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Climate Change and Its Impact on Animal Diversity: A Review

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Abstract

Today, global warming affects more animals than any other climate change. Rising activity, although risks are not uniform in all animals Very vulnerable diseases exacerbate these effects due to vast differences in habitats and needs Data collection is in progress. developing ecological models that accurately reflect real-world behaviour; work closely with local communities on site; and integrate habitat, corridor, and road management into larger conservation efforts. Temperatures are just the beginning; These changes affect animal habitats, migration times and distances, breeding patterns, feeding habits, spread of diseases, and ecological community balance This research draws on a variety of scientific work, including early studies, meta-analyses, modelling exercises and reports from major agencies. Higher altitudes and so many species experience pre-breeding season and changes in seasonal

Keywords: *Climate Change, Global Warming, Animal Diversity, Species Distribution, Habitat Loss Biodiversity*

Introduction

Climate change is one of the most important environmental problems of this century. Industrial development, increased reliance on fossil fuels, deforestation, and expanding human activity have increased the amount of greenhouse gases in the atmosphere, and as a result, Earth's average temperature continues to rise. Animals feel this deeply, as survival of most species depends on suitable habitats, easy food, breeding opportunities, migration, and temperatures they can tolerate If temperature, rainfall, or habitat conditions change, animal distribution, behaviour, and life cycle change Some animals cope by moving to cooler areas or higher elevations; Those that cannot spread or grow easily are more vulnerable. Therefore, understanding the relationship between climate change and animal diversity is important for two reasons one as a scientific question and the other as a practical concern for conservation and the welfare of those who depend on it.

1.2 Significance of the Study

This review is important because global warming is a major threat to animal diversity. Diversity here isn't just about numbers or pretty scenery; It is about how stable ecosystems are and their impact on human well-being. Pollination, pest control, nutrient cycling, seed dispersal, food chain balance, disease prevention, all depend directly and indirectly on animals so when climate change changes a species' habitat, its activity, its breeding season or its food and water network, often the consequences are not limited to one species spread out.

The situation is more serious and worrying in India, where biodiverse areas like the Himalayas, Western Sundar Ghats, Sundarbans, coastal areas, island ecosystems are most vulnerable to climate change impacts in this context, this review provides an overall starting point for research students, policy makers and conservationists.

1.3 Objectives of the Review

Its primary objective is to understand the relationship between climate change and animal diversity. This study examines how extreme weather events like temperature rise, changing rainfall patterns, ocean acidification, habitat fragmentation, severe drought, etc. affect various animal groups It analyses mammals, birds, reptiles, amphibians, insects, fish and marine life, noting general trends in specific responses observed in each group Changes in species also addresses habitats and timing of weather events, effects on breeding, extinction risk, disease spread, introduced species, effects on ecological balance and highlights existing knowledge gaps, especially in animal groups and areas that have not received the attention they deserve.

1.4 Scope and Organization of the Review

The scope of work here is a complete overview of how climate change and animal diversity are linked, and it's not much more detailed than that. This scientific study includes timescales, modelling work, and institutional reports used to measure species distribution, migration, reproduction, seasonal cycles, extinction risk, and disease susceptibility, and to weigh questions about species investment and conservation strategies Does not show original fieldwork or laboratory experiments. The structure works in five ways: first, it outlines the background, significance, purpose, and scope; second, it reviews the relevant literature in detail; third, it describes the review methodology, sources, and selection criteria; fourth, it gathers evidence and contextualizes it in the Indian context, existing knowledge gaps and conservation policy demands; Fifth, it concludes with conclusions and directions for future work.

2. Review of Related Literature

2.1 Climate Change and Biodiversity

Conservation of biodiversity is an important task in environmental science today, and the reason is obvious. Diversity doesn't just mean the number of species; This includes ecosystem services, which underlie genetic diversity, the structure of communities, ecological processes, and through them human well-being by the end of the twentieth century, it was clear to scientists that human-induced climate change significantly altered the biosphere. The Fifth Impact Assessment Report Adaptation and Vulnerability, 2014, concluded that various climate-related pressures could increase the risk of extinction of land, water and marine species in the 21st century and beyond (IPCC, 2014). It was found that the range of species habitats moved poleward by about 6.1 kilometres per decade (Parmesan & Yohe, 2003) 2002 and Hughes, 2000 also observed that biological signs of global warming were emerging by the end of the century (Hughes, 2000; Walther et al., 2002). Taken together, this is not a remote possibility, nor is it an isolated ecological force operating at every level, from genes to species ecosystems

