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Community science data provide evidence for upward elevational range shifts by Eastern Himalayan birds

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Abstract

The ongoing climate crisis is a significant threat to global biodiversity. As Earth warms, many species respond by shifting their geographical ranges either polewards, or in mountainous regions, upslope towards higher elevations, presumably to track suitable thermal environments. Upslope range shifts are of particular concern in tropical mountain ranges because: (a) tropical species are particularly thermally sensitive; (b) species moving upwards could become locally extirpated as they run out of habitable space; and (c) tropical mountains harbor a high fraction of Earth's terrestrial biodiversity. Rapid upslope shifts can, therefore, result in significant biodiversity losses. We used community science data over a 13-year period to evaluate whether 93 Eastern Himalayan bird species might be shifting to higher elevations. To do this, we analyzed changes in their occurrence probabilities in eBird checklists from birdwatching hotspots at fixed elevations. We found patterns consistent with upslope range shifts; species with elevational ranges primarily below hotspot elevations show increases in their occurrence probability over time, and those with most of their elevational ranges above a hotspot elevation decline in occurrence probability. Our findings are suggestive of rapid responses to climate change by Eastern Himalayan birds. We caution that Eastern Himalayan bird species might be at special risk from increasing global temperatures because of heightened thermal sensitivity coupled with high rates of warming in the region. To remain resilient in the face of climate change, Eastern Himalayan birds likely require undisturbed habitats spanning entire elevational gradients, to track rising temperatures by moving to higher elevations.

KEYWORDS
climate change, Eaglenest Wildlife Sanctuary, eBird, elevational ranges, tropical mountains

1 | INTRODUCTION

The sixth mass extinction in Earth's history is currently underway (Ceballos & Ehrlich, 2018), and is driven primarily by climate change and the loss and degradation of natural habitats (Pimm, 2008). Among the many impacts that climate change has on biodiversity, one of the most fundamental is shifts in the geographical ranges of species (Chen et al., 2011). With climate change leading to ever-increasing temperatures globally, both terrestrial and marine species are shifting their geographic ranges to track their optimum thermal niches, either latitudinally (i.e., towards the poles), elevationally (i.e., towards mountain summits), or both (Chen et al., 2009; La Sorte & Jetz, 2010; Lenoir et al., 2020; Parmesan & Yohe, 2003). Upslope shifts in species' elevational ranges, especially for thermally sensitive

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tropical species inhabiting relatively aseasonal habitats (Freeman et al., 2021; Janzen, 1967; Mamantov et al., 2021; Wormworth & Şekercioğlu, 2011), have been demonstrated for a range of taxa, from comparatively immobile groups such as plants (Feeley et al., 2011; Morueta-Holme et al., 2015; Salick et al., 2019) to more mobile species such as ectotherms (Chen et al., 2009; Raxworthy et al., 2008), birds (Forero-Medina et al., 2011; Freeman et al., 2018; Freeman & Freeman, 2014; Neate-Clegg, Horns, et al., 2020; Tingley et al., 2012), and mammals (Moritz et al., 2008; Rowe et al., 2015). Plants in the Himalayas have been shown to move upslope, presumably as a response to increasing temperature (Salick et al., 2019), and it is likely that Himalayan birds will track these vegetational and thermal shifts (Lenoir & Svenning, 2015), especially in the light of well-documented and rapid upslope shifts to higher elevations by montane birds in other tropical regions such as in Papua New Guinea and Andes (Freeman et al., 2018; Freeman & Freeman, 2014).

These rapid upslope shifts may present a problem for the continued survival of tropical montane species by increasing the probability of local mountaintop extinctions (the "escalator to extinction"; Freeman et al., 2018), via not only a possible direct reduction in area available for occupancy, but also through indirect effects such as increased competition and other secondary and stochastic drivers of local extirpation (Brook et al., 2008; Elsen & Tingley, 2015; Marris, 2007; Şekercioğlu et al., 2012; Thomas et al., 2004). Biodiversity losses arising from extirpations on tropical mountains could be significant, because tropical mountains house a disproportionately high fraction of Earth's terrestrial biodiversity and endemic species (Myers et al., 2000).

