APPENDIX 4. Additional comparisons of the hierarchical Bayesian (HB_3) and maximum likelihood (ML) models, including comparisons of the number of species with trend estimates and the classification of species trends into the categorical assessments of population status used in Environment Canada's Status of Birds in Canada website (Environment Canada 2011).

Comparing the number of species with trend estimates.

Methods

Each model has specific criteria for the minimum data required to estimate a trend for a particular area. These different criteria mean that the list of species and regions with trend estimates will, to some extent, depend on the model being used. We contrasted the number of species with trend estimates for each model for each of the assessed regions (i.e., at the national, BCR, and single stratum scales). We provided lists of the unique species for the national and New Brunswick regions, as examples of the types of species included or excluded based on these criteria. At the limits imposed by either set of minimum data criteria, trend and annual index estimates will almost certainly be of low quality. However, we have included this comparison here to document the newly included and excluded species, and to explain some of the factors leading to the changed list of species with estimated trends.

Results

The HB_3 model generated trends for more species than the ML model at every scale we considered (Figure A4.1). At a national level, the difference was small, but in New Brunswick and in each of the BCRs, the differences were more pronounced. At the national level, species with small Canadian distributions (Table A4.1) were more likely to meet the HB_3 model's lower stratum-level minimum route-count in at least one stratum; while species with broad Canadian

distributions but very low local abundance (Table A4.1) were more likely to meet the ML model's higher national-level minimum route-count across the country. In New Brunswick, the HB_3 model's species list included an additional 26 species that were present on fewer than the 14 BBS routes required by the ML model, for the jackknife estimation of variance (Geissler and Noon 1981). Similarly, the HB_3 model was able to estimate trends for an additional 27 species on average, across the Canadian BCRs (excluding BCR 7), which increased the number of species on the BCR-specific species lists by 6-52%. In addition, 59 species met the HB_3 model's criteria in BCR 7, but no trends were estimated by the ML model, because BCR 7 does not contain the minimum 14 routes required.