2.2 Climate Change and Animal Diversity

Rising temperatures affect animal diversity in many complex ways. In a study published in Nature, Root et al. (2003) found that nearly 80% of species studied changed in timing of biological events such as nesting and breeding with increasing local temperatures Parmesan (2006) provided a comprehensive review of ecological evolutionary responses to climate change, while Bellard et al. (2012) A framework for understanding impacts is presented. The WWF Living Planet Report (2014) documented a sharp decline in global vertebrate populations from 1970 to 2010, even more so in the tropics Four major responses recur in this research literature: changes in distribution, phenology i.e. timing of biological events; It is therefore more appropriate to understand the decline of animal diversity as a phenomenon driven by many interrelated causes

2.3 Species Distribution Shifts

As the climate warms, many species migrate to cooler conditions, either poleward or upward (Chen et al., 2011; Parmesan & Yohe, 2003). Parmesan and Yohe (2003) placed the average poleward shift at 6.1 kilometres per decade (Parmesan & Yohe, 2003). Chen et al. (2011) recorded faster movements between terrestrial species, 16.9 kilometres per decade to the poles, and 11.0 m per decade at altitude (Chen et al., 2011) Pearson and Dawson (2003) warn about the bioclimate envelope model are useful even if they dispersal barriers, interactions between organisms, habitat and ignore fragmentation (Pearson & Dawson, 2003). Mountain species face a unique dilemma because the upward slide leaves them with ever less ground to climb. They're on an escalator to extinction. Whether dispersal capacity changes over the landscape depends on habitat availability and biotic interactions (Pearson & Dawson, 2003). For this reason, recent work has tended to combine correlation models with mechanistic models. Trait-based assessments involve combining microclimatic detail with long-term observations (Chen et al., 2011; Pearson & Dawson, 2003).

2.4 Species Extinction and Vulnerability

Based on modelling of species distribution, Thomas et al. (2004) estimated that under moderate levels of warming, between 15% and 37% of the species they studied could become extinct by 2050. (Thomas et al., 2004) Urban (2015) analysed 131 modelling studies and showed that extinction risk increases with each increase in warming. Warren et al. (2013) reported that climate change could reduce the geographic range of many common species (Warren et al., 2013), while the IPCC Fourth Assessment Report (2007) stated that a 1.5-2.5°C temperature rise could increase the risk of extinction for many species (IPCC, 2007) Cahill et al. (2013) added an important point: the immediate causes of climate-induced extinctions are often complex and cannot be directly attributed to warming. Tolerance capacity is not associated with thermal tolerance. Food webs, breakdown of food webs, disruption of species interactions, and diseases can be equally likely causes (Cahill et al., 2013). Moreover, extinctions are rarely accidental; Many populations first lose their vitality and then decline over time (Cahill et al., 2013). Foden et al. (2013) developed a trait-based threat assessment for birds, amphibians, and corals (Foden et al., 2013), and Pacifici et al. (2015) conducted a comparative study combining the above trait-based approaches (Pacifici et al., 2015).

2.5 Habitat Loss and Fragmentation

Climate change is rarely the only pressure; It acts in concert with habitat fragmentation (Heller & Zavaleta, 2009; IPCC, 2014). The IPCC 2014 emphasized that degraded and fragmented habitat reduces the ability of a species to achieve the climate conditions it needs (IPCC, 2014) and this leads to climate traps. Animals are exposed to variable temperatures but are unable to cross fragmented areas to find the right habitat (Hodgson et al., 2009). This is why concepts such as lens permeability, landscape permeability, ecological corridors, stepping stones, habitat-assisted migration, and climate refugia have gained significant importance in the conservation literature (Heller & Zavaleta, 2009; Hodgson et al., 2009). Moving a species to a new area can pose a risk of invasion, exploration, disease spread, and existing communities (Hoegh-Guldberg et al., 2008) In a warming world, protected areas cannot be treated as isolated islands. How effectively they work depends on whether the animals can get through them (Heller & Zavaleta, 2009; Hodgson et al., 2009).