With rapidly accelerating warming, predicting how tropical montane species shift their ranges to higher elevations is essential: (a) because different species are likely to move upslope at different rates, leading to novel ecological communities and species interactions (Angert et al., 2011); and (b) to plan adequate long-term and large-scale measures to maximize the resilience of species to climate change. Such an understanding is especially urgent for eastern Himalayan species, because the region is exceptionally biodiverse (second only to the Amazon-Andes system; Grenyer et al., 2006), and is warming at an average rate of 0.06°C per year (Shrestha et al., 2012), far faster than in mountains in Papua New Guinea (0.008–0.01°C per year; Freeman & Freeman, 2014) or the Andes (0.014°C per year; Freeman et al., 2018), and faster than the global average. By the end of the 21st century, surface air temperatures in the Himalayas are set to warm further by 2.6–4.6°C according to the CMIP5 scenario (Sabin et al., 2020). Amongst various taxonomic groups, birds provide a useful study system to investigate the impacts of climate change because they are relatively well-studied compared with other taxonomic groups, and community science initiatives such as eBird, an online community science database of bird sightings (Sullivan et al., 2014) have made large amounts of data collected at certain sites over the years publicly available. India in particular is one of the largest contributors to eBird data globally (SoIB, 2020; K.B.A. Team, 2022). Finally, because the Himalayas are warming much faster than the global average, the responses to climate change of relatively mobile taxonomic groups such as birds can serve as a bellwether to anticipate how tropical montane biodiversity might be impacted by climate change in the future.

Given the thermal sensitivity of tropical species in general (Freeman et al., 2021; Janzen, 1967; Perez et al., 2016) and eastern Himalayan birds in particular (Srinivasan et al., 2018), and the rapidity of warming in the Eastern Himalayas (Shrestha et al., 2012), we hypothesized that eastern Himalayan bird species would show rapid upslope elevational range shifts (see Srinivasan & Wilcove, 2021). Using eBird checklist data from two "hotspots" in a relatively well-birded site in the Eastern Himalayas, we compared the probability of occurrence of species in checklists between two time periods (2006–2010 and 2016-2019). We predicted that the difference in occurrence probability of species over time would be strongly related to species' elevational ranges. For species for which the mid-point of their elevational ranges were below the elevation of the hotspot, we expected increases in occurrence probability over time as species moved upslope and towards the hotspot elevation. For species for which the mid-point of their elevational ranges were above the hotspot elevation, we expected declines in occurrence probability at the hotspot over time, because they should show movement upslope away from the hotspot.

2 | METHODS

2.1 | Study area

We studied bird populations in Eaglenest Wildlife Sanctuary (27°4′12″ N, 92°24′36″ E; EWLS) and Singchung Bugun Village Community Reserve (27°9′36″ N, 92°27′36″ E; SBVCR), West Kameng district, Arunachal Pradesh, India (Figure 1). In the region as a whole, EWLS and SBVCR represent an area with minimal land-use change, apart from some historical military-related construction activity, which was halted several decades before. EWLS and SBVCR also encompass vast, continuous elevational gradients, potentially allowing species to move upslope continuously in response to climate change. It is, therefore, highly likely that any contemporary shifts in elevational ranges result from climate change.

We initially selected all five birdwatching hotspots designated by eBird at different elevations within EWLS and SBVCR for analysis. eBird is an online freely downloadable community science database in which birdwatchers upload their sightings and checklists of birds (eBird, 2021; Sullivan et al., 2014; Wood et al., 2011). Some locations, deemed particularly important based on the number and set of species recorded, and the numbers of checklists reported, are then designated as eBird hotspots. Within EWLS and SBVCR, the designated hotspots are Khellong (750m a.s.l), Sessni (1250m), Bongpu (1950m), Lama Camp (2350m) and Eaglenest Pass (2780m). For each species at each hotspot, our aim was to investigate how the probability of the species being reported in a standardized checklist changed over time. To do this, we:

