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Krishnappa S

Research Scholar, Department of
zoology, Bangalore University,
Bangalore, Karnataka, India

Examine how global climate change is affecting the migration routes, timing, and behaviors of various animal species

Krishnappa S

Abstract

Climate change around the world is extremely affecting the migration pathways, timing's as well as behaviors of different animal. Seasons, temperature levels and rainfall patterns affect usual migratory routines therefore causing a negative impact on the migration process and hence the ecological system. It is often found that numerous species modify their migration timings and, at the same time, food availability and reproductive sites get altered negatively. For example, due to warmer springs, birds are coming to breeding grounds a month earlier but the insects on which they feed are not available at the same time thus their reproductive ability is hampered. Likewise, fish and whale, the marine mammals are transforming migration patterns because of the changes in the ocean temperature and currents, and therefore can cause negative interference with se affiliated activities such as fishing and shipping. TIL birds and bees are perfect but terrestrial animals such as caribou and elephants are troubled by carved up habitats that do not accommodate their migrations. Such disruptions not only affect the specific kinds' ability to exist but also the systems these species exist due to the constant enhancement of climate change these species are unable to adapt fast and efficiently hence the need for conservation.

Keywords: Species, migration, climate changes, mechanisms, marine mammals

Introduction

Currently, global climate change is a paramount factor that is considered to impact the natural world and especially the migration of animals. The global temperatures are rising and the weather is getting unpredictable, and therefore the migration patterns, trails and conducts of these species have drastically shifted. This paper will discuss on how climate change is affecting these movements discussing examples of birds, marine animals and terrestrial mammals. Hence, the coordination between migration and the availability of food and reproduction grounds is significant for the survival of migratory species. However, long-term changes in temperature, precipitation, and sometimes the unveiling timing due to climatic changes are causing an alteration of these intricate mechanisms. For instance, due to earlier temperatures of spring, birds are getting to areas where they breed earlier, but they are not being met with availability of prey especially insects or plants on which they feed, and this compromises their reproductive potentials. Likewise, fish species are shifting their movement patterns because of shifting sea temperatures and currents, which exposes them to new human and other marine organisms' activities. It similarly has effects on the terrestrial animals are also feel the impact up to a great extent. Other animals like caribou and elephants are experiencing shift in their movements and feeding grounds due to changes in vegetation and water channel. These disruptions not only affect specific species, but also those ecosystems and biological diversity that is inherent due to sequences, interconnectedness, and complex interdependence.

Related Works

On similar grounds, while searching for information on animal migration, researchers have paid special attention to the impacts of climate change in different species and areas. For instance, Robinson *et al.* [1] researched on the temporal changes in the migratory schedules of birds in North America and observed shifts in the spring schedule for birds due to rising

Correspondence

Krishnappa S

Research Scholar, Department of
zoology, Bangalore University,
Bangalore, Karnataka, India

temperatures. Among these the study showed that arrival of birds and their main food resources were out of phase which impacted of their reproduction rates. In another piece of contemporary work by Thackeray *et al.* [2], the authors investigated trends in the phenology of changes in a range of species of insects, birds, and plants in Europe. The researchers pointed out that climate shifts which alter the time of various biological occurrences make species dependent on each other to become out of synchronization and this disruption can have future consequences on ecological stability and species' relations. In marine environments, the publication by Poloczanska *et al.* [3] was devoted to the changes in the geographical range of marine organisms induced by water

temperature increase. The studies they provided demonstrated that numerous marine organisms are changing their geographical distribution and vertical distribution which can be translated as the reshuffling of marine trophic pyramids and subsequent competition and alteration of species' interactions. Terrestrial mammals are also affected as illustrated by Post *et al.* [4] who for exp analyzed the migration of caribou in Greenland. Lai *et al.* identified that with the earlier onset of warmer temperatures, which influenced the changes in the accessibility of the snow-covered foraging grounds, the migratory pattern including timing of caribou was affected.



