IMPACT OF CLIMATE CHANGE ON BIRDS

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Contents

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ABSTRACT

The project focuses on assessing the impact of climate change on bird species, with a particular emphasis on species distribution shifts due to global warming. Using data science and machine learning techniques, the project analyzes bird sightings and climate data over multiple decades to predict how bird populations, specifically the Scottish crossbill, will respond to changes in temperature, precipitation, and habitat availability. The project employs logistic regression, glmnet, and species distribution modelling (SDM) to forecast future distributions of bird species under different climate scenarios (RCP 4.5 and RCP 8.5). The results provide insights into the relationship between climate change and avian ecosystems, informing conservation strategies and policy decisions aimed at preserving vulnerable species.

Introduction

- Bird populations are declining around the world.
- While many factors contribute from habitat loss to pesticides,
- temperature — it is increasingly clear that climate change is an important driver behind this worrying trend.
- Climate patterns have shifted throughout Earth's long history, but the speed of human-caused climate change in the Anthropocene is unprecedented, making it more difficult for birds to adapt.

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Introduction

- **About the Project**: This study examines the effects of climate change on Birds.

- **Focus on**: The research emphasizes the Scottish crossbill(Loxia scotica), a species particularly vulnerable to climatic variations.

- **Machine Learning Techniques**: Advanced machine learning algorithms are employed to analyze avian sightings and climatic data.

- **Long-Term Study:** Avian distribution patterns are evaluated over multiple decades.

Introduction

- **Insights on Climate**: The research aims to elucidate the relationship between climate change and avian ecosystems.

- **Creating Pseudo-Absences:** Pseudo-absence data are generated to enhance model precision.

- **Critical Insights into Climate Impact:** This investigation provides crucial insights into climate-induced species alterations.

- **Scalable and Adaptable Approach:** The methodology applies to diverse species and datasets.

- **Real-World Applications:** Research findings inform conservation strategies and climate policy formulation.

Modeling the Timing of Migration of a Partial Migrant Bird using Ringing and Observation

Migratory Birds and Climate Change

Impact on Migration Patterns: Rising global temperatures are disrupting the schedules of migratory birds. Many species are arriving earlier at their breeding and feeding grounds, which can affect the availability of food and nesting sites.

Example: Long-distance migratory birds, such as geese and swallows, are arriving up to 13 days earlier due to warming temperatures. This can lead to mismatches between the timing of their arrival and the peak availability of food, like insects or plant blooms.

Consequences: Early arrival may also affect their breeding success, as the conditions for rearing young may not align with their new schedules. This can contribute to population declines in some species.

Altered Migration Routes: Changes in climate can also force birds to alter their traditional migration routes. Some may be unable to find suitable stopover habitats along the way, which can increase mortality rates during migration.

Example: The Bar-tailed Godwit, which undertakes one of the longest non-stop migrations, has had to modify its stopover points due to changing weather patterns, impacting its energy reserves.

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Shifts in Bird Ranges and Conservation Priorities in under Climate Change

Possibility of Disease

Increased Disease Risks: As birds shift their ranges, they encounter new species and environments, increasing disease transmission risks. Warmer temperatures also expand the range of disease-carrying insects, such as mosquitoes.

Example: Mute Swans migrating from the Caspian Sea to Western Europe have spread avian influenza (bird flu), causing outbreaks in wild and domestic birds, with significant impacts on human health and agriculture.

Vector-borne Diseases: Climate change allows mosquitoes to thrive in previously cooler areas, leading to increased spread of diseases like West Nile Virus.

Example: The expansion of West Nile Virus into North America has been linked to migratory birds spreading the virus as they shift ranges due to climate changes.

Conservation and Solutions

Adapting Conservation Strategies: Conservation efforts must focus on protecting habitats where birds are expected to shift. Climate corridors can provide safe passage for migrating species.

