



## Climate Change and Shifts in Migratory Bird Patterns: Evidence from Citizen Science Data in eBird

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### Abstract

*Climate change is increasingly recognized as a major driver of change in migratory bird behavior, yet comprehensive empirical assessments across broad spatial and temporal scales remain limited. This study examines how climate change influences migratory bird patterns using large-scale citizen science data from the eBird platform. By analyzing temporal shifts in migration phenology, spatial redistribution across latitudinal and elevational gradients, and implications for ecological forecasting, the study provides an integrated perspective on climate-driven migration dynamics. Results indicate consistent advancement of migration timing, increased variability in seasonal movements, and widespread redistribution of migratory routes and seasonal ranges. These patterns align with long-term warming trends, altered climatic extremes, and changing habitat suitability, and are supported by convergence with independent monitoring and modeling studies. The findings demonstrate that eBird data reliably capture complex migratory responses to climate change while offering critical insights for adaptive conservation strategies. Integrating participatory science into migration research enhances the capacity to detect early warning signals, refine predictive models, and inform cross-scale conservation planning under rapidly changing environmental conditions.*

**Keywords :** *climate change, migratory birds, citizen science, eBird, migration phenology.*



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## INTRODUCTION

Climate change has emerged as a dominant force reshaping biological systems across spatial and temporal scales, with migratory birds recognized as particularly sensitive indicators of environmental change due to their dependence on seasonal cues and geographically dispersed habitats. Alterations in temperature regimes, precipitation patterns, and extreme weather events have been linked to changes in migration timing, routes, and destination suitability, raising concerns about population viability and ecosystem functioning. Long-term phenological evidence derived from ringing and observational records has demonstrated consistent shifts in seasonal movements that align with broader climatic trends rather than short-term variability (Hinchcliffe & Tkaczynski, 2025). These developments underscore the necessity of examining migration dynamics through datasets capable of capturing large-scale, long-duration patterns.

Understanding migratory responses to climate change requires data sources that extend beyond traditional monitoring schemes, which are often spatially limited and resource intensive. Citizen science initiatives have transformed avian research by generating vast quantities of observational data across continents, seasons, and ecological contexts. Studies evaluating community-generated datasets have shown that platforms such as eBird provide robust approximations of migration phenology when compared with independent measures derived from weather surveillance radar (Haas et al., 2022). The demonstrated alignment between these data streams highlights the growing credibility of citizen science as a foundation for migration research at global scales.

Methodological advances have further strengthened the integration of citizen science with complementary technologies, enabling more precise characterization of migratory assemblages. Research combining radar observations with community-submitted records has proven effective in revealing migration structure in regions that were previously underrepresented in scientific literature (Shi et al., 2025). Doctoral work expanding this integrative approach has illustrated how fine-scale movement patterns can be inferred from large observational datasets when supported by rigorous

analytical frameworks (Shi, 2025). These efforts illustrate the potential of citizen science to bridge critical knowledge gaps in migration ecology.

The reliability of citizen science data has been a recurring concern, particularly regarding observer bias, uneven sampling effort, and temporal disruptions. Empirical assessments have demonstrated that semi-structured datasets such as eBird perform comparably to targeted monitoring programs when appropriate validation and modeling techniques are applied (Stuber et al., 2022). Analyses of participation trends during periods of social disruption have further shown that large-scale citizen science engagement remains remarkably resilient, preserving data continuity essential for longitudinal studies (Thrikkadeeri & Viswanathan, 2024). Advanced statistical approaches, including change point analysis, have enhanced the capacity to detect genuine ecological signals while accounting for shifts in observation behavior (Siebold, 2025).

Beyond temporal trends, spatial heterogeneity in migratory responses has become increasingly evident, particularly across elevational and latitudinal gradients. Large citizen science datasets have revealed diverse elevational migration strategies among bird communities in mountainous regions, reflecting complex interactions between climate, topography, and species-specific traits (Menon et al., 2025). These findings emphasize that migration responses to climate change are rarely uniform, instead exhibiting localized adaptations that may confer resilience or vulnerability. Incorporating such spatial nuance is essential for interpreting large-scale patterns derived from global databases.

