Appendix 2. Comparison of relative abundance rasters used to weight stratum-level trends from migration monitoring.

While the statistical model described in this study can estimate stratum-specific population trends, we require independent estimates of the relative abundance of birds within each geographic strata (which also must be referenced to a particular year) in order to calculate range-wide estimates of population trends from this modeling framework. This is necessary because trends within each stratum must be "weighted" appropriately within a range-wide context; a large positive trend in a stratum that contains almost no birds will have a small effect on the continental trend compared to a small negative trend in a stratum that contains a large number of birds.

In this study, we calculated continental trends using two alternative relative abundance rasters describing Blackpoll Warbler abundance throughout boreal North America. First, we used a map produced by the Boreal Avian Modeling Project (BAM) using boosted regression trees fit to a large dataset of point counts across North America that correct for variation in protocols among surveys (Solymos et al. 2013; Stralberg et al. 2015). This raster is illustrated in Figure A2.1a, and represents a prediction of relative density for the year 2011. Second, we extracted a relative abundance map for Blackpoll Warbler from the community science project eBird using the 'ebirdst' package in R, which represents a prediction of relative abundance for the year 2022 (Fig. A2.1b; Fink et al. 2023).

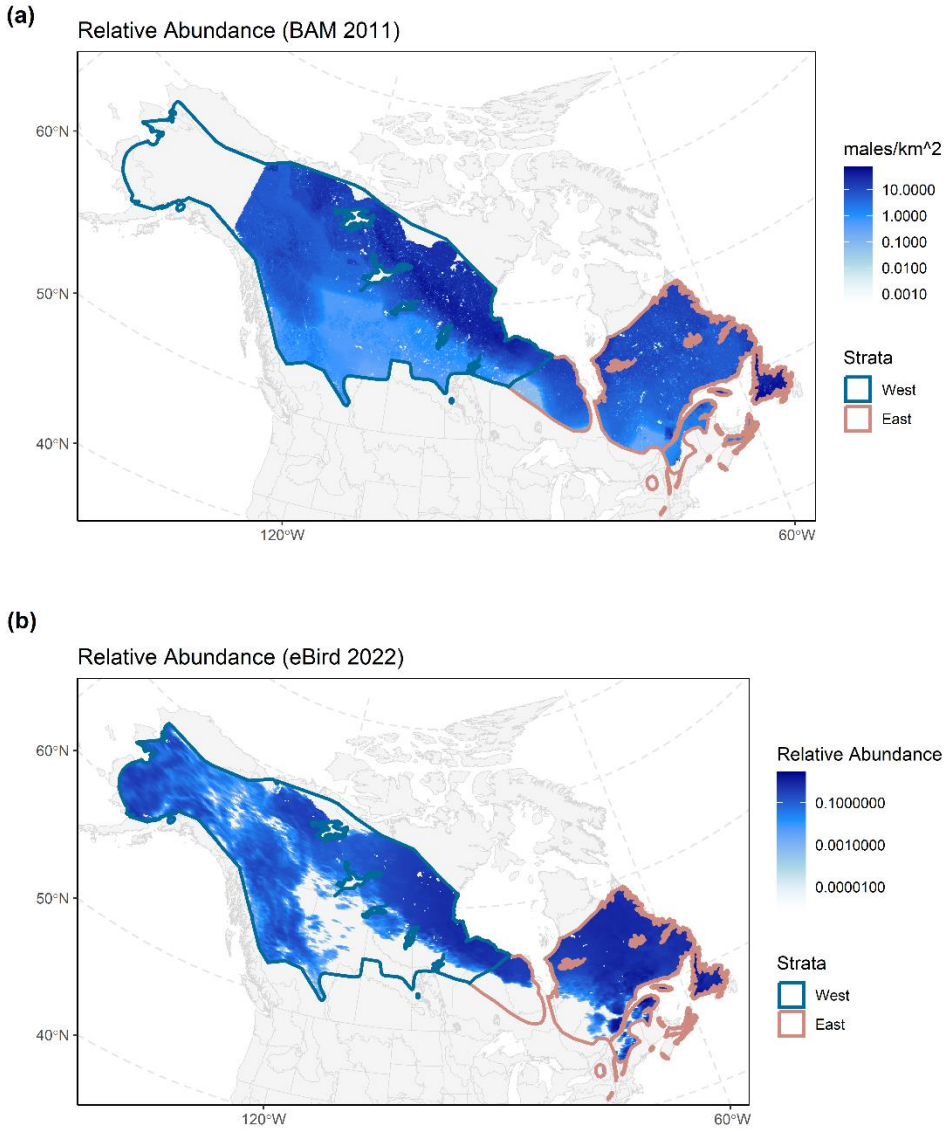

Fig. A2.1. Relative abundance maps based on two independent sources of information. Panel a) based on predictions from the Boreal Avian Modeling Project (2020) representing males per square kilometre. Panel b) based on predictions from eBird (Fink et al. 2023) representing the expected number of birds detected by an expert eBirder on a 1 hour, 2 kilometer traveling checklist at the optimal time of day for the species. Note that each raster has its own scale.

Importantly, the raster produced by BAM excludes the Alaskan portion of the Blackpoll Warbler breeding range. However, there is a strong positive relationship (p-value <0.001; R^2 = 0.81; Fig. A2.2) between BAM's predicted density and the average count of Blackpoll Warbler on BBS routes within each of the USGS analytical strata (i.e., BCR-province intersections). Thus, we used this relationship to

generate a prediction of the expected abundance in the missing portion of the Alaskan breeding range, and added this the total calculated directly from the BAM raster.