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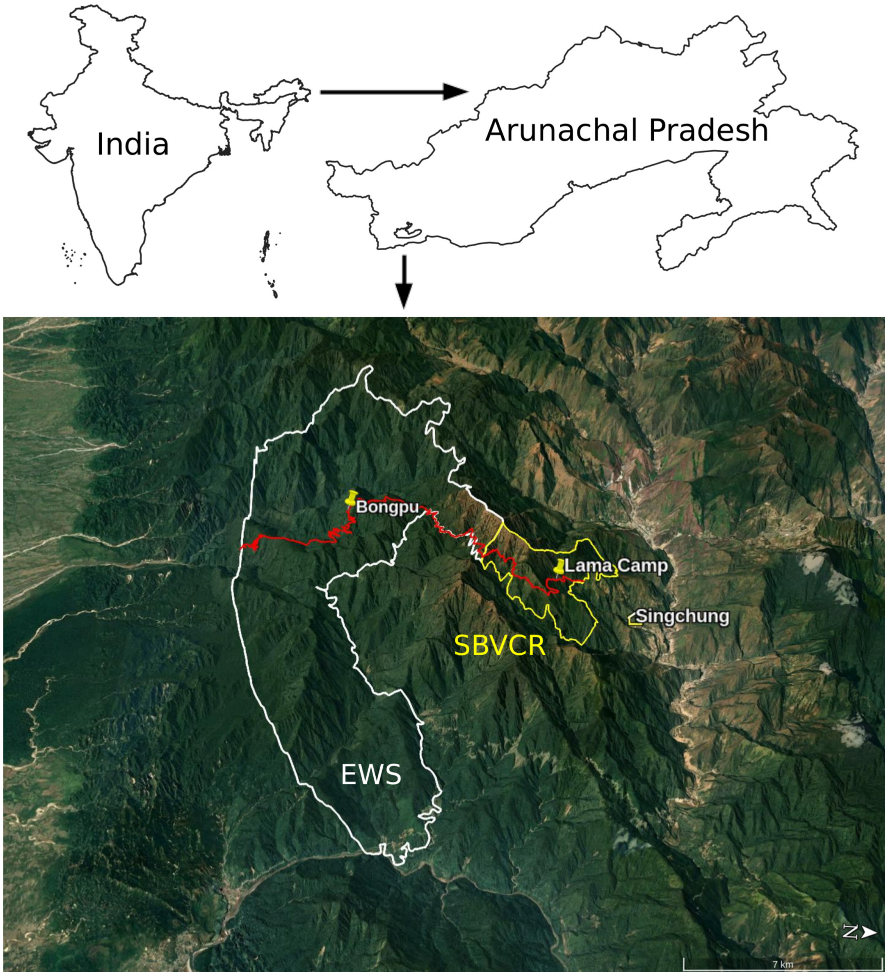

FIGURE 1 Outline map of India (top left) showing the location of Arunachal Pradesh (top right) and below the boundaries of the Singchung Bugun Village Community Reserve (SBVCR; yellow) and Eaglenest Wildlife Sanctuary (EWS; white). The two hotspots for which eBird data were analyzed are Lama Camp (in SBVCR; 2350m ASL) and Bongpu (in EWS; 1950m ASL). The road passing through both the protected areas is shown in red. Also see Figure S1 for further information. Note that the bottom panel is oriented such that north faces towards the right, unlike the upper panels in which north is upwards

a. Limited ourselves to analyzing data from only complete stationary checklists, as well as complete traveling checklists made within a 1 km distance along the road from the hotspot (Figure S1) and no longer traveling checklists, because of the possibly significant elevational changes on traveling even short distances within the Himalayas.
b. Limited ourselves to data from the breeding season (March to May) to avoid the confounding impacts of seasonal elevational migration of birds within the Himalayas. Along these lines, we excluded records of species that are likely to be seasonal migrants, especially species known to be high-elevation breeders (breeding at >3000m), and hence would likely be on passage during our study period. Additionally, we removed species that tend to be highly mobile (swifts, raptors) and have large home ranges, or that may have been observed from afar and, therefore, might not necessarily be recorded at the exact elevation of the hotspot.
c. Limited ourselves to analyzing data from only two hotspots (Bongpu and Lama Camp, both in montane broadleaved forest) that were more intensively birded and had enough checklists (94 and 132, respectively) to compare occurrence probabilities over time. The number of checklists from Khellong (5), Sessni (29), and Eaglenest Pass (19) were too low to analyze. The 226 selected checklists with checklist and observer IDs for Bongpu and Lama Camp have been listed in the supplement as Table S2.

Additionally, some of the recorded species may still be moving upwards elevationally in March (these species have been excluded from the analyses; see above). For most species, however, breeding activity begins in mid-March at 2000m at the same study sites (Srinivasan, 2013; Srinivasan et al., 2015; Srinivasan & Quader, 2019). In mid-March, there is a complete breakdown of mixed-species bird flocks and the formation of conspecific breeding pairs, displays of territoriality and song, and the collection of nesting material. However, in order to mitigate the possible effect of some species that may still be moving upwards as a phenological response in March, we also carried out a separate analysis of the checklists with data from the month of March excluded. This left us with 62 checklists from Bongpu and 85 checklists from Lama Camp.