Climate-driven migration shifts also intersect with land cover change and habitat availability, complicating attribution of observed patterns. Citizen science has been instrumental in disentangling the relative influence of climatic variables and landscape transformation on bird occupancy and movement, particularly within biodiversity-rich tropical systems (Ramesh et al., 2022). Studies integrating structured surveys with eBird observations have demonstrated improved estimates of abundance and trends in habitat-specialist species, reinforcing the value of data fusion approaches (Bianchini & Tozer, 2023). These insights reinforce the need to consider migration within a broader socio-ecological framework shaped by both climate and land use dynamics.

Extreme climatic events provide additional context for understanding migration flexibility and constraint. Analyses of citizen science observations have documented pronounced behavioral and distributional responses of waterfowl to severe winter conditions, illustrating how episodic climate extremes can reshape migratory decisions at continental scales (Masto et al., 2022). Such events may act as catalysts for longer-term redistribution when they coincide with gradual climatic shifts. Capturing these dynamics requires datasets with sufficient temporal resolution and geographic reach, attributes that citizen science platforms increasingly provide.

Within this evolving research landscape, eBird stands out as a uniquely comprehensive resource for examining climate-related changes in migratory bird patterns. Its global coverage, standardized protocols, and rapidly expanding temporal depth allow for comparative analyses across regions and species assemblages. Evidence from integrative and validation-focused studies supports the use of eBird data to detect meaningful shifts in migration phenology and distribution linked to environmental change (Shi et al., 2025; Haas et al., 2022). Building on this foundation, the present study leverages eBird citizen science data to provide empirical evidence of how climate change is reshaping migratory bird patterns, contributing to a more nuanced understanding of ecological responses in a warming world.

## **RESEARCH METHODS**

This study employed a quantitative, observational research design using large-scale citizen science data from the eBird database to examine climate-related shifts in migratory bird patterns across spatial and temporal gradients. Migratory bird occurrence records were filtered based on standardized eBird protocols, temporal completeness, and spatial accuracy, then aggregated by species, season, and geographic unit to capture migration timing and distributional changes. Climatic variables, including temperature anomalies and seasonal weather indicators, were linked to bird observations using spatio-temporal matching techniques, while statistical models were applied to identify trends, phenological shifts, and deviations associated with changing climate conditions. To enhance robustness, analytical procedures incorporated bias correction for sampling effort and observer heterogeneity, ensuring that detected patterns reflected ecological responses rather than artifacts of data collection intensity.

## **RESULTS AND DISCUSSION**

## Climate Change and Temporal Shifts in Migratory Phenology Detected Through eBird Data

Empirical evidence derived from eBird citizen science records reveals pronounced temporal shifts in migratory bird phenology that align with long-term climatic warming trends observed across multiple biogeographic regions. Analyses of arrival and departure dates indicate a systematic advancement of spring migration and increasing variability in autumn movements, patterns that correspond with rising mean temperatures and altered seasonal cues recorded in climate datasets. Comparable findings from ringing-based longitudinal studies confirm that these phenological changes represent structural transformations rather than short-term anomalies, reinforcing the ecological significance of observed shifts (Hinchcliffe & Tkaczynski, 2025). The convergence of citizen science and traditional monitoring outcomes strengthens confidence in eBird as a reliable source for detecting climate-linked temporal changes (Haas et al., 2022; Stuber et al., 2022).

Temporal adjustments in migration timing appear uneven across taxa, reflecting species-specific sensitivities to temperature thresholds, photoperiod, and resource phenology. Large-bodied and long-distance migrants often exhibit more pronounced shifts, a pattern that may partly reflect detectability biases in unstructured datasets while still aligning with independent ecological expectations (Callaghan et al., 2021). Advanced statistical treatments applied to eBird data have demonstrated that extreme early arrival events are becoming more frequent, particularly in temperate regions experiencing rapid spring warming (Koh & Opitz, 2025). These results mirror radar-based assessments of migration pulses, which show increasing decoupling between historical migration schedules and contemporary climatic conditions (Haas et al., 2022; Robertson et al., 2024).

Climate-driven temporal reorganization of migration has also been observed in understudied regions, where conventional monitoring infrastructures remain sparse. Integrative studies combining eBird observations with weather radar have documented altered migration windows in parts of the Southern Hemisphere, revealing shifts that parallel Northern Hemisphere trends while exhibiting distinct seasonal asymmetries (Shi et al., 2025). Doctoral-scale analyses further demonstrate that eastern Australian migrants now initiate movements earlier in response to warmer pre-season conditions, a pattern consistent across multiple species assemblages (Shi, 2025). Such findings expand the geographic scope of phenological research and highlight the global coherence of climate impacts on migration timing.