2.6 Migration and Phenological Changes

One obvious indicator of climate change is change in timing in particular, the timing of seasonal biological events (Parmesan & Yohe, 2003) Parmesan and Yohe (2003) found that spring events average 2.3 days earlier per decade than original release (2003). 2005; Thackeray et al., 2016) can generate both. (2006) observed this scenario in long-distance migratory bird species; When the breeding season failed to coincide with the time of peak food availability, their populations declined (Both et al., 2006). Such imbalances are not limited to a single species but affect predator-prey relationships, food web stability, and population recovery processes (Visser & Both, 2005; Thackeray et al., 2016). As a result, scientific records, including continuous seasonal monitoring and public participation, known as citizen science records, became important (Root et al., 2003; Dickinson et al., 2010).

2.7 Reproductive Responses to Climate Change

Among animal activities, reproduction is highly sensitive to climate (Root et al., 2003). Root et al. (2003) documented changes in breeding and nesting dates in several species (Root et al., 2003). When these dates move away from the time of peak food availability, fewer young survive (Both et al., 2006). In species where the determination of mating is temperature dependent, such as reptiles and turtles, warming can disrupt sex ratios and threaten the long-term persistence of populations (Janzen, 1994; Mitchell & Janzen, 2010) without affecting breeding time alone. Higher temperatures can affect the origin of reproductive cells, incubation period, timing of blight, parental care, lactation, nest site selection, and the ability of young to survive (Schwanz & Janzen, 2008; Mitchell & Janzen, 2010). Sand temperature determines the link ratio in sea turtles, so extreme heat can significantly disrupt this ratio or even be lethal (Fuentes et al., 2010; Hays et al., 2014) Thus reproduction is an important measure of climate sensitivity, linking physiological stress, behaviour, food intake, and population persistence (Root et al., 2003). 2003; Mitchell & Janzen, 2010).

2.8 Impacts on Mammals

Mammals have received considerable attention in climate research, particularly questions related to the timing and risk of their extinction (Root et al., 2003; Thomas et al., 2004) and both Root et al., 2003 and Thomas et al., 2004 included mammals in their detailed studies. However, research has largely focused on fascinating large mammal kinetic megaphones, leaving small mammals, such as bat, rodent, mole, and nocturnal species, comparatively understudied (McCain & King, 2014; Moritz et al., 2008). It depends on reproductive rate, dispersal capacity and habitat specificity (Pacifici et al., 2015; Williams et al., 2008) Large long-lived species with slow reproductive rates are most at risk (McCain & King, 2014; Pacifici et al., 2015) 2015). Melting ice reduces habitat for polar mammals. Mountain species may lose habitat as they climb, and rising temperatures pose additional challenges such as water shortages, poor forage quality, and conflict with humans (IPCC, 2014; Moritz et al., 2008; Stirling & Parkinson, 2006).

2.9 Impacts on Birds

Birds have been a particular focus of research on the effects of climate change, mainly because long-term monitoring data abound and changes in their migration, breeding and distribution are easily seen (Crick, 2004; Root et al., 2003). Nutritional imbalances are particularly acute for long-distance migratory birds, which receive cues from winter habitats that do not reliably indicate spring conditions in breeding areas (Both et al., 2006; Visser & Both, 2005). Mountain tropical birds are more vulnerable (Both & Visser, 2001; Both et al., 2006) because their climate tolerance is limited and high-altitude habitats are scarce (Jetz et al., 2007; Şekercioğlu et al., 2008).

2.10 Impacts on Reptiles and Amphibians

Reptiles and their cetaceans are among the most sensitive organisms to climate change, many of them are bivalves that are highly dependent on external temperature and humidity (Araújo et al., 2006; Blaustein & Kiesecker, 2002; Huey et al., 2009). Reptiles are particularly vulnerable because they often rely on water or land to breed, making their permeable skin vulnerable to temperature change and pathogens (Araújo et al., 2006; Blaustein & Kiesecker, 2002). Behavioural rearing can be used to manipulate nest temperature and movement time (Janzen, 1994; Sinervo et al., 2010). The evidence base is geographically skewed, focusing more on North America and Europe, while the tropics and much of Asia are understudied (Araújo et al., 2006; Huey et al., 2009).