2.2 | Calculations: eBird proportions

For each hotspot (Bongpu and Lama Camp), we divided eBird checklists into two time periods (earlier and later – 2006 to 2010 and 2015 to 2019, respectively). No checklists were available from before 2006, for the years 2011 to 2014, or after 2019. Checklist

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length has been shown to be an excellent reflector of both observer quality and effort (Szabo et al., 2010; Horns et al., 2018; although there are other metrics to assess quality and effort, such as using the Checklist Calibration Index; Johnston et al., 2018). On average, checklist lengths differed between our earlier and later periods at both hotspots with earlier checklists containing more species than later checklists (Figure S2). To account for potential differences in effort and observer quality between our two time periods, we, therefore, estimated from the data—for each species at each hotspot in each time period separately—the probability of a species occurring in a standardized checklist of a particular length. We did this using a logistic generalized linear model with a logit link, such that

$$P(\text{species reported}) \sim \text{checklist length} + \text{time period} + \text{location} + \text{time period: location}$$

where each checklist is a sample, checklist length is an integer variable (number of species in a checklist), time period is a factor variable with two levels (earlier and later), location is a factor variable with two levels (i.e., the two hotspots: Bongpu and Lama Camp) and time period:location is an interactive term allowing for the estimation of the probability of occurrence of a species in a standardized checklist in earlier and later time periods at Bongpu and Lama Camp separately.

To run the logistic regressions, we included: (a) only those checklists longer than the median checklist length; and (b) species recorded at least ten times across all checklists at a particular location. We then used parameter estimates from the logistic regressions to estimate the probability that a particular species would be recorded in a standardized checklist (length = 40 species) at each location in earlier and later time periods. This approach minimizes potential biases arising from variations in observer quality and effort (Horns et al., 2018; Johnston et al., 2018). While the number of observers might be an important factor influencing the birds recorded in a checklist across the two time periods, we did not include this variable in the model because an ANOVA on the number of observers in each time period indicated no significant statistical differences-($R^2 = 0.00$; $F_{1,190} = 0.24$, $p = 0.63$). For each location, we subsequently subtracted the probability of occurrence in the earlier time period from the probability of occurrence in the later time period. A positive number, therefore, means that the probability of occurrence of the species increased over time at the given location, and a negative number indicates that the probability of occurrence declined at the given location (Figure S3). We expected that for a species, the difference in the occurrence probability over time would be correlated with its elevational range relative to the elevation of the hotspot. Species with most of their historical elevational ranges below the hotspot elevation should show increases in occurrence probability as climate warming compels such species to move upslope to occupy higher elevations than before. Species with most of their elevational ranges above a given hotspot elevation should show declines in occurrence probability over time as they leave thermally suboptimal elevational zones for higher elevations.

We extracted data on the upper and lower breeding elevational range limits (Table S1) of Eastern Himalayan species from Spierenburg (2005), Srinivasan et al. (2018) and Billerman et al. (2020). We then calculated the midpoint of the breeding elevational range for each species, and subtracted the elevation of each hotspot/location from the midpoint of the breeding elevational ranges. Negative values, therefore, represent species for which elevational ranges are largely below the elevation of the eBird hotspot, and positive values species for which elevational ranges are largely above the hotspot elevation. To test for potential relationships between difference in range midpoint from hotspot elevation and change in probability of occurrence over time across species, we used a weighted linear regression, using the number of observed occurrences of each species as model weights (Table S1).

We tested whether correction for phylogeny was required using the phylogenetic Moran's *I*, using a species phylogeny sourced from BirdTree (Jetz et al., 2012) All analyses were done using Program R (R Core Team, 2021).