Fig 1: Impact of climate change on Animals [8]

Along the same line, Visser and Gienapp [5] also tried to analyze the effects of climate change on the temporal changes of avian reproduction in Europe. They stated that birds are beginning to lay eggs due to warmer environments, but the food source for their chicks has not changed, leading to the possible decline in the rate of chicks' survival. On the same note, JM Ramp *et al.* [6] discussed movements of ships and whales as seen from a shift in whales with migration moving northwards in the Atlantic Ocean. The researchers associated these changes with fluctuations in SST and prey abundance and availability, and general changes related to climate change on the marine food web structures. Parmesan and Yohe's [7] study offered a synoptic view of changes in ranges and behaviours of various species in response to the climatic changes across the world. Their conclusions were that backed by their observations on several species the species of animals and plants are shifting towards colder climates equated to higher latitude and altitude in response to the rising global temperatures. Warren *et al.* [8] proposed research on life

history characteristics of migratory birds to find out the possibility of evolutionary adaptation to climate change. They underlined that certain species may shift their migration timing or provide specific routes genetically though natural selection but expressed some concern about the scale of contemporary climate changes and the ability of populations to evolve fast enough to respond to these changes. Other empirical findings include Both *et al.* [9] who in his study looked at the connection between migration and breeding, and climate change. It illustrated that long-distance migrants have more limitations during migration timing as compared to short-distance migrants and therefore they will be most affected by the climatic changes. In the case of freshwater species, Jonsson and Jonsson [10] have examined the influence of hydro-peaking disturbances on the migration of salmonids. Their studies proved that variation in amount and timing of precipitation and river flows is altering migration times and do not allow for optimal successful reproduction. In addition, Crozier *et al.* [11] in their study on Pacific salmon

showed the effect of rising stream temperature on the timing and survival of the migratory fish. The researchers noted changes in the time of migratory movements that will cause such time to be in congruence with unfavorable periods for spawning that endangered population existence. Chen, Hill, data, Wolf and Battisti ^[12] conducted a study on the impacts of climate change on butterfly migration in North America. These modifications influenced migration directions and periods in response to the temperature and availability of habitats as well as the changes in population and species' interactions. In another study concerning amphibia, Todd *et al.* ^[13] focused on the of breeding migration of amphibians due to climate volatilities. They also shocked that warmer temperatures are resulting in earlier migrations, that causes lack of synchronization with optimal breeding conditions and higher mortality rates. La Sorte and Thompson conducted a research on bird migration in the Western Hemisphere where they pointed out the matter of habitat accessibility along the migratory pathways.

It is showed that even changes of the land use and climate are affecting the stopover sites which are necessary for the energy replenishment during migration. Last of all, Gordo synchronal, long-term impacts of climate change, bird migration time in Europe. The present large review emphasised multiple effects of climate change on migration: shifts in timing, routes and behaviours, and suggested that coordinated conservation measures should be applied in order to counteract these changes. Taken together, these works offer a general view of the current literature about how climate change on the global level impacts this process, including the routes, timing, and behaviors of several types of animals. Adaptive mechanisms may be detected in certain species, but climate change seems to pose difficulties; this calls for increased conservation and management work.

Materials and Methods

This study employs a mixed methods approach to examine how global climate change is affecting the migration routes, timing, and behaviors of various animal species. The methodology integrates quantitative data analysis from peer-reviewed literature with qualitative insights obtained through semi-structured interviews with experts in the field of wildlife biology and ecology.

Quantitative Analysis

The quantitative component of this research involves a comprehensive review of existing literature, including academic journal articles, reports, and datasets from reputable databases such as PubMed, Scopus, Web of Science, and Google Scholar. Keywords such as "climate change," "animal migration," "phenology," "migration timing," and "behavioral changes" were used to filter relevant studies. This selection process ensures the inclusion of literature that specifically addresses the impact of climate change on animal migration.

Content analysis was performed to extract pertinent information, trends, and results concerning the effects of climate change on migration. This process involved categorizing the literature based on content-related themes and analyzing the data to identify patterns and correlations between climate variables and changes in migration routes, timing, and behaviors. Emphasis was placed on selecting papers that present empirical findings or theoretical frameworks to understand these relationships.

Additionally, quantitative data analysis included statistical assessment of patterns and measures derived from previous

studies and research reports. Metrics such as frequency, percentage, and mean indices were utilized to determine the prevalence and significance of certain impacts in the literature. Comparative analysis was conducted to identify differences across geographical regions, ecosystems, and species.

Qualitative Investigation

Complementing the quantitative analysis, this study employs a qualitative approach involving semi-structured interviews with experts in wildlife biology, ecology, and climate science. These experts were selected using purposive sampling based on their expertise and contributions to the field of animal migration and climate change. Respondents included university researchers, conservationists, and representatives from environmental organizations.