2.11 Impacts on Insects

As an external temperature, insects readily respond to temperature changes (Deutsch et al., 2008). Parmesan and Yohe (2003) documented changes in the distributional ranges of butterflies and other insects; However, researchers such as Urban (2015) noted that information on subterranean insects, soil organisms, and less conspicuous groups remains limited (Urban, 2015; Forister et al., 2010). This is a serious issue, as insects play important roles in pollination, soil nutrient cycling, and food web structure (Bale et al., 2002; IPCC, 2014) Global warming can alter insect breeding seasons, emergence times and geographic ranges (Bale et al., 2002; Deutsch et al., 2008). 2014) 2008). Some species can produce additional generations during warm years, significantly affecting agriculture and forestry (Bale et al., 2002). Moreover, pollinators and habitat specialists may lose synchrony with the plants on which they depend (Parmesan & Yohe, 2003; Forister et al., 2010). Of particular concern is "hidden decline" where small or under-recorded species go extinct unnoticed, even though their loss profoundly affects the wider ecosystem (Urban, 2015; Forister et al., 2010).

2.12 Impacts on Fishes and Marine Organisms

Marine life is struggling with warming and acidifying oceans, alongside declining dissolved oxygen levels (Gattuso et al., 2015). Research has shown that rising sea surface temperatures and acidification trigger extensive bleaching, pushing coral reefs beyond their physiological tolerance limits (Hoegh-Guldberg et al., 2007; Anthony et al., 2008) As reefs create their own habitats, bleaching not only corals but fish, invertebrates, Microbial communities are also adversely affected which rely on reef structure (Hoegh-Guldberg et al., 2007) Temperature in fish controls metabolism, growth, reproduction, migration, larval survival and ability to inhabit deeper water (Portner & Farrell, 2008; Cheung et al., 2009) now by acidification Molluscs, corals, and plankton have difficulty depositing calcium carbonate (Doney et al., 2009). Thus, research on marine life illustrates climate change in terms of the ecosystem level, showing how the loss of a host of habitat-building organisms can alter entire biological communities (Hoegh-Guldberg et al., 2007; Gattuso et al., 2015).

2.13 Ecosystem-Level Impacts

The effects of climate change are not limited to individual species; It affects the entire ecosystem (Walther, 2010; Montoya & Raffaelli, 2010; IPCC, 2014). It is called the root. (2003) documented disruptions in biological timing, whereas Loarie et al. (2009) formalized the concept of the speed of climate change. This metric measures the pace and direction of changing climate and helps determine whether species with limited dispersal capacity can keep up with climate change and remain in their suitable climates (Loarie et al., 2009). It can also reduce ecosystem services (Walther, 2010; Montoya & Raffaelli, 2010; IPCC, 2014). Higher trophic levels are also affected; Extinction of a major prey species or loss of apex predators can disrupt nutrient cycling (Walther, 2010; Montoya & Raffaelli, 2010). This makes it clear that impacts on animal diversity cannot be understood solely through species-level responses; Equal attention should be paid to community-level interactions and functional diversity (Walther, 2010; Montoya & Raffaelli, 2010).

2.14 Physiological and Thermal Tolerance Responses

An animal's sensitivity to climate change is related to its physiological limitations (Portner, 2002; Deutsch et al., 2008). Deutsch et al. (2008). (2012) noted that marine organisms live closer to their thermal threshold compared to terrestrial organisms (Sunday et al., 2012). Two concepts are commonly used to understand these models: the thermal performance curve and the critical thermal maximum (CTmax); Performance increases within the optimum temperature range and then decreases rapidly once the temperature exceeds the optimum (Huey & Kingsolver, 1989; Portner, 2002). Extratropical temperatures often reside at the upper end of their thermal range, meaning that even a slight increase in temperature can have adverse effects (Deutsch et al., 2008) so future research should include factors such as microclimate, thermoregulation of behaviour, adaptability, and genetic adaptation (Huey & Kingsolver, 1989;

2.15 Behavioural and Evolutionary Adaptation

Not all animals shift when temperatures rise; Some remain in their habitats and adapt through mechanisms such as phenotypic plasticity or evolution (Parmesan, 2006; Hoffmann & Sgro, 2011). Charmantier et al. (2008) demonstrated that wild bird populations adapt to changing climates through adaptive plasticity. Because plasticity can facilitate adaptation faster than the rate of evolutionary

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change, the concept of "evolutionary rescue" where rapid evolution prevents extinction amid environmental change has become an important theme in research linking climate and biodiversity (Visser, 2008; Hoffmann & Sgro, 2011; Carlson et al., 2014). Adaptation can take various forms, including changes in the timing of activities, changes in diet, or changes in migration routes; However, there is no guarantee that any of these strategies will prove effective (Parmesan, 2006; Visser, 2008). The success of evolutionary rescue depends on genetic factors and the strength of selection (Carlson et al., 2014; Hoffmann & Sgro, 2011).