2.3 | Assumptions and limitations of our analyses

Our analyses assume several underlying patterns, and are also limited by the nature and quantity of the data we use for our inferences:

1. Abundant range centers/rare peripheries: Our predictions relating to upward range shifts towards or away from elevational hotspots depending on the upper and lower elevational bounds of species' range limits contain two related assumptions: (i) that elevational ranges are constrained both directly and indirectly by temperature (Burner et al., 2020; Freeman et al., 2019), and will, therefore, respond primarily to changes in the thermal environment; and (ii) for any species, the relationship between elevation and abundance would show roughly a unimodal distribution, such that abundance approaches zero at the upper and lower bounds of the elevational range of the species, and approaches a peak at some intermediate elevation (see Burner et al., 2019; Gaston, 2009).
2. Data limitations:
   (i) Proportion data: The aim of our analyses was to infer elevational range shifts of Eastern Himalayan bird species, likely in response to climate change. Truly measuring this would require showing significant changes in the lower and upper bound of species' elevational ranges over time. For example, community science data from eBird has been used to study seasonal altitudinal migrations in Taiwanese birds (Tsai et al., 2021). These data, unfortunately, are not available in many places, including our study site, and we use elevation-specific changes in the modeled probability with

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which species could be reported in checklists over time as a proxy for change in abundance with elevation, and, therefore, change in elevational range (see assumption #1 also). Further, we have no way of calculating the degree to which a given shift (in meters) in elevational range corresponds to a change over time in the probability that a particular species could be recorded in a checklist. Our response variable, therefore, is difficult to interpret biologically, and does not have clearly interpretable physical units.

(ii) Volume of data: The number of checklists we use for our analyses are low—94 for Bongpu and 132 for Lama Camp. A further limitation of our analyses arises from the fact that the checklists also have to be divided into two time periods, thereby reducing the number of checklists per time period. While the Eastern Himalayas are exceptionally biodiverse, these low volumes of data have led to the unavoidable jettisoning of a majority of bird species from the analyses, limiting us to analyzing changes in occurrence probability for only 93 species (out of the 302 that were recorded in total in eBird checklists that satisfied our criteria for inclusion in the analyses).

(iii) Life-history traits: Because of the paucity of checklists and the low number of species included in our analyses, there is limited variation in life-history traits; we were, therefore, unable to relate variability in upward range shifts as a function of: (a) direct physiological mechanisms such as thermal tolerances by examining correlations between occurrence probability and thermally relevant species traits such as body mass; and/or (b) via indirect mechanisms such as the need to track food resources, by examining species' diets and probabilities of occurrence (Angert et al., 2011).

3. Finally, we assumed that species did not become any more resilient to climate change and associated thermal stress over our study period.

3 | RESULTS

Across all five designated hotspots in our study landscape, the eBird data yielded 28,238 bird records from 1079 complete checklists. Upon filtering the data to include only complete (stationary or traveling <1km) checklists from the breeding season from Bongpu and Lama Camp, we obtained 4300 bird records of 302 species from 226 eBird checklists. Of the 302 species, most were recorded infrequently (<10 times), and had to be excluded from the analyses, leaving us with 2548 individual records representing 93 relatively common species (Table S1). These records were part of 94 checklists from Bongpu and 132 checklists from Lama Camp.

As expected, at both hotspots separately, species' elevational ranges were correlated with the modeled changes in occurrence probability over time. At Bongpu (1950m, Figure 2a) and Lama Camp (2350m, Figure 2b), species with elevational ranges largely above the hotspot-specific elevations (i.e., positive values on the *x*-axis) showed decreases in occurrence probability over time, while species that occurred largely below the elevation of the hotspot showed increases in probability (linear regression; $ß_{\text{Bongpu}}$ = difference in occurrence probability of 0.41 over time per 1000m difference from mid-point of species' elevational range, $F_{1,47} = 18.88$, $p < 0.01$, $R^2 = 0.29$; $ß_{\text{Lama Camp}}$ = difference in occurrence probability of 0.27 over time per 1000m difference from mid-point of species' elevational range, $F_{1,56} = 6.82$, $p < 0.05$, $R^2 = 0.11$).