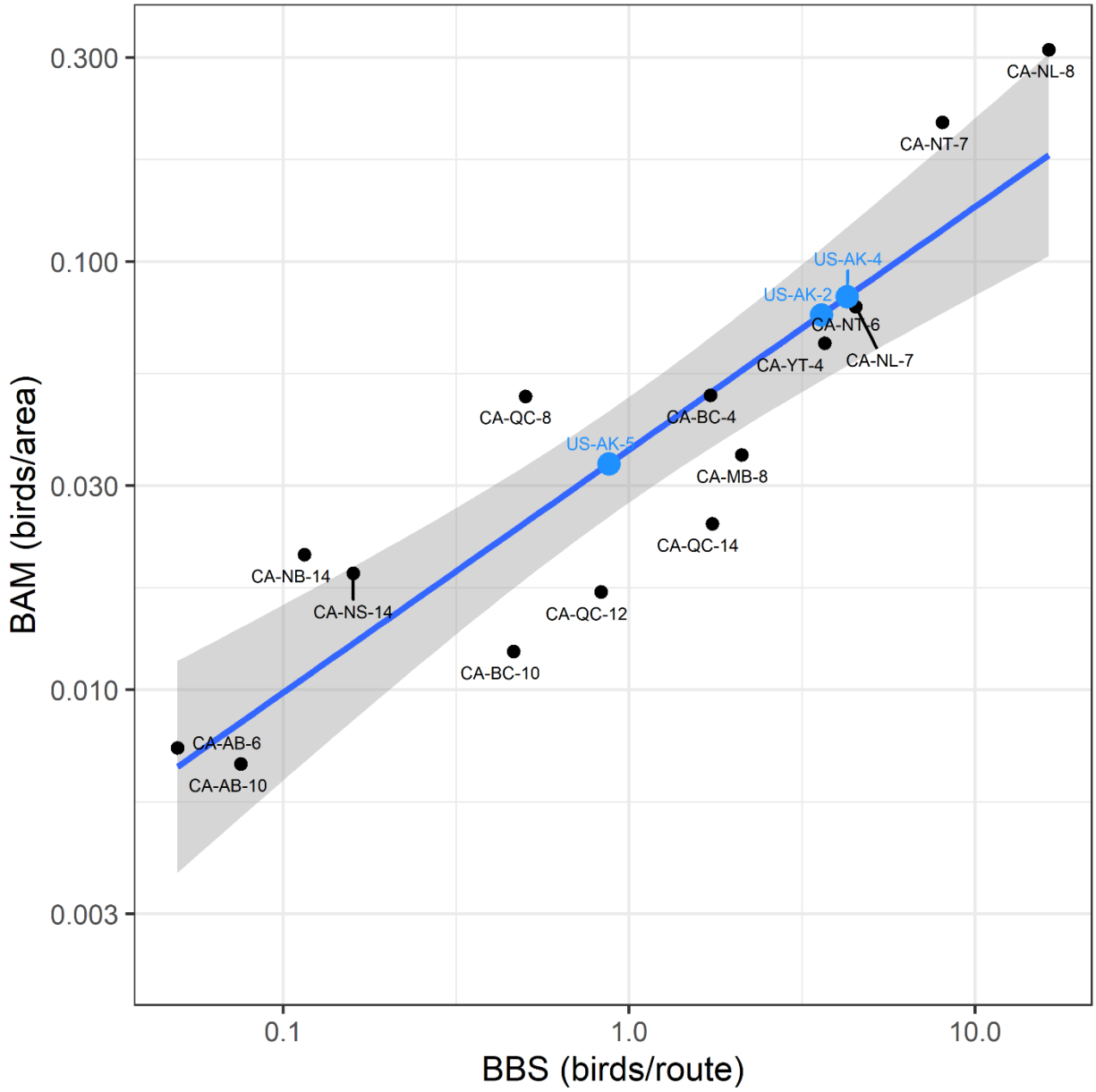

Fig. A2.2. The relationship between mean count per BBS route, and mean density based on the Boreal Avian Modeling Project's density surface. Points represent different USGS analytical strata, which are the intersection of provinces and BCRs. Black points are strata where data are available for both BBS and BAM. Blue points are the three BBS analytical strata in Alaska for which predictions were generated (Alaskan BCRs 2, 4, and 5) and added to the total abundance estimated directly from the BAM raster.

The relative abundance map produced by BAM suggests the Blackpoll Warbler population was 1.99 times more abundant in the West stratum than the East stratum in 2011, and 2.43 times more abundant when the "imputed" portion of the Alaskan breeding range is included based on the analysis illustrated in Figure A2.2.

Literature Cited

Boreal Avian Modelling Project. 2020. BAM Generalized National ModelsDocumentation, Version 4.0. Available at https://borealbirds.github.io/. DOI: 10.5281/zenodo.4018335

Fink, D., T. Auer, A. Johnston, M. Strimas-Mackey, S. Ligocki, O. Robinson, W. Hochachka, L. Jaromczyk, C. Crowley, K. Dunham, A. Stillman, I. Davies, A. Rodewald, V. Ruiz-Gutierrez, C. Wood. 2023. eBird Status and Trends, Data Version: 2022; Released: 2023. *Cornell Lab of Ornithology, Ithaca, New York.* https://doi.org/10.2173/ebirdst.2022

Stralberg, D., Matsuoka, S. M., Hamann, A., Bayne, E. M., Sólymos, P., Schmiegelow, F. K. A., ... & Song, S. J. (2015). Projecting boreal bird responses to climate change: the signal exceeds the noise. *Ecological Applications*, *25*(1), 52-69.