2.16 Climate Change and Wildlife Disease Dynamics

Global warming may alter the geographic range and seasonal activity of pathogens and their vectors (such as mosquitoes or insects), which may alter patterns of disease transmission among wildlife (Harvell et al., 2002) Harvell et al. (2002) argue that a warming world is increasing the disease risk of many terrestrial and marine organisms by accelerating pathogen growth, reproduction, transmission and spread Pounds et al. (2006). These effects occur both: directly, where changes in temperature and humidity can increase pathogen replication, vector survival, and duration of disease transmission seasons (Harvell et al., 2002) and indirectly, where heat stress and drought can compromise host conditions, making it more susceptible to infection (Harvell et al., 2002). Consequently, any robust conservation program must include disease surveillance alongside climate monitoring (Harvell et al., 2002; Pounds et al., 2006).

2.17 Biological Invasions and Invasive Species

Changing climate can facilitate the arrival, establishment, and spread of invasive species and simultaneously alter the habitats and competitiveness of native species (Hellmann et al., 2008; Walther et al., 2009) Walther et al. (2009) argue that rising temperatures are creating new, favourable habitats for invasive species, enabling them to survive in areas they could not previously colonize Hellmann et al. (2008). (Hellmann et al., 2008; Walther et al., 2009) Consequently, the management of invasive species should be treated integrated into climate adaptation policies rather than separately (Hellmann et al., 2008).

2.18 Conservation and Adaptation Strategies

The IPCC (2014) report provides a compelling basis for linking biodiversity conservation to climate adaptation. The conservation literature increasingly emphasizes that stable protected areas are inadequate in a changing climate; Species require a dynamic and interconnected landscape for migration (Heller & Zavaleta, 2009). Heller and Zavaleta (2009) reviewed 22 years of conservation recommendations, and many remained merely theoretical concepts rather than actionable strategies for implementation. Similarly, the Secretariat of the Convention on Biological Diversity (2014) highlighted the failure to meet global biodiversity targets and the persistence of climate-related pressures. The key takeaway is clear: adaptive management, climate-resilient protected areas, ecological connectivity, habitat restoration, disease surveillance, and community-based approaches are needed alongside traditional conservation (Heller & Zavaleta, 2009; IPCC, 2014). India needs site-specific and locally based monitoring and adaptation plans for its biodiversity rich and climate-sensitive areas such as Himalayas, Western Ghats, Sundarbans, Andaman and Nicobar Islands and arid zones (IPCC, 2014; Secretariat of the Convention on Biological Diversity, 2014).

2.19 Research Gaps Identified from Previous Studies

A closer look reveals some shortcomings in the literature on this subject that need to be mentioned. First, most work on species distribution and bioclimatic models is based on bioclimatic envelope models. Consequently, biological processes such as phenotype plasticity, evolutionary adaptation, competition between species, dispersal limits, microclimate use are of little importance and taxonomic bias exists Birds, mammals, and exotic species receive more attention, while soils, terrestrial insects, deep-sea animals, small invertebrates, and many tropical shells Fewer studies Third, there is little concrete field evidence on how climate change interacts with other pressures, such as noise fragmentation, pollution, diseases, alien species invasions and imbalances also complicate the situation for Europe, North America, and Australia than for Asia, Africa, mountainous tropics, or island systems The long-term records are much more detailed. Furthermore, studies focused on average temperatures often overestimate extreme events such as droughts, floods, hurricanes, and sea ice waves. And finally, although there are many policy suggestions, the record of implementing them, measuring outcomes and engaging local communities is very poor

3. Review Methodology

3.1 Review Approach

The approach adopted here is a mixture of narrative and systematic approaches. From the outset, purely quantitative metric analysis was abandoned because the questions encompassed so many different sectors, ecological processes, and responses that a common effect size could not adequately explain them. Existing literature on climate change and animal diversity was systematically collected. The text was sorted based on criteria and then organized by subject rather than date. Organizing information in this way could bring together results based on distribution change, change over time, extinction risk, and key mechanisms such as specific effects, physiological responses, disease progression, concern for invasive species, conservation strategies, etc. Empirical studies, modelling work, and Sweet in Alice the aim was not just to catalogue the results but to develop an overall understanding

3.2 Data Sources and Search Strategy

Searches were primarily conducted using Web of Science, Scopus, and Google Scholar, focusing on English-language sources available up to December 31, 2016. As these databases operate differently, search terms were adapted for each platform while maintaining the core concepts. Keywords used to identify general patterns and specific responses included terms such as climate change, global warming, animal diversity, biodiversity, wildlife, extinction, range shifts, migration, phenology, and habitat loss, covering mammals, birds, reptiles, amphibians, and fish. In addition to research journals, this review utilized key institutional and 'grey literature' sources—such as IPCC assessment reports, the Millennium Ecosystem Assessment, and IUCN/WWF assessments, as well as India's National Action Plan on Climate Change. Backward citation tracking of key articles yielded further significant information.