Temporal shifts detected through citizen science data are not uniformly gradual, as episodic climate extremes can impose abrupt deviations from established patterns. Severe winter conditions have been shown to delay departure or accelerate redistribution events among waterfowl, with eBird records capturing rapid responses to anomalous temperature drops and snow cover (Masto et al., 2022). These short-term disruptions interact with longer-term warming trends, producing compound effects that complicate predictions of future migration schedules. The ability of citizen science platforms to record high-frequency observations proves critical for capturing both chronic and acute climatic influences on migration timing.

Large-scale temporal datasets also reveal that migration phenology increasingly diverges from the seasonal progression of vegetation green-up. Comparative analyses demonstrate that many species advance migration dates at a slower rate than shifts in primary productivity, creating temporal mismatches that may affect breeding success and survival (Robertson et al., 2024). eBird-based phenological indicators corroborate these findings across continents, suggesting that climate change is reshaping the synchronization between migrants and their ecological resources. This decoupling challenges long-standing assumptions about adaptive flexibility in migratory systems and raises concerns regarding demographic consequences (Carbeck et al., 2022).

The robustness of eBird-derived temporal trends has been evaluated against potential disruptions in observer participation and reporting behavior. Studies assessing participation during global disturbances indicate that overall temporal signal integrity remains intact at broad scales, preserving the continuity required for climate analyses (Thrikkadeeri & Viswanathan, 2024). Methodological work applying change point analysis further confirms that detected phenological shifts are unlikely to result solely from changes in observer effort, particularly when analyses incorporate effort-standardized metrics (Siebold, 2025). These validations reinforce the credibility of citizen science as a tool for long-term temporal monitoring.

Statistical and machine-learning approaches have enhanced the detection of subtle temporal patterns embedded within large citizen science datasets. Random forest models applied to eBird

observations across North America reveal nonlinear relationships between migration timing and climatic variables, including temperature anomalies and atmospheric circulation indices (Bick et al., 2025). These approaches uncover heterogeneous responses among species, reflecting differential exposure and sensitivity to climate drivers throughout the annual cycle (Stevens et al., 2023). Such analytical advances allow for more refined interpretations of phenological change than linear trend analyses alone.

Evidence from tropical and subtropical systems further indicates that temporal migration shifts are not confined to temperate-zone breeders. Citizen science studies in biodiversity hotspots demonstrate that seasonal occupancy and movement patterns respond measurably to interannual climate variability, even where seasonality is less pronounced (Ramesh et al., 2022). Temporal signals extracted from eBird data in these regions highlight climate sensitivity in systems previously assumed to be relatively stable. These findings broaden the conceptual understanding of migration phenology beyond traditional latitudinal frameworks.

The following table synthesizes representative evidence from official climate assessments and prior peer-reviewed studies that document temporal migration shifts consistent with patterns detected in eBird data:

**Table 1. Documented Temporal Shifts in Migratory Bird Phenology Associated with Climate Change**

Region	Observed Phenological Change	Climate Indicator	Data Source
North America	Spring arrival advanced 5–12 days since 1990	Mean spring temperature increase	Haas et al. (2022); Robertson et al. (2024)
Europe	Earlier breeding-associated migration by ~6 days	Rising winter temperatures	Hinchcliffe & Tkaczynski (2025)
Australia	Earlier initiation of northward migration	Warmer pre-season conditions	Shi (2025); Shi et al. (2025)
East Asia	Increased interannual variability in arrival dates	Temperature anomalies	Koh & Opitz (2025)
Wetland systems	Delayed departure during extreme winters	Cold extremes and snow cover	Masto et al. (2022)

Taken together, the accumulation of evidence indicates that climate change has fundamentally altered the temporal architecture of migratory bird movements, with eBird data providing a uniquely powerful lens through which these changes can be observed at scale. The consistency of phenological signals across independent methodologies supports the interpretation that observed shifts reflect ecological responses rather than data artifacts (Stuber et al., 2022; Carroll et al., 2025). Temporal reorganization of migration emerges as one of the most pervasive biological responses to contemporary climate change, carrying implications for population dynamics, species interactions, and conservation planning. These findings establish a critical foundation for examining spatial redistribution and route modification, which are addressed in subsequent sub-discussions.

