Map showing foreign recoveries and foreign encounters of boreal birds for the Powdermill banding program, 1961–2004. The curved lines, drawn by eye, describe the pattern of southward movement of boreal landbird migrants hypothesized in this paper.

data sets. While these have provided a means to estimate some populations, routes and counts have been biased to the southern part of the boreal forest, where the land is more accessible and where observers are much more numerous. Consequently, the remoteness and inaccessibility of much of the northern part of the region have made it a true *terra incognita* with respect to bird population trends. Sample sizes are low, and estimates of bird numbers for many species are imprecise (Bart et al. 2004). Thus, the bird conservation community needs additional methods of monitoring populations of boreal forest–nesting birds in order to detect and investigate possible causes of declining trends (e.g., Dunn et al. 2005).

The Powdermill Avian Research Center (PARC), located in the mountains of southwestern Pennsylvania (40.05°N, 79.16°W), has been the site of a large-volume bird banding program every year since 1961. Species and subspecies composition, as well as recoveries stemming from the Powdermill banding program, provide some evidence that birds originating from boreal forest as far northwest as Alaska and across the Canadian Maritimes, concentrate in the mid-Appalachian region of the eastern U.S. during their southward migration. Just 36 species of boreal birds (<20% of 190 species of birds banded) comprise 44% of all spring captures and 49% of fall captures at Powdermill. Overall, boreal birds make up half of the top ten species banded at Powdermill from 1961 to 2008: Dark-eyed Junco (*Junco hyemalis*; $n > 36{,}000$), White-throated Sparrow (*Zonotrichia albicolis*; $n > 17{,}600$), Ruby-crowned Kinglet (*Regulus calendula*; $n > 13{,}500$), Yellow-rumped "Myrtle" Warbler (*Dendroica coronata*; $n > 13{,}200$), and Magnolia Warbler (*D. magnolia*; $n > 12{,}500$).

A map of band recoveries of boreal species encountered at Powdermill (Fig. 6.1) hints at movements of birds to and from the northwest, across the Great Lakes region. The two encounters farthest to the north and west of Powdermill—a Dark-eyed Junco and a Yellow-rumped Warbler, respectively—suggest a migration trajectory for Powdermill banded birds that can be extended to Alaska. In fact, we regularly catch individuals ascribable to the large Alaskan subspecies of Yellow-rumped Warbler, *D. c. hooveri* (Dunn and Garrett 1997) (144 out of 3,809, or 3.8% of