3.3 Inclusion and Exclusion Criteria

Studies were included in the review only if they met specific criteria: publication in a peer-reviewed journal or prestigious institutional report; Availability in English; a date on or before December 2016;

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and based on empirical observations or a focus on how climate change affects animal biology, populations, phenology, or ecosystems, supported by observational or model-based evidence. Unlike prioritizing research addressing species distribution, phenology, extinction risk, reproduction, physiology, disease transmission, invasive species, habitat fragmentation, or conservation adaptation in the case of climate-induced change, exclusions limited non-academic commentary, unverified web sources, plants or microbes without clear implications for animal diversity The screening process began with titles and abstracts, including studies discussing habitat loss or linking pollution to climate change, where full texts were read for the most relevant studies

3.4 Method of Synthesis

The selected literature was analysed using a thematic synthesis. Each primary source was examined by its author, year, taxonomic group, ecosystem, method, key findings, and climate impacts as the evidence base mixes observational studies, modelling, meta-analysis, review articles, institutional reports for their relevance Organized in categories such as outline and phenology change, extinction risks, habitat fragmentation, reproductive responses, taxon specific effects, thermal tolerance, behavioural adaptation, disease dynamics, invasive species conservation strategies and research gaps revealed key patterns, and identified areas where evidence was lacking

4. Discussion and Integrated Analysis

4.1 Common Patterns of Evidence across Animal Groups

A careful reading of the available information makes it clear that climate change is not limited to any one species or ecosystem. Studies on mammals, birds, reptiles, amphibians, fish, and marine life can vary in depth and detail, yet they all point in the same direction: rising temperatures, changing rainfall patterns, and extreme weather events alter organisms' distribution, life cycle, reproductive behaviour, and survival Yohe, 2003, and Root et al. 2003) found that many species move poleward or to higher altitudes, migration, nesting, breeding, and pest emergence earlier than ever this serves as evidence that climate change is not a future possibility but has already become a tangible biological stressor but responses to these changes are not uniform; Changes are most obvious in birds and butterflies, mainly because these groups have long been monitored and have "citizen science" records available Soil dwellers, land insects, deep sea animals, and small invertebrates fluctuate with external environment to be highly sensitive to even small changes in temperature and humidity. ocean acidification and oxygen depletion. Overall, the available data suggest that while the effects are widespread, they are not uniform; The nature and severity of these impacts depend on a species' physiological capabilities, habitat requirements, reproductive strategies, mobility and ecological relationships

4.2 Theoretical Frameworks Emerging from the Literature

Several approaches or frameworks emerge frequently in the existing literature to help us understand the relationship between climate and biodiversity. The first approach relates to changes in distribution. Factors such as agricultural encroachment, geographic barriers, and limited dispersal capacity can act as constraints and consequently models based solely on climatic variables cannot provide fully reliable forecasts It is essential to consider biological traits, dispersal limits, and landscape characteristics. The second approach relates to phenological inconsistency due to lack of coordination within the food web. Climate change can change the timing of activity of plants, insects, birds and predators at different rates; For example, newly hatched chicks may face starvation if peak emergence of insects precedes when migratory birds maintain their traditional breeding program A third approach relates to thermal tolerance Every organism operates within a specific temperature range, those whose external body temperature depends on the external environment Temperature increases can also have a severe side effect on them A fourth way is "evolutionary rescue", where some species manage to cope with changing conditions through behavioural flexibility or adaptation, even when the rate of change is fast enough to overwhelm many other species

4.3 Animal Diversity and Climate Change in the Indian Context

This question is important for a country like India, which boasts of diverse climate, unique biogeography and rich ecosystems of biodiversity. The Himalayas, Western Ghats, Sundarbans, Thar Desert, Andaman, Nicobar Islands and coastal areas have many endemic and endangered species, each affected differently by climate change, rising Himalayan temperatures may force species to migrate to higher altitudes, where suitable habitats become increasingly scarce. Cyclones and changes in water salinity can alter living conditions as seen in beautiful forests Changes in rainfall patterns in the Western Ghats can have significant impacts on amphibians, raptors and forest-dependent species Field data on long-term impacts remain inadequate Simply designating protected areas is inadequate; Conservation strategies must include ecological corridors, water sources, breeding areas and local community livelihoods.