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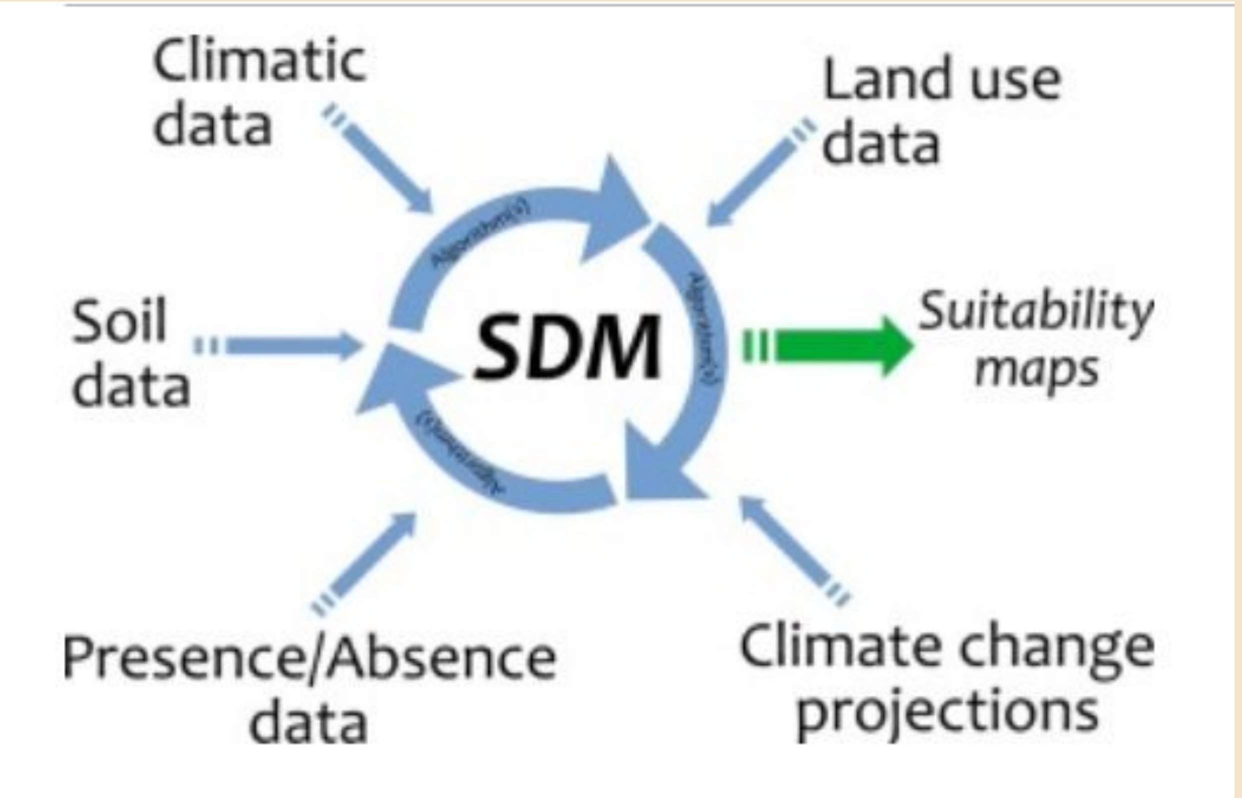
Species distribution modeling to support forest management

Species Distribution Modeling (SDM) predicts where species can survive based on climate and environmental data.

- It helps forest management by forecasting how species distributions might change due to climate change.
- SDMs use occurrence data and various modeling techniques to map current and future habitats.
- Though widely used, they often rely on existing species data, which may not fully capture their adaptability to new conditions.
- SDMs are useful for planning conservation



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Requirement Analysis

Functional Requirements

1.Data Collection:

- Fetch bird occurrence data from APIs (GBIF, eBird).Integrate climate data from WorldClim and CMIP5 climate models.

2. Species Distribution Modeling:

- Implement MaxEnt and Logistic Regression models to predict bird species' distribution under future climate scenarios.