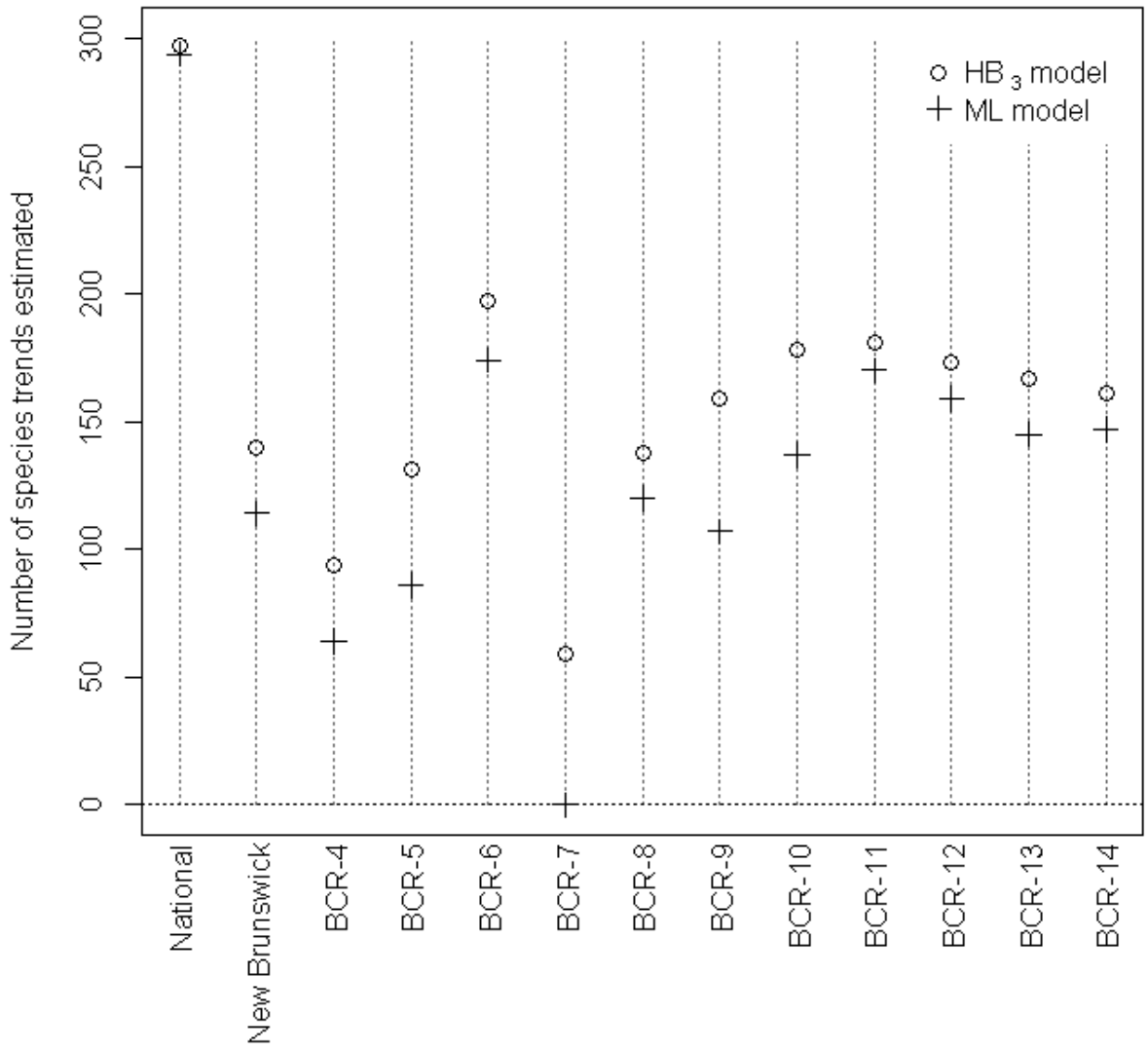

Figure A4.1. Number of Canadian BBS trends estimated by the previously used maximum likelihood (ML) model and the new hierarchical Bayesian (HB_3) model, for various regions of Canada. See Figure 1 in main paper for BCR definitions.

TABLE A4.1. Lists of Canadian BBS species trends uniquely estimated by each of two models: the previously used maximum likelihood (ML) model, and the new hierarchical Bayesian (HB_3) model. Lists are presented in taxonomic order at two scales: 1) the national scale and 2) for New Brunswick, which serves as an example of a smaller region where the difference in the number of species trends estimated is greater than at the national level (Figure A4.1).

	Maximum Likelihood (ML)	Hierarchical Bayes (HB_3)
National	Trumpeter Swan (*Cygnus buccinator*) Spruce Grouse (*Falcipennis canadensis*) Red-throated Loon (*Gavia stellata*) Northern Goshawk (*Accipiter gentilis*) Burrowing Owl (*Athene cunicularia*) Great Gray Owl (*Strix nebulosa*) Northern Saw-whet Owl (*Aegolius acadicus*) Prairie Falcon (*Falco mexicanus*)	Pacific Loon (*Gavia pacifica*) Black Oystercatcher (*Haematopus bachmani*) Least Sandpiper (*Calidris minutilla*) Black-legged Kittiwake (*Rissa tridactyla*) Black Guillemot (*Cepphus grille*) Pigeon Guillemot (*Cepphus columba*) Marbled Murrelet (*Brachyramphus marmoratus*) White-throated Swift (*Aeronautes saxatalis*) Black-chinned Hummingbird (*Archilochus alexandri*) Carolina Wren (*Thryothorus ludovicianus*) Western Bluebird (*Sialia mexicana*)
New Brunswick	Merlin (*Falco columbarius*)	American Wigeon (*Anas Americana*) Mallard (*Anas platyrhynchos*) Blue-winged Teal (*Anas discors*) Northern Pintail (*Anas acuta*) Green-winged Teal (*Anas crecca*) Ring-necked Duck (*Aythya collaris*) Common Eider (*Somateria mollissima*) Common Goldeneye (*Bucephala clangula*) Ring-necked Pheasant (*Phasianus colchicus*) Pied-billed Grebe (*Podilymbus podiceps*) Black-crowned Night-Heron (*Nycticorax nycticorax*) Bald Eagle (*Haliaeetus leucocephalus*) Sora (*Porzana carolina*) Common Tern (*Sterna hirundo*) Great Horned Owl (*Bubo virginianus*) Barred Owl (*Strix varia*) Horned Lark (*Eremophila alpestris*) Purple Martin (*Progne subis*)

	White-breasted Nuthatch (*Sitta carolinensis*) Eastern Bluebird (*Sialia sialis*) Brown Thrasher (*Toxostoma rufum*) Pine Warbler (*Setophaga pinus*) Nelson's Sparrow (*Ammodramus nelson*) Fox Sparrow (*Passerella iliaca*) Eastern Meadowlark (*Sturnella magna*) Northern Cardinal (*Cardinalis cardinalis*) Red Crossbill (*Loxia curvirostra*)

Comparing the categorical assessments of population status.

