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Climate Change Impacts on Wildlife: A Structured Review of Mechanisms, Recent Evidences, and Conservation Strategies

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ABSTRACT: Climate change posed a significant threat to global biodiversity, affecting wildlife across terrestrial, marine, and polar ecosystems. This review aimed to synthesize the mechanisms through which climate change impacted wildlife and to evaluate recent empirical evidence (2020–2025). A structured literature search was conducted using major scientific databases, and studies were categorized based on climatic drivers and ecological responses. The synthesis indicated that rising temperatures, altered precipitation patterns, extreme weather events, and oceanic changes were driving shifts in species distributions, phenology, and population dynamics. Case studies revealed increasing risks of trophic mismatches, habitat loss, and species decline across diverse ecosystems. The review further evaluated conservation strategies, highlighting the roles of climate mitigation, habitat connectivity, and ecosystem-based adaptation. The inclusion of literature up to early 2025 ensured that the review reflected the most recent scientific findings and evolving climate impacts on wildlife. These findings underscored the need for integrated, evidence-based approaches to enhance wildlife resilience under accelerating climate change.

KEYWORDS: Climate change; wildlife conservation; species range shifts; phenological mismatch; ocean warming; climate adaptation

Introduction

The climate crisis was arguably the most pressing environmental issue faced in the 21st century. The crisis was driven primarily by anthropogenic greenhouse gas (GHG) emissions, resulting from human activities such as fossil fuel extraction and combustion, deforestation, intensive agricultural and livestock farming, and industrial practices. The climate crisis was changing the global climate system at an unprecedented pace [1], and the global average surface temperature had increased by approximately 1.1 °C above pre-industrial levels. In some areas, particularly polar and mountainous regions, climate change had led to higher warming rates, with some regions warming at more than twice the global average [2]. More importantly, climate change was no longer just a prediction; it had become a real phenomenon that was altering ecosystems by reshaping, modifying, and damaging ecosystems and threatening the survival of many species. Climate change posed particular risks to wildlife as environmental conditions shifted due to rising temperatures. Wildlife had evolved to live within defined environmental conditions, including relatively stable temperature, humidity, and rainfall, but climate change threatened these conditions within habitats significantly.

Even slight shifts in these conditions disrupted physiological functions, reproductive success, migration patterns, and predator–prey relationships [3]. For many species, climate shifts that occurred too rapidly for adaptation or migration contributed to population declines and, in some extreme cases, local or global extinctions. The consequences of climate change were multifaceted. Direct effects included increased heat stress, altered metabolic rates, and higher mortality due to extreme weather events such as heatwaves, floods, wildfires, and storms. Indirect effects were also significant. For example, the loss or destruction of critical habitats disrupted food chains, caused mismatches between breeding and food availability, and facilitated the spread of invasive species, pathogens, and parasites into new habitats [4]. Climate change further exacerbated existing human pressures such as habitat loss and degradation, overfishing, and pollution, leading to multiple intersecting threats. One clear outcome was the redistribution of species.

Numerous studies indicated that species were shifting toward the poles or to higher elevations. In the oceans, fish migrated to cooler waters, while in mountain ranges, alpine plants moved upslope [5,6]. These shifts had serious repercussions for ecosystems by disrupting the balance of established communities. Similarly, changes in the timing of biological events resulted in phenological mismatches. For example, migratory birds arrived after the peak abundance of their insect prey, while pollinators emerged before flowering began, threatening their survival. Changes observed in marine ecosystems were equally concerning. Warming oceans, acidification, and deoxygenation altered coral reefs, changed fish migration patterns, and threatened larger marine animals such as whales, seals, and seabirds. Repeated bleaching events in the Great Barrier Reef highlighted how climate extremes pushed ecosystems toward collapse [7].

The considerable loss of sea ice in polar regions threatened ice-dependent species such as polar bears (*Ursus maritimus*) and emperor penguins (*Aptenodytes forsteri*). The climate emergency was not a future threat; it had already caused significant impacts on the planet. Global wildlife populations had declined dramatically in recent decades, with climate change emerging as a major driver alongside habitat destruction and exploitation. If warming trends continued, a substantial proportion of species would face extinction risks in the coming decades. To address this crisis, integrated strategies were required, including reducing greenhouse gas emissions and enhancing adaptive capacity in species and ecosystems.

Effective solutions needed to combine local conservation strategies, such as wildlife corridors and habitat protection, with global policy frameworks, including the Paris Agreement and the Kunming–Montreal Global Biodiversity Framework. Despite extensive research, there remained a need for an integrated synthesis linking mechanisms with recent empirical evidence across ecosystems. This review aimed to synthesize the major mechanisms through which climate change affected wildlife, integrate recent case studies (2020–2025), and critically evaluate current conservation strategies. Specifically, it sought to (i) identify key climatic drivers affecting wildlife, (ii) compare ecological responses across taxa and ecosystems, and (iii) assess the effectiveness and limitations of existing conservation approaches.