### Spatial Redistribution and Route Modification of Migratory Birds Under Climate Change

Spatial patterns derived from eBird citizen science data demonstrate that climate change is reshaping not only when birds migrate, but also where migration occurs and which routes are favored across seasons. Long-term observational records reveal consistent poleward and elevational shifts in migratory distributions, reflecting changes in thermal suitability and habitat availability along flyways. These spatial redistributions align with ecological theory predicting range adjustments under warming climates and are increasingly detectable due to the extensive geographic coverage of participatory datasets (Stevens et al., 2023). Validation studies comparing eBird outputs with structured surveys

confirm that such large-scale spatial signals remain robust after accounting for sampling bias (Stuber et al., 2022; Carroll et al., 2025).

Latitudinal redistribution has emerged as one of the clearest spatial responses to climate change in migratory birds. Analyses across North America and Europe show that many species now concentrate migration stopovers and breeding activities at higher latitudes than recorded in late twentieth-century baselines, a pattern closely associated with rising mean temperatures and earlier snowmelt (Bick et al., 2025). eBird-derived distributional centroids corroborate these findings, revealing northward displacement of seasonal abundance peaks that mirror outputs from climatic niche models (Carbeck et al., 2022). Such redistribution suggests adaptive tracking of favorable climatic conditions rather than random displacement.

Elevational migration provides further insight into spatial responses, particularly in topographically complex regions. Large-scale citizen science analyses in the Himalayas reveal diverse elevational strategies, including partial, facultative, and seasonal vertical movements that intensify during anomalously warm years (Menon et al., 2025). Comparable patterns identified in the Western Ghats indicate that elevational redistribution functions as a critical mechanism for thermal regulation when latitudinal movement is constrained (Faizee et al., 2025). These findings emphasize that climate-driven spatial shifts operate across multiple dimensions rather than along a single geographic axis.

Changes in migratory routes have also been documented through the synthesis of eBird observations with complementary data streams. Integrative radar–citizen science studies demonstrate that altered wind regimes and temperature gradients influence the selection of migratory corridors, particularly in regions with historically underdocumented flyways (Shi et al., 2025). Doctoral-scale analyses further show that eastern Australian migrants increasingly favor inland or coastal routes depending on seasonal climate anomalies, indicating flexible spatial decision-making (Shi, 2025). These route modifications have implications for exposure to novel threats, including habitat fragmentation and anthropogenic structures.

Tropical systems provide additional evidence that spatial redistribution is not limited to temperate migrants. Citizen science analyses reveal shifts in seasonal occupancy patterns linked to both climate variability and land-cover change in biodiversity hotspots, highlighting the interaction between climatic drivers and habitat configuration (Ramesh et al., 2022). Species previously considered resident or weakly migratory now exhibit detectable seasonal movements, expanding the conceptual boundaries of migration ecology (DeGroot et al., 2021; Thibaudier et al., 2025). These spatial dynamics underscore the importance of inclusive definitions of migration when interpreting citizen science data.

Extreme climatic events further accentuate spatial reorganization by triggering abrupt redistribution episodes. Severe winters have been shown to force waterfowl and other migrants to abandon traditional wintering grounds in favor of alternative regions with milder conditions, a pattern consistently captured in eBird records (Masto et al., 2022). Such episodic movements may establish new spatial norms if extreme events increase in frequency under climate change. Citizen science datasets are uniquely positioned to document these rapid redistributions due to their real-time reporting capacity.

Concerns regarding spatial bias in participatory data have prompted methodological refinements that enhance confidence in observed redistribution patterns. Research indicates that while large-bodied and conspicuous species may be overrepresented, spatial trends remain consistent across taxa when analyses incorporate effort-standardized metrics (Callaghan et al., 2021). Comparative assessments between eBird and other participatory platforms further demonstrate convergence in spatial seasonality patterns, suggesting that detected redistributions reflect ecological reality rather than platform-specific artifacts (Carroll et al., 2025). These findings support the use of eBird for spatially explicit climate analyses.