Methods

We also compared how each model would classify species into the five population status categories used for Environment Canada's "Status of Birds in Canada" assessment (i.e., "Large Decrease", "Moderate Decrease", "Little Change", "Moderate Increase", and "Large Increase" Environment Canada 2011). We estimated the proportion of species that would be classified into the same categories according to the trend estimates from the two models, as well as the proportion that would be classified into categories that were, at most, one category apart in the ranking.

Results

Categorical assessments of long-term population change from the two models were the same for approximately half of species' trends in each region (Figure A4.2, open circles), and most were within a single category (Figure A4.2, open triangles). Within each region, short-term estimates of change were more likely to differ between the two models than the long-term estimates, but 60-80% of species were classified within at most one category by trend estimates from the two models (Figure A4.2, closed circles and triangles).

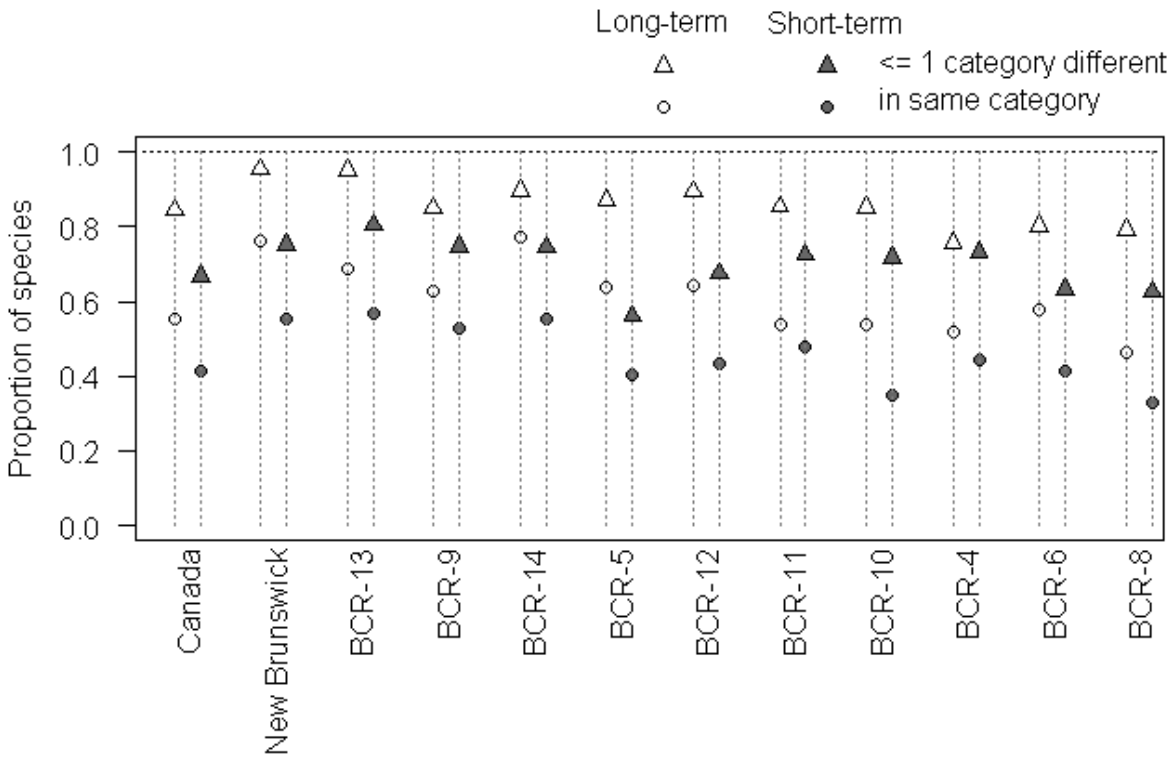

Figure A4.2. The proportion of species with BBS trend estimates that fall into the same "Status of Birds in Canada" (Environment Canada 2011) population status category (upper plot) or within 1 population status category (lower plot), when estimated by the previously used maximum likelihood (ML) model and the new hierarchical Bayesian (HB_3) model. BCRs are sorted in descending order of the ratio of the square root of sample size to area. These comparisons do not consider the precision of the estimated trends, for reasons explained in the methods. See Figure 1 in the main paper for BCR definitions.

Environment Canada. 2011. Status of Birds in Canada – 2011. Environment Canada, Ottawa, Ontario, Canada. www.ec.gc.ca/soc-sbc.

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