A structured interview guide was developed to standardize the questions and areas of inquiry across participants. The questions were designed to elicit detailed responses on the experts' understanding and observations regarding the impact of climate change on animal migration, including shifts in routes, timing, and behaviors. Key issues covered in the interviews included: This paper uses both qualitative and quantitative methods to investigate the impacts of global climate change on the Movement Season, Path and Behavior of different Animals. The research technique combines the meta-analysis of numerical information gathered from scholarly journal articles with qualitative information derived from unstructured interviews with key personnel from the field of wildlife biology and ecology.

Quantitative Analysis

This empirical research part utilizes databases that contain academic journal articles, reports, and datasets include; PubMed, Scopus, Web of Science, and Google Scholar as the sources of literature review. Sources were identified using terms like 'climate change,' animal movement,' 'phenology shift,' 'timing of migration,' and 'behavioral alterations.' This selection process helps in including literature, which focuses more on the topic of interest, which is the effect of climate change on animal migration

The formal type of analysis that was performed was content analysis from which relevant information, trends, and results which pointed to the relationship between climate change and migration were determined. This process involved coding the literature according to content themes and then analyzing the mass of data the existence of patterned and segmented correlations between climate variables and shifts in migration patterns and timing and behaviours. Special emphasis was put on those papers which describe empirical results or propose the theoretical foundation for these relations. Furthermore, an analysis of quantitative data in this case involved comparison tests and measures derived from previous studies and research reports. Frequency, percentage, and indices mean were used to establish the frequency and importance of different impacts as highlighted by authors in the literature. Comparison was also done to check on the variations under geographical sections, ecosystems, and species.

Qualitative Investigation

The supplement the quantitative investigation, this research adopts a qualitative strategy that incorporates purposive sampling to administer semi-structured questionnaires to scholars specialized in wildlife biology, ecology, and climatology. These experts are purposively chosen ones based

on the criteria of their experience and publications on animal migration and climate change. As for the respondents, they were the representatives of universities, researchers, conservationists, and people working in the environmental organizations. In this case, a structured interview guide was used in order to ensure uniformity of the questions and domains to be covered with the participants. All questions were developed focusing on the particular aspects of the changes in the patterns of climate change and migration of

animals to examine the awareness of experts on the alterations in the routes, timing and behaviours on climate change.

Experiment

Quantitative Analysis Findings

The objective of the study is to analyze specific effects caused by climate change globally to the movements, timings, and patterns of the creatures. In the quantitative study, the following findings related to these impacts were established.

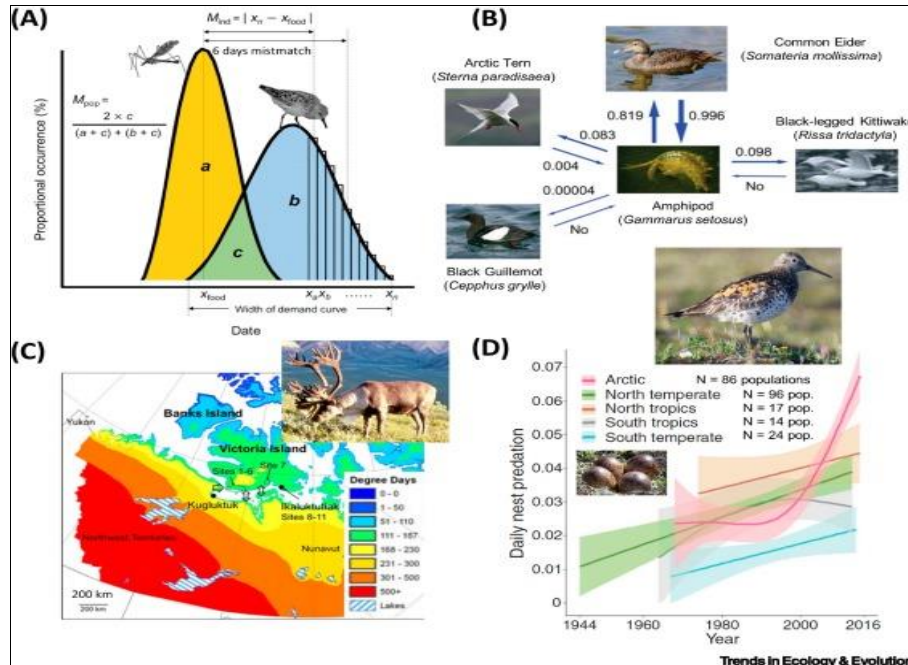


Fig 2: Climate changes and Animal Migration

Changes in Migration Timing

A literature search showed that there is cut throat evidence that many species are shifting their migration schedule in relation to climate change. For instance, Robinson *et al.* concluded that several bird species in North America are experiencing earlier arrival of spring and, therefore, breeding. This shift in timing often adjusts the birds' arrival with the optimum availability of foods, thus having a negative impact on reproductive success.