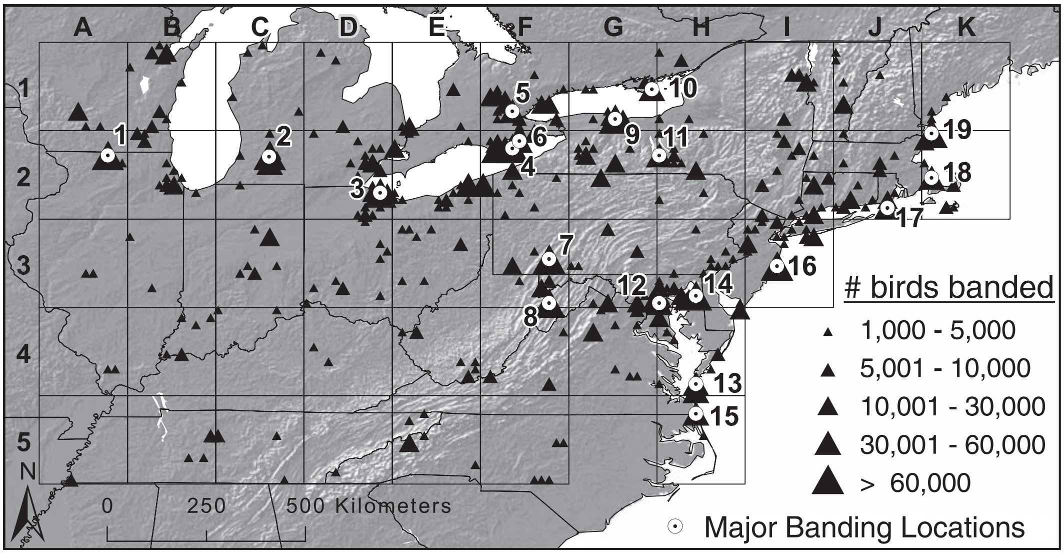

Figure 6.2. Map showing source locations and approximate sample sizes from data used in this study. Major banding sites (i.e., locations contributing >30,000 records) are labeled as follows: 1(Sand Bluff Banding Station), 2 (Kalamazoo Nature Center), 3 (Black Swamp Bird Observatory), 4 (Long Point Bird Observatory), 5 (Ausable Bird Observatory), 6 (Haldimand Bird Observatory/Selkirk), 7 (Powdermill Avian Research Center), 8 (Allegheny Front Migration Observatory), 9 (Braddock Bay Bird Observatory), 10 (Prince Edward Point Bird Observatory), 11 (Kestrel Haven Avian Migration Observatory), 12 (Patuxent Bird Banding Station), 13 (Kiptopeke Bird Banding Station), 14 (Chino Farms Banding Station), 15 (Back Bay Banding Station), 16 (Island Beach), 17 (Block Island Banding Station), 18 (Manomet Bird Observatory), 19 (Shoals Marine Lab/Appledore Island).

birds from 1995 to 2004; birds of this race were not consistently noted prior to 1995), and also the "Cassiar's" Dark-eyed Junco, *J. h. cismontanus* (Leberman 1976) (353 out of 11,619, or 3.0% of birds from 1989 to 2004), whose range extends from the Yukon Territory to central Alberta.

The purpose of this study was to determine if the large, funnel-shaped pattern of migration suggested by Powdermill's data is, in fact, supported by data from other banding stations. That is, do banding data collected throughout the eastern U.S. support the hypothesis that migration of many boreal birds is not a simple north–south movement along a broad longitudinal front, but rather a strongly funneled (especially from the northwest) movement that results in a geographical concentration of boreal birds along the Appalachian Mountains in the mid-latitudes of eastern North America. If so, this would open up the possibility that data from a network of banding stations strategically located near the neck of this hypothesized migratory funnel could be used to assess continental population trends for many boreal species that are otherwise difficult to monitor via standard migration monitoring approaches (e.g., Dunn et al. 1997, Hussell and Ralph 2005).

METHODS

In order to assess the overall distribution of boreal birds at migration banding stations in the eastern U.S., we obtained all original landbird banding records from the Bird Banding Laboratory spanning a 15-year period from 1989 to 2004. Our study area encompassed the mid-latitudes of eastern North America (i.e., 35–45°N and 70–90°W). Because we were specifically interested in assessing the boreal bird composition of migrant communities, only data from the spring (March through May) and fall (August through November) migration seasons were analyzed. These cutoff dates were chosen to eliminate the majority of resident bird captures from the sample and the majority of birds caught as a result of target netting (e.g., baited at feeders or attracted using audio lures). We analyzed a total of 3,544,376 banding records for this study. The banding records themselves were represented by >2,000 unique latitude-longitude coordinates within our study area. However, data from 275 discrete banding locations where >1,000 birds were banded during the 15-year period contributed the vast majority (90%) of the banding data analyzed for this study, and 25 major banding locations (>30,000 birds during the study period) accounted for 50% of the banding records analyzed for this study (Fig. 6.2).