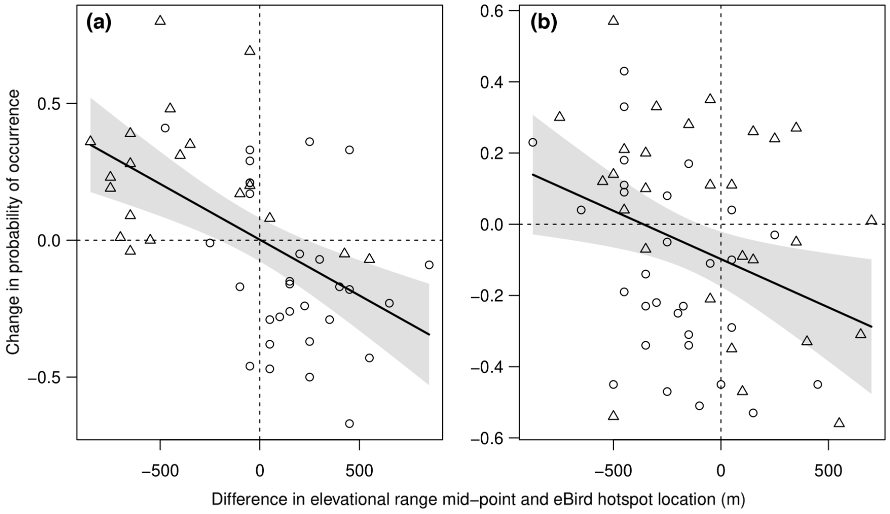

FIGURE 2 At both 1950m (a) and 2350m (b) ASL, species found at lower elevations (negative values on the *x*-axis) also had higher probabilities of occurrence in later eBird checklists than in earlier checklists (positive values on the *y*-axis), which is consistent with upslope range shifts. In the plots, open circles denote species common to both hotspots, while open triangles denote species exclusively found at that particular hotspot. Solid lines and grey polygons represent best fits from a weighted linear regression and their associated 95% confidence intervals, respectively. Dashed lines represent no change in occurrence probability over time (horizontal lines) and no difference between hotspot elevation and elevational range midpoint (vertical lines)

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Some species had wide elevational ranges, and were found at both hotspots (represented by open circles in Figure 2)—for these species, patterns in change in occurrence probability often differed strongly and qualitatively between the two hotspots. One of the strongest qualitative differences, for instance, was shown by the Yellow-bellied Fairy-fantail (*Chelidorhynx hypoxanthus*), which declined markedly (by ~46%) in its probability of occurrence at 1950m, but a showed a strong (~43%) increase in occurrence probability at 2350m (Table S1).

The phylogenetic Moran's I-test on the generated phylogeny showed no significant phylogenetic structure in change in probability of occurrence at either site (95% CIs for phylogenetic Moran's for the difference in proportion of checklists in which a species was reported = [−0.03, 0.00] for Bompu and [−0.03, 0.01] for Lama Camp).

The analyses of the data excluding records from March shows ($n = 45$ species) qualitatively identical results to the analyses of the entire dataset (i.e., March included; see Figure S4). With the March data excluded as well, there was a decrease in occurrence probability for species with elevational ranges lying largely above the hotspot, while the opposite was seen for species below the hotspot (linear regression; $ß_{\text{Bongpu}}$ = difference in occurrence probability of 0.65 over time per 1000m difference from mid-point of species' elevational range, $F_{1,25} = 10.54$, $p < 0.01$, $R^2 = 0.30$; $ß_{\text{Lama Camp}}$ = difference in occurrence probability of 0.31 over time per 1000m difference from mid-point of species' elevational range, $F_{1,30} = 3.57$, $p < 0.07$, $R^2 = 0.11$).

4 | DISCUSSION

Our results from analyses of the change in the occurrence probabilities of species at particular elevations from community science data are consistent with upslope range shifts in Eastern Himalayan bird species. We find these patterns over a relatively short period (13 years), and with the use of occurrence probability data inferred from species checklists as a proxy for actual elevational range shifts, rather than measuring changes in the lower and/or upper bound of the elevational ranges of species over time. Our results relating species-specific elevational ranges and differences in probability of occurrence over time are also consistent with recent long-term demographic work from the same study area (Srinivasan & Wilcove, 2021) at one of the hotpots we analyze (Bongpu, 1950m a.s.l). At Bongpu, species with elevational ranges largely below 1950m showed survival increases over an eight-year period, while those with most of their elevational ranges above 1950m faced survival declines over time.

Semi-structured data (such as eBird collects) carries several biases inherent in their reporting, and hence may not be an accurate indicator of true trends, especially for rarer species (Boersch-Supan et al., 2019, Neate-Clegg, O'Brien, et al., 2020). Several of these biases need to be accounted for while developing and interpreting, for instance, species distribution models, but are not likely to influence the proportion data that we use in our analyses. Of the other potential biases, our analysis mitigates several of the possibilities that could result in biased inferences. Some biases characteristic of eBird data are spatial, taxonomic and temporal biases, and variation in detectability arising from differences in species' abundances, birder skill and effort (Callaghan et al., 2019; Johnston et al., 2021; Kelling et al., 2015; Kelling et al., 2019; Strimas-Mackey et al., 2020). The use of only complete checklists minimizes taxonomic biases, and by using only summer counts across time at well-defined locations minimizes temporal and spatial biases. By selecting species with only a certain threshold number of records, and hence representing the most common species present, biases in detection due to local abundance is lessened. As a result, potentially the only biases in the data we consider arise from variations in observer quality and effort. For this reason, we used checklist length as a proxy for both observer quality and effort (Horns et al., 2018), selected only those checklists longer than median length, and using a binomial GLM, standardized the probability of occurrence of species for a "standard" checklist with a length of 40 species.