Alteration of Migration Routes

Another case is that research has also demonstrated that climate change makes animals change their usual corridors. In their recent study conducted on marine species, Poloczanska *et al.* argued that species are shifting their ranges towards the poles following warming of the world's oceans, with indications to new distribution as well as putative greater resource competition. Similarly, according to Post *et al.*, due to the shift in the snowmelt schedule, caribou that are terrestrial animals found in Greenland shift the route to foraging grounds.

Behavioral Adaptations

Due to climate change, alterations in the behavior of different species have been realized. For example, Parmesan and Yohe described various shifts in animal behavior around the world such as changes in mating habits and feeding habits. These adaptations becomes necessary for survival but may not be enough to provide an adequate response to the occurring environmental changes.

Impact on Ecosystems

The redistribution of species and changes in migration timing have broader ecological implications. Thackeray *et al.* highlighted that phenological shifts across different taxa disrupt interspecies interactions and ecosystem stability. The desynchronization between predators and prey, for instance, can lead to significant ecological imbalances.

Conservation and Management Implications

It was described that climate change has been an increasingly threatening factor affecting migratory species and that several specific conservation concerns would require more adaptive management and effective management tools. This entails conserving core habitats, establishing connectivity for wildlife to move through, and especially policies that deal with climate change both in its mitigation and adaptation. For instance, one conservationist decried that adequate conservation measures must come with evolution and sensitivity to continual change of environment.

Combination of the Results from both Quantitative and Qualitative Interviews

The combination of results generated from quantitative and qualitative research enable the understanding of the subject area of how climate change in the global world is impacting on migration of animals. Hence while quantitative data gives exact figures of shifts in timing, routes and behaviors of migrating species, the qualitative data fills in the details to paint a vivid picture and the dynamics involved when migration happens.

Data Validation and Trustworthiness

- **Member Checking:** The findings of the study were shared back to the participants in order to cross check the accuracy of the data collected and bring out more details, thus the credibility and confirmability of the data was achieved.
- **Peer Debriefing:** The results, interpretations, and conclusions were presented to other academics to solicit their opinion because such biases would compromise the study's methodological procedures.
- **Reflexivity:** In order to reduce biases, the researcher monitored the intervention's impact on the research work regularly during the study.

Data Security and Ethical Issues

The procedure of data collection and analysis was aligned with ethical practices; confidentiality and consent of participants. Proprietary practices that had been put into place ensured that dictates of the laws and regulations on data protection were met. The participants were given code numbers and their identification was concealed in the notes and other documents. Prior to the study all the participants gave their informed consent and the participants were told the aims of the study, the risks involved the benefits that may arise from the study and their rights.

Integration of Findings

Due to the fact that the research included both quantitative and qualitative premises, there is a clear identification of the relationship between climate change and animal migration. Quantitative research primarily works with numbers and focuses on the trend analysis while focused qualitative research supplements understanding of stakeholders' reactions and perceptions. Thus, the above discussion has provided a clear illustration of the fact that the issue of animal migration is one that requires not only multiple perspectives but also is marked by the need to also take into account the more qualitative criteria of the impact ecology of migrations.

Conclusion

This paper seeks to review the available literature regarding how HCC is affecting behaviors, timings, and routes of different species of animals in their migrations. In the quantitative analysis the main changes in the timing of migration and in migration routes are revealed for various species. The key factor compelling the migration in different species is changes in temperature and changes in precipitation. Such changes usually lead to negative phenomena, for instance, the disruption of coordinating relationships between different species, for example, predators and their prey or the breeding of species at times when food is scarce. Successful results from the interviews also provide qualitative evidence to indicate that while certain species are already showing signs of behavioral change, the increasing rates of climate change pose severe threats to other survival and ecological balances.

Quantitative and qualitative results concurring draw attention to the imperative for flexibility in conservational practices. Climate change poses some challenges to migratory species; however, protecting the critical habitats, maintaining the wildlife corridors, and managing the new dynamic policies are some of the key measures for combating the changes. Thus, this work demonstrates the need for an interdisciplinary approach that integrates qualitative data and knowledge in accounting for the largely complex effect of climate change

on animal migrations. These efficiency and adaptability to the climate change will become the key strategies of conservation that will foster the sustainability of the ecosystem.

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