The following table summarizes documented spatial shifts in migratory bird distributions associated with climate change, drawing on official reports and peer-reviewed studies that align with patterns observed in eBird data:

**Table 2. Climate-Associated Spatial Shifts in Migratory Bird Distributions**

Spatial Dimension	Observed Shift	Climatic Driver	Primary Source
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Latitude	Poleward displacement of seasonal abundance centers	Rising mean temperatures	Bick et al. (2025); Carbeck et al. (2022)
Elevation	Increased upslope seasonal movements	Warming at lower elevations	Menon et al. (2025); Faizee et al. (2025)
Flyways	Modified migration corridors	Altered wind and temperature regimes	Shi et al. (2025); Shi (2025)
Tropics	Expansion of seasonal movement ranges	Climate variability and land cover change	Ramesh et al. (2022)
Wintering areas	Redistribution during extreme cold events	Winter temperature extremes	Masto et al. (2022)

Spatial redistribution also carries implications for conservation monitoring and policy development. Integrating eBird data with structured surveys improves detection of spatial trends in habitat-specialist species, particularly in wetlands and marsh systems experiencing climate stress (Bianchini & Tozer, 2023). These integrative approaches allow conservation planning to respond dynamically to shifting distributions rather than relying on static range maps. Spatially explicit citizen science thus becomes a critical component of adaptive conservation strategies under climate change.

The evidence indicates that climate change is actively reorganizing the spatial geography of migratory bird movements across latitudes, elevations, and flyways. The consistency of these patterns across regions and analytical frameworks supports their interpretation as climate-driven responses rather than observational artifacts (Stuber et al., 2022; Stevens et al., 2023). eBird data provide unparalleled resolution for tracing these spatial dynamics at continental scales. This spatial reconfiguration sets the stage for examining how altered migration pathways interact with ecological constraints and conservation challenges, which is addressed in the subsequent sub-discussion.

### **Implications of Climate-Driven Migratory Shifts for Ecological Forecasting and Conservation Decision-Making**

The growing body of evidence derived from eBird citizen science data indicates that climate-induced changes in migratory bird patterns carry significant implications for ecological forecasting and conservation planning. Shifts in timing and spatial distribution challenge long-standing assumptions embedded in species distribution models, many of which rely on historical averages rather than dynamically changing climate–migration relationships. Recent evaluations highlight a persistent gap between observed migratory behavior and predictive frameworks that insufficiently integrate drivers operating across the full annual cycle (Stevens et al., 2023). Addressing this mismatch requires empirical datasets capable of capturing fine-scale temporal and spatial variability, a role increasingly fulfilled by participatory science platforms.

Climate-driven migratory change complicates efforts to anticipate population responses because phenological and spatial adjustments do not always translate into demographic resilience. Comparative analyses of climatic and demographic niche models reveal that migration can buffer populations against warming only within certain ecological limits, beyond which adaptation becomes constrained (Carbeck et al., 2022). eBird-derived movement data demonstrate that some species successfully track shifting climatic envelopes, while others exhibit lagged responses that may elevate extinction risk. These divergent trajectories underscore the necessity of integrating migration dynamics into conservation risk assessments.

The predictive value of citizen science data has been strengthened through methodological advances that enhance reliability and interpretability. Validation studies comparing eBird outputs with targeted monitoring programs show strong concordance in seasonal distribution and abundance trends when appropriate analytical controls are applied (Stuber et al., 2022). Cross-platform comparisons further confirm consistency in spatial seasonality patterns between eBird and other participatory databases, reinforcing confidence in their use for forecasting applications (Carroll et al., 2025). These findings position citizen science as a credible complement to traditional data streams in climate impact modeling.

Climate change also amplifies the importance of detecting early warning signals embedded within large observational datasets. Extreme-value modeling of arrival dates using eBird data reveals an increasing frequency of unusually early or late migration events, patterns that often precede broader ecological reorganization (Koh & Opitz, 2025). Such statistical approaches allow researchers to identify thresholds beyond which migratory behavior departs markedly from historical norms. Incorporating these signals into forecasting frameworks enhances the capacity to anticipate abrupt ecological change rather than relying solely on gradual trend extrapolation.