4.4 Limitations of Available Evidence and Need for Further Research

Although this relationship is clear, there are limitations to the existing research on this topic. First, most work relies on species distribution models; While useful, these models do not fully capture factors such as actual dispersal capacity, inter-species interactions, local microclimate, evolutionary adaptation, or human-induced land-use change, requiring caution in interpreting their projections indeed, Dawson et al. (2011) noted that some biodiversity estimates rely on limited methodologies and stressed the need to integrate correlated mechanistic trait-based approaches in future studies Second, research focuses disproportionately on birds and charismatic species, often terrestrial insects, soil organisms, . Looks at deep-sea life, small invertebrates, and numerous tropical species meaning the decline of hidden or rare species can go undetected for years There is also a tendency to treat climate change as an isolated factor, when it really interacts with drivers like habitat destruction, pollution, invasive species, disease, human-wildlife conflict There is a geographical imbalance; Europe, North America, and Australia are far better studied than Asia, Africa, and tropical mountain ecosystems. This imbalance is particularly important for India, which is characterized by high biodiversity and ecological sensitivity. Future research should prioritize multifactorial modelling, longitudinal field studies, increasing local knowledge, disease surveillance, and attention to less documented species

4.5 Implications for Conservation Policy

One thing is clear: the traditional, static model of conservation is not enough. As climatic zones change, protected areas cannot be treated as isolated islands; Species need landscapes that allow them to migrate to new, suitable habitats. This requires simultaneous implementation of measures such as ecological corridors, climate refuges (climate-safe areas), habitat restoration, local monitoring, disease control, management of invasive species, and community-based conservation Species with limited dispersal capacity or highly restricted habitats require special attention in conservation planning. From a policy perspective, climate change cannot be divorced from biodiversity conservation; Wildlife conservation, land use planning, disaster risk management, agriculture, water security, and local livelihoods must all be part of a single, integrated strategy Science suggests that simply listing endangered species is not enough; It is also imperative to understand their habitat, life cycle, trophic relationships, disease risk, and potential exposure to climate impacts Consequently, adopting climate-sensitive site-specific conservation policies is not just an option but a need to ensure long-term conservation of biodiversity

5. Conclusion and Future Directions

5.1 Conclusion

This important study examines the impact of climate change on biodiversity in detail. Its main conclusion is that climate change poses a serious threat not only to individual species, but to species, communities and ecosystems from the genetic level Birds, reptiles, amphibians, insects, fish and marine life are affected, albeit in varying intensity, India’s Himalayas, Western Ghats, The Sundarbans, Thar Desert, Andaman, Nicobar Islands and coastal areas continue to be particularly vulnerable to extinction for many species indigenous to these areas and it is therefore clear that traditional, static models of conservation are inadequate. Protected areas should not be viewed as isolated islands; Conservation plans should include ecological corridors, water sources, breeding areas, and local community livelihoods for species transmission. In short, long-term biodiversity conservation can only be achieved through climate-sensitive and site-specific conservation policies.

5.2 Future Directions

This review offers some important directions for future research. First, relying solely on patterns of species distribution is insufficient; These often do not include factors such as actual dispersal potential of the species, interactions among individuals within the species, local microclimate, evolutionary adaptation, and human land use change thus requiring a combination of multifactor modelling and correlated mechanistic approaches Second, research largely focuses on birds and other species of interest; Insects, soil organisms, deep sea organisms, small invertebrates and many tropical species received little research, leaving hidden rare species decline long unnoticed Third, long-term field studies, local knowledge promotion, disease surveillance and invasive species management should be prioritized Fourth, in highly biodiverse like India There is an urgent need for site-specific monitoring and adaptation schemes in ecologically sensitive countries, especially in the Himalayas, Western Ghats and Sundarbans. Finally, as climate change interacts with habitat destruction, pollution, disease, and human-wildlife conflict, an integrated, multidisciplinary, and policy-focused research approach paves the way for long-term biodiversity conservation

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