We caution that our results—although certainly expected in the light of rapid warming in the Eastern Himalayas (Shrestha et al., 2012)—should be viewed as preliminary until such time that (a) direct measures of change in elevational range over time are available; (b) more detailed analyses of long-term distribution patterns of mountain-top species can potentially identify local extirpations and declines; and (c) across-Himalayan comparisons can be made to check for heterogeneity in species' response to climate change along the length of the range. A large number of studies on the elevational ranges of Himalayan birds have already been carried out across the entire range (e.g., Acharya et al., 2011; Bhatt & Joshi, 2011; Elsen et al., 2017; Price et al., 2014; Schumm et al., 2020; Srinivasan et al., 2018). While these are relatively recent, unlike data from the Andes and from Papua New Guinea, in time, these data can be used as a baseline to compare later-day elevational ranges.

A further promising area for research is to tease apart differences between abiotic factors such as temperature, biotic interactions such as competition and resource use and factors such as vegetation structure in influencing the elevational ranges of species (Burner et al., 2020; Elsen et al., 2017). These factors will likely have different roles in influencing the ranges of different species and populations (e.g., frugivores might be more expected to be constrained by the distribution of fruiting plants), thereby also influencing how species traits such as body size and diet interact with climate change to reset elevational ranges. The rate of shift of whole habitats and how these lag behind climate may also impact the continued survival of species; for example, while Bornean moths shift upward fairly concurrently with warming (Wu et al., 2019), plants in the Alps tend to lag far behind (Rumpf et al., 2018), though this could be a consequence of the long generation time of trees coupled with the inherent thermal tolerances of these plant species. This creates the problem of the movements of mobile taxa tied to a specialized habitat being constrained by slow upward shifts of vegetation compared to climate. There is also a tradeoff between tracking the thermal niche and the metabolic demand as the partial pressure of oxygen declines with increasing altitude, which may further constrain shifts

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(Jacobsen, 2020). Local topographies (Gaüzère et al., 2017) and increasing seasonality with climate change and consequent shifts in hygric niches (Boyle et al., 2020) could also impact the populations independent of upslope shifts; for instance, local microclimatic refugia against more pronounced seasonality with further climate warming might in fact allow species to survive for longer durations at a certain elevation without upslope shifts. Hence, building a complete understanding of species' responses to climate change is important to predict which kinds of species are most vulnerable to continued warming in tropical mountains, and to identify potential steps to minimize the impacts of climate change on such species. In the Eastern Himalayas, it is likely that birds will require contiguous expanses of old-growth forest across elevational gradients to enable upslope range shifts and maintain resilience to climate change (Srinivasan & Wilcove, 2021).

One future direction of study would be to compare these rates of upslope shift for tropical montane biotas across the planet, in order to assess which regions and taxonomic groups are most at risk to possible extirpations, or even extinction in the case of range-restricted endemic species (Carroll et al., 2015). This preliminary prediction technique is a tractable framework for making inferences in other tropical biotas, prerequisite to the presence of a significant number of community science datasets for the region, and information on the elevational bounds for at least some of the species recorded there.

AUTHOR CONTRIBUTIONS

K.S.G. and U.S. conceptualized the study, K.S.G and U.S. designed the methods of analysis, and curated and formally analyzed the data, K.S.G. wrote the original draft, U.S. provided revisions and additions to several sections of the manuscript.

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CONFLICT OF INTEREST

The authors declare no competing interests. The research findings and conclusions of this work are solely those of the authors. The corresponding author confirms on behalf of all authors that there have been no involvements that might raise the question of bias in the work reported or in the conclusions, implications, or opinions stated.

DATA AVAILABILITY STATEMENT

The data as well as the code that support the findings of this study are openly available in the Dryad Digital Repository: https://doi.org/10.5061/dryad.r4xgxd2g0 (Girish & Srinivasan, 2022).

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