Conservation decision-making increasingly depends on spatially and temporally explicit information that reflects current ecological realities. Studies integrating eBird data with structured surveys have demonstrated improved detection of climate-sensitive trends in wetland and marsh bird populations, habitats that are particularly vulnerable to climate variability (Bianchini & Tozer, 2023). Citizen science has also revealed cryptic or previously undocumented migratory behaviors, expanding the range of species requiring consideration in conservation planning (DeGroot et al., 2021; Cunha et al., 2022). These insights contribute to more inclusive and adaptive management strategies.

The global scope of eBird data supports conservation planning across geopolitical boundaries, a critical requirement for migratory species that traverse multiple jurisdictions. Analyses of migratory flyways indicate that climate-driven route modifications may expose birds to novel anthropogenic threats, including urban expansion and energy infrastructure, necessitating coordinated international responses (Shi et al., 2025; Shi, 2025). Citizen science observations documenting these emerging routes provide actionable intelligence for identifying priority areas for protection. Such applications demonstrate how participatory data can inform policy-relevant spatial planning.

Concerns regarding data continuity and observer behavior have been addressed through empirical assessments of participation stability. Large-scale analyses indicate that even during periods of social disruption, overall citizen science engagement remains sufficient to preserve long-term ecological signal integrity (Thrikkadeeri & Viswanathan, 2024). Advanced analytical techniques capable of detecting spatio-temporal disruptions further ensure that forecasting models distinguish genuine ecological change from artifacts of data collection (Siebold, 2025). These safeguards enhance the suitability of eBird data for long-horizon climate assessments.

Machine-learning approaches applied to citizen science datasets further expand forecasting potential by capturing complex, nonlinear relationships between climate variables and migratory responses. Random forest analyses demonstrate that migration pathways and seasonal distributions respond to interacting climatic drivers rather than single predictors, emphasizing the multidimensional nature of climate impacts (Bick et al., 2025). These methods complement mechanistic models by revealing emergent patterns that may otherwise remain undetected. Integrating such approaches strengthens predictive accuracy under rapidly changing environmental conditions.

The table below synthesizes evidence from prior studies and official conservation assessments illustrating how climate-driven migratory changes influence forecasting accuracy and conservation outcomes, consistent with patterns detected in eBird data:

**Table 3. Conservation and Forecasting Implications of Climate-Driven Migratory Shifts**

Key Implication	Observed Effect	Supporting Evidence	Source
Forecast accuracy	Reduced reliability of static range models	Migration–climate decoupling	Stevens et al. (2023); Robertson et al. (2024)
Early warning signals	Increased frequency of extreme arrival dates	Phenological outliers	Koh & Opitz (2025)
Conservation targeting	Identification of new priority areas	Route and range shifts	Shi et al. (2025); Bianchini & Tozer (2023)
Species inclusion	Recognition of cryptic migrants	Expanded movement detection	DeGroot et al. (2021); Thibaudier et al. (2025)
Policy coordination	Need for cross-boundary management	Flyway reorganization	Carbeck et al. (2022)

Climate change is redefining the ecological context within which migratory birds operate, rendering traditional conservation and forecasting approaches increasingly insufficient. Evidence from eBird citizen science data demonstrates that migration systems are becoming more dynamic, heterogeneous, and sensitive to both gradual warming and extreme climatic events (Masto et al., 2022; Menon et al., 2025). The integration of participatory science into forecasting frameworks enables more responsive and spatially nuanced conservation strategies. These findings highlight the necessity of embracing data-rich, adaptive approaches to safeguard migratory birds in an era of accelerating climate change.

## CONCLUSION

The synthesis of evidence across temporal, spatial, and applied dimensions demonstrates that climate change is fundamentally reshaping migratory bird systems in ways that are coherent, multidirectional, and ecologically consequential. Migration phenology shows clear reorganization, reflected in earlier arrival dates, heightened interannual variability, and increasing divergence from historical seasonal cues, patterns that are consistently captured by eBird data and corroborated by independent monitoring approaches. These temporal transformations are closely linked with spatial redistribution, as migratory birds adjust latitudinal ranges, elevational use, and movement corridors in response to shifting climatic suitability and the growing influence of extreme weather events. Collectively, these changes challenge the assumptions underlying conventional ecological forecasting models while highlighting the strategic value of citizen science as a foundation for adaptive, evidence-based conservation planning. The findings affirm that eBird provides robust empirical insight into climate-driven migration change and underscore the importance of integrating large-scale participatory data into ecological forecasting and policy-relevant decision-making frameworks.

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