3. Visualization and Reporting:

- Develop interactive maps (using Folium) to visualize distribution changes.

Requirement Analysis

Non-Functional Requirements

1. Performance: - Efficient handling of large datasets.

2. Scalability: - Ability to scale from specific species/regions to broader areas.

3. Usability: - Simple interface for non-technical users (e.g., conservationists)

4. Accuracy: - Ensure high predictive accuracy through cross-validation.

5. Maintainability: The codebase should be modular, allowing future improvements and updates.

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DATA SCIENCE & MACHINE LEARNING

- **Data Science** involves extracting knowledge and insights from large datasets. In this project, we leverage data science to analyze bird species distribution and climate data to predict future shifts due to climate change.

- **Machine learning** enables us to build predictive models that forecast future species distributions based on historical data and climate projections, it identifies patterns and makes decisions with minimal human intervention and does computational data analysis.

- **Data Collection and Integration:** Gathering of bird occurrence data from GBIF and eBird, and climate projections from WorldClim and CMIP5. Data is integrated into a single database (GridDB) for efficient querying and analysis.

- **Exploratory Data Analysis (EDA)**: Initial analysis of the data helps in understanding trends, such as the species distribution across decades, and highlights data quality issues, outliers, and patterns.

- **Data Visualization:** Folium for interactive maps and Matplotlib for heatmaps and time-series visualizations, helping in displaying the geographic shifts in bird populations.

- **Statistical Analysis:** Statistical methods are employed to detect correlations between climate variables and bird species movements, providing insights into the factors influencing species distribution

- **Predictive Modeling:** Using MaxEnt to model bird species distribution and Logistic Regression (via scikit-learn) to classify the presence/absence of species under different climate scenarios (2050, 2070).

- **Data Preparation:** Preprocessing steps include cleaning bird occurrence data, geo-referencing locations, and generating pseudo-absence data for more accurate model training.

- **Relationship Evaluation:** Machine learning helps us evaluate relationships between bird populations and climate factors like temperature and precipitation, leading to actionable insights for conservation strategies.

Algorithms :

- **Logistic Regression:** Logistic regression is used to predict the presence or absence of bird species based on environmental features such as temperature and precipitation. It's a simple yet effective classification algorithm.
  Example: It's like asking, "Will the bird live in the desert if it rains more?" The computer says "yes" or "no" based on the data.

- **MaxEnt:** Maximum Entropy Modeling predicts the most likely distribution of a species based on environmental constraints. This algorithm is ideal for presence-only data and is widely used in ecological modeling.
  Example: Imagine you know a bird loves to live in sunny forests. MaxEnt will check all the sunny forests in the future and tell us where the bird will probably go.

Conclusion :

In summary, the Impact of Climate Change on Birds project reveals how global warming is altering bird populations, migration patterns, and habitats. Using Species Distribution Modeling and logistic regression, we predict how species distributions will shift with changing climate conditions. The study, particularly on the Scottish crossbill, highlights challenges like habitat loss and food scarcity, emphasizing the need for targeted conservation efforts. This research can inform future strategies to mitigate climate change impacts and protect bird populations.

TITLE	REFERENCE LINK	PUBLISHED BY	PUBLISHED YEAR
Using Machine Learning to Predict Bird Migration Patterns Under Climate Change	:https://www.frontiersin.org/journals/ecology-and-evolution/articles/10.3389/fevo.2021.777478/full	Frontiers in Ecology	MAY 2023
Shifts in Bird Ranges and Conservation Priorities in China under Climate Change	https://www.researchgate.net/publication/344623348_Shifts_in_bird_ranges_and_conservation_priorities_in_China_under_climate_change	ResearchGate	JUNE 2020
Species distribution modelling to support forest management	https://www.sciencedirect.com/science/article/abs/pii/S0304380019303254	ScienceDirect	November 2019

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