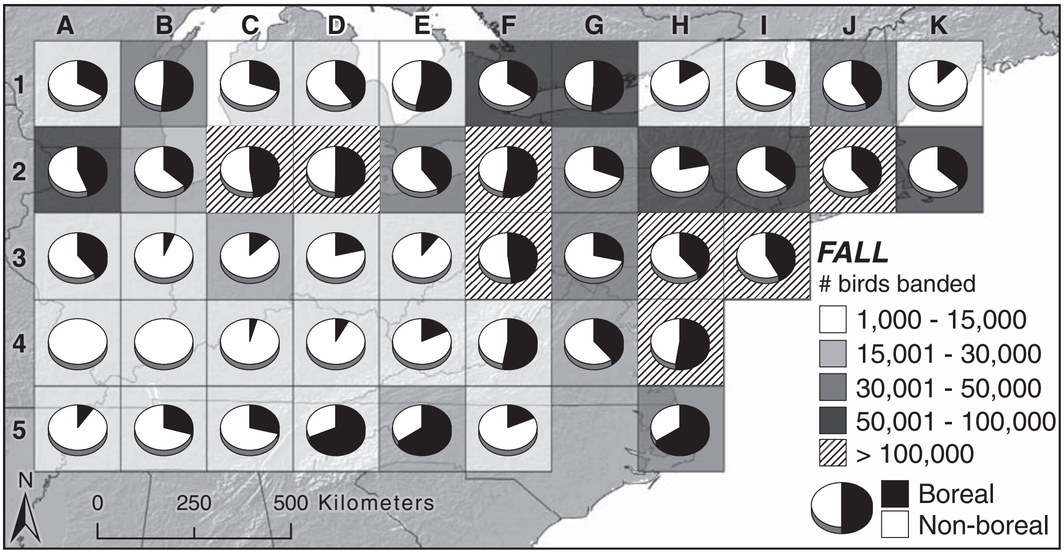

Figure 6.3. Map showing the total number of birds banded in fall (1989–2004) and the percent boreal/not boreal in each of 46 two-degree latitude–longitude grid-blocks covering the mid-latitudes of eastern North America (i.e., the study area for this paper).

We defined as “boreal” 44 species and four distinctive subspecies having an estimated 50% or more of their global breeding population occurring in the boreal forest region of North America, based on Blancher and Wells (2005) (Appendix 6.1). Banding records were summarized for a total of 48 two-degree lat-long blocks and overlaid graphically on a map of our study area. We deleted two of the 48 grid-blocks (J3 and G5) from the study because of small sample sizes (i.e., fewer than 5,000 birds banded in the 15-year period). For all of our spatial analyses, we used ArcGIS 9.2.

To assess geographic concentrations of boreal birds at migration banding stations, we examined the total numbers and percentages of boreal migrants per grid-block for each season. Because the majority of banding records (60%) were from the fall season, and overall patterns proved similar between seasons (although less pronounced in spring), we present detailed data for fall only. Prior to this study, we had computed linear regressions of capture rates (birds per 100 net-hours) on year for selected fall migrants banded at Powdermill from 1962 to 2001. We compared these trends with trends calculated from data submitted by cooperating Canadian Migration Monitoring Network (CMMN) stations, specifically Long Point Bird Observatory (LPBO), the only network station whose banding program spans a time period equivalent to that of Powdermill. The CMMN uses a combination of banding totals and one or more other migration counts to compute daily estimated totals and analyzes the mean seasonal estimated total using non-linear trend analyses (Hussell and Ralph 2005). Due to differences in methodology, comparisons between CMMN and Powdermill trends in this study are meant to be provisional, that is, simply suggestive of similarities or differences.

RESULTS

Overall, 917,450 (43%) of 2,144,057 fall banding records were boreal birds. The average percentage of boreal birds across all 2° lat-long grids was 33% (range, 1–69%; Appendix 6.2). Highest percentages (≥ca. 50%) of boreal birds occurred in grids adjacent to the shores of the Great Lakes (B1, C2, D2, E1, F2, G1), along the Appalachian Mountains from southwestern Pennsylvania south (F3, F4, D5, E5), and along the Atlantic coast from Delaware south (H4, H5) (Fig. 6.3; Appendix 6.2). Conversely, low average percentages (≤ca. 20%) occurred in grid-blocks due south of the Great Lakes and west of the mountains (A4, A5, B3, B4, C3, C4, D4, E3, E4), southeast of the mountains away from the coast (F5), along the northern New England coast (K5), and east of Lake Ontario (H1) (Fig. 6.3; Appendix 6.2). The overall directions of migration and areas of concentration, that is, funneling, suggested by our geographic analysis of boreal bird percentages at banding sites throughout the mid-latitudes of eastern North America mirror the shape of the proposed distribution based on band encounters of boreal birds from Powdermill (Fig. 6.1).

In our analysis of long-term fall capture-rate trends for 81 selected species at Powdermill (including 30 boreal species), we found nonsignificant trends for the majority (42 species), increasing trends for 25, and decreasing trends for 14 (a complete list of Powdermill trend analyses can be accessed at http://www.westol.com/~banding/Fall_2001_Trend_Table.htm). Within these trend groups, boreal species contributed most to the declining group (8 species; 57%), followed by the nonsignificant trend group (17 species; 40%), and, last, the increasing trend group (5 species; 20%). Four out of five boreal species with significantly increasing trends at Powdermill also had increasing trends based on CMMN analyses of Long Point Bird Observatory data. Of the eight species showing declines based on Powdermill banding data, two (Blackpoll Warbler, *D. striata*, and Nashville Warbler, *Vermivora ruficapilla*) show the opposite trend at LPBO; four (Least Flycatcher, *Empidonax minimus*; Palm Warbler, *D. palmarum*; Wilson's Warbler, *Wilsonia pusilla*; and Lincoln's Sparrow, *Melospiza lincolni*) show no significant trend at LPBO, and two (Olive-sided Flycatcher, *Contopus cooperi*, and Connecticut Warbler, *Oporornis agilis*) were not represented in any of the CMMN station's statistical analyses.

DISCUSSION

Boreal birds contribute greatly to the abundance and diversity of landbirds migrating through the mid-latitudes of eastern North America, just as they do to wintering bird communities in the southern U.S. and throughout the Neotropics (Robertson et al., this volume, chapter 7). The observed pattern of boreal bird concentrations at banding locations within our study area provide support for the hypothesis, based on long-term observations at a single banding location (PARC), that their fall migrations do not take the form of simple north–south movements across a broad longitudinal front. The large percentage contributions of boreal birds to fall banding samples along the shores of the western Great Lakes are not evident at latitudes immediately to the south. Instead, the pattern indicates that the overall movement of boreal birds is southeast across the Great Lakes and then southwest along the main axis of the Appalachian Mountains. This convergence of boreal species from both the northwest and northeast toward the Great Lakes is suggested by the spread of banding encounters at Powdermill (Fig. 6.1), as well as by band recoveries for stations in the CMMN (Dunn et al. 2006). Birds of northwestern origin that do not "reorient" from their original southeasterly course upon reaching the Appalachian Mountains eventually will find themselves at or beyond the Atlantic coastline. Evidence suggests that, disproportionately, these are inexperienced hatching year birds with survival probabilities much lower than adults (Ralph 1978, 1981). This, in turn, suggests that data from Atlantic coastal banding stations may not be entirely suitable for population monitoring purposes. Of course, not all boreal birds caught at Atlantic coastal banding stations are inexperienced overshoot migrants—many undoubtedly originate in the northeastern boreal habitats and simply move southward along the Atlantic Coast well east of the Appalachian Mountains.

However, because so many boreal birds do appear to funnel toward the Great Lakes and the mid-Appalachians, banding stations along this route, and especially those closest to the "neck" of the migration funnel (Fig. 6.2; e.g., sites 7 and 8—Powdermill and Allegheny Front), may be particularly well positioned to collect migration data that are useful for monitoring their populations (Dunn 2005). Importantly, results of our study also can be used to identify areas where the establishment of additional major banding stations would be strategic in the context of a mid-latitude migration monitoring network for boreal birds—for example, ridges in southern West Virginia, western Virginia, western North Carolina, and eastern Tennessee. Boreal bird species were well represented, but the overall banding totals were comparatively small in these areas (Fig. 6.3).

In the future, obtaining information about the geographical source areas from which migrant banding samples are drawn—for example, using feather isotopes, genetic data, and/or morphometrics—will greatly increase the population monitoring value of data collected at these sites (e.g., Dunn et al. 2006). In addition, if it can be shown that annual variation in the geographic origin(s) of migrants at individual banding sites is limited, then analysis of data from long-term banding sites like Powdermill Avian Research Center, Long Point Bird Observatory, and Allegheny Front Migration Observatory could potentially be used not only to monitor future population change, but also to provide valuable information on historical trends.

Based on results of our study—and following the recommendations of Carlisle and Ralph (2005)—we conclude that the focused collection and analysis of data from a clustered network of existing and newly established migration banding sites farther south than those within the CMMN, located within and near the mid-Appalachian region where boreal birds appear to become much more concentrated, especially in fall, will prove to be an efficient and reliable means for assessing population trends for boreal birds—in some cases, perhaps the only means for scarce or secretive species, such as Connecticut Warbler and Olive-sided Flycatcher. Importantly, because of well-known limitations and biases associated with the use of mist nets for conducting quantitative bird surveys (Dunn and Ralph 2004), we strongly recommend that banding sites within any such future migration monitoring network all follow published recommendations for the proper use of mist nets in monitoring efforts (Ralph et al. 2004), as well as advice regarding the incorporation at every banding site of at least one additional daily count method for estimating numbers of boreal birds (Dunn et al. 2004).

Finally, we think the findings of this study have implications beyond the possible strategic importance of the mid-Appalachians for monitoring populations of landbirds whose origins are in the expansive and largely inaccessible boreal forest region of North America. The same small neck of a broad migration funnel that provides opportunities for population monitoring may, ironically, constitute a population "bottleneck" for boreal landbirds. This is because the mid-Appalachians currently are experiencing rapidly increasing land use pressure related to extraction of fossil fuels (e.g., coal and natural gas) and the development of renewable wind energy. In short, governmental and nongovernmental agencies working in the region have both high responsibility and significant opportunities for promoting the conservation of boreal landbird migrants.

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APPENDIX 6.1

Boreal landbird species and subspecies and the total number of each banded from 1989 to 2004 in the mid-latitudes of eastern North America

Common Name	Scientific Name	No. Banding Records
Yellow-bellied Sapsucker	*Sphyrapicus varius*	2,842
Olive-sided Flycatcher	*Contopus cooperi*	195
Yellow-bellied Flycatcher	*Empidonax flaviventris*	10,420
Alder Flycatcher	*Empidonax alnorum*	188
Least Flycatcher	*Empidonax minimus*	20,867
Northern Shrike	*Lanius excubitor*	187
Cassin's Vireo	*Vireo cassinii*	1
Blue-headed Vireo	*Vireo solitarius*	8,507
Philadelphia Vireo	*Vireo philadelphicus*	4,775
Gray Jay	*Perisoreus canadensis*	72
Boreal Chickadee	*Poecile hudsonica*	7
Ruby-crowned Kinglet	*Regulus calendula*	113,993
Gray-cheeked Thrush	*Catharus minimus*	14,677
Swainson's Thrush	*Catharus ustulatus*	66,902
Hermit Thrush	*Catharus guttatus*	57,446
Bohemian Waxwing	*Bombycilla garrulous*	83
Tennessee Warbler	*Vermivora peregrina*	40,378
Orange-crowned Warbler	*Vermivora celata*	2,554
Nashville Warbler	*Vermivora ruficapilla*	26,426
Magnolia Warbler	*Dendroica magnolia*	96,834
Cape May Warbler	*Dendroica tigrina*	12,521
Yellow-rumped "Myrtle" Warbler	*Dendroica coronata coronata*	228,791
Yellow-rumped "Audubon's" Warbler	*Dendroica c. auduboni*	10
Black-throated Green Warbler	*Dendroica virens*	17,327
Blackburnian Warbler	*Dendroica fusca*	5,834
"Western" Palm Warbler	*Dendroica palmarum palmarum*	17,010
"Yellow" Palm Warbler	*Dendroica p. hypochrysea*	4,417
Bay-breasted Warbler	*Dendroica castanea*	9,056
Blackpoll Warbler	*Dendroica striata*	37,739
Black-and-white Warbler	*Mniotilta varia*	22,797
Northern Waterthrush	*Seiurus noveboracensis*	24,367
Connecticut Warbler	*Oporornis agilis*	2,374
Mourning Warbler	*Oporornis philadelphia*	7,800

APPENDIX 6.1 (*continued*)

Common Name	Scientific Name	No. Banding Records
Wilson's Warbler	*Wilsonia pusilla*	18,269
Canada Warbler	*Wilsonia canadensis*	16,238
Clay-colored Sparrow	*Spizella pallida*	134
Le Conte's Sparrow	*Ammodramus leconteii*	23
Fox Sparrow	*Passerella iliaca*	9,880
Lincoln's Sparrow	*Melospiza lincolnii*	14,997
Swamp Sparrow	*Melospiza georgiana*	45,852
White-throated Sparrow	*Zonotrichia albicollis*	210,274
White-crowned Sparrow	*Zonotrichia leucophrys*	17,306
"Eastern" White-crowned Sparrow	*Z. l. leucophrys*	5,954
"Gambel's" White-crowned Sparrow	*Z. l. gambelii*	163
Dark-eyed Junco	*Junco hyemalis*	181,097
Rusty Blackbird	*Euphagus carolinus*	1,350
Pine Grosbeak	*Pinicola enucleator*	45
White-winged Crossbill	*Loxia leucoptera*	35

APPENDIX 6.2

Sample sizes by map grid from Figure 6.3

Grid ID	Boreal	Not Boreal	Total
A1	3,746	7,680	11,426
A2	22,193	28,731	50,924
A3	1,605	2,562	4,167
A4	33	5,664	5,697
A5	403	3,500	3,903
B1	20,730	19,697	40,427
B2	10,839	19,125	29,964
B3	359	4,697	5,056
B4	92	9,394	9,486
B5	2,104	5,169	7,273
C1	858	2,051	2,909
C2	71,716	78,528	150,244
C3	2,623	16,820	19,443
C4	85	1,697	1,782
C5	1,428	3,581	5,009
D1	3,018	4,662	7,680
D2	69,565	68,891	138,456
D3	3,093	11,215	14,308
D4	160	1,712	1,872
D5	4,193	1,878	6,071
E1	7,577	6,513	14,090
E2	17,201	26,599	43,800
E3	1,089	8,846	9,935
E4	2,238	10,383	12,721
E5	16,642	8,581	25,223
F1	29,738	58,571	88,309
F2	129,631	115,161	244,792
F3	92,675	101,058	193,733
F4	3,999	3,503	7,502
F5	932	3,971	4,903
G1	41,390	39,353	80,473
G2	9,122	21,083	30,205
G3	12,622	32,192	44,814
G4	10,407	17,036	27,443

APPENDIX 6.2 (*continued*)

Grid ID	Boreal	Not Boreal	Total
H1	952	4,902	5,854
H2	13,951	48,510	62,461
H3	57,147	92,747	149,894
H4	67,378	60,194	127,572
H5	22,192	11,249	33,441
I1	4,000	9,156	13,156
I2	19,278	34,689	53,967
I3	57,863	81,182	139,045
J1	12,320	17,993	30,313
J2	38,767	61,514	100,281
K1	421	2,863	3,284
K2	28,630	50,510	79,140