2. Review Methodology

This review adopted a structured narrative approach to synthesize current knowledge on climate change impacts on wildlife. Scientific literature was collected from major databases, including Web of Science, Scopus, PubMed, and Google Scholar. Searches were conducted using combinations of keywords such as “climate change AND wildlife”, “species range shifts”, “phenological mismatch”, “ocean warming”, and “climate adaptation”. Studies published between 2000 and early 2025 were considered, with particular emphasis on recent literature (2020–2025) to capture emerging trends, newly documented climate events, and the most up-to-date ecological responses. Inclusion criteria consisted of peer-reviewed journal articles, global assessment reports (e.g., IPCC), and studies focusing on ecological and physiological responses of wildlife to climate change. Exclusion criteria included non-peer-reviewed sources, studies lacking ecological relevance, and outdated literature unless considered foundational. Selected studies were categorized based on major mechanisms of climate impact (temperature changes, altered precipitation, extreme events, and oceanic changes) and across different ecosystem types (terrestrial, marine, and polar). Case studies were selected based on ecological significance, data availability, and representation of diverse biomes. A qualitative synthesis approach was applied to identify patterns, interactions among stressors, and key trends across studies. The inclusion of literature up to early 2025 ensured that the review reflected the most recent scientific findings and evolving climate impacts on wildlife.

3. Mechanisms of Climate Impact on Wildlife

3.1. Rising temperatures and thermal stress.

Global temperatures have risen by approximately 1.1 °C above pre-industrial levels, with polar and high-elevation regions experiencing warming at more than twice the global average [8]. Temperature is a critical ecological driver that influences physiological processes, reproductive success, and survival across wildlife taxa. Ectothermic organisms (e.g., fish, amphibians, and reptiles) are particularly vulnerable because their body temperature and metabolic performance are directly dependent on ambient conditions [9]. As temperatures exceed species-specific thermal tolerance limits, physiological stress increases, leading to reduced growth, impaired immune function, and elevated mortality rates. In contrast, endothermic species such as birds and mammals maintain internal temperature regulation but experience increased energetic demands under thermal stress [10]. This often results in reduced reproductive output, altered foraging behaviour, and decreased survival under prolonged extreme conditions. Importantly, thermal stress also has demographic consequences, influencing population-level processes such as recruitment, survival rates, and long-term population stability.

Across taxa, extreme temperature events have been linked to large-scale mortality and increased extinction vulnerability, particularly in species with limited thermal tolerance or restricted geographic ranges. For example, mass die-off events, such as those observed in flying fox populations during extreme heatwaves in Australia (2019–2020), illustrate how acute thermal stress can rapidly impact wildlife populations [11]. The major pathways through which climate change affects wildlife are summarized in Figure 1.

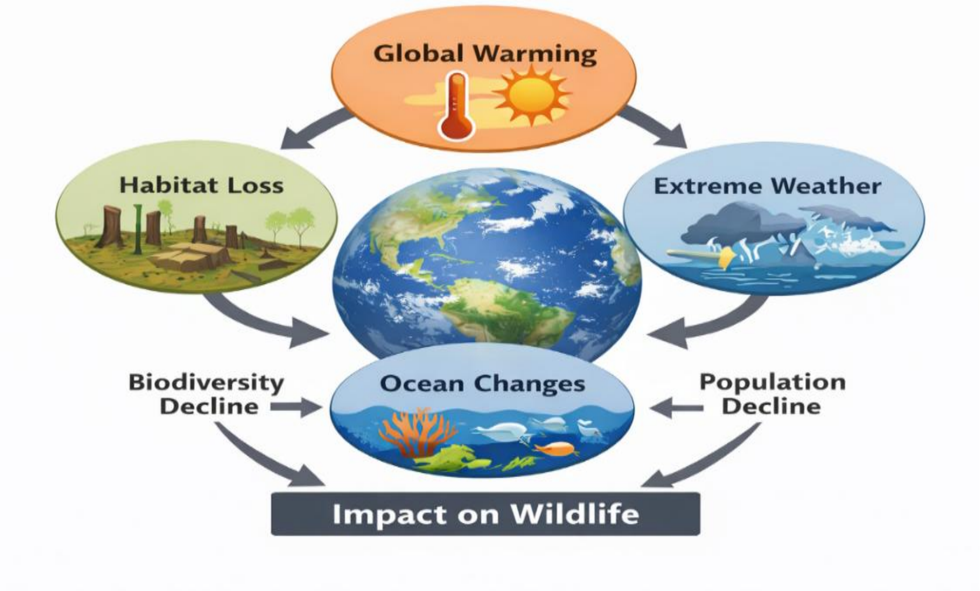

Figure 1. The major pathways through which climate change impacts wildlife.

3.2. Altered precipitation patterns.

Species that depend on predictable precipitation cycles are particularly vulnerable to alterations in rainfall patterns and increased climatic variability. Many amphibians, for instance, rely on seasonal rainfall for breeding, and disruptions in precipitation timing or intensity can result in the desiccation of breeding pools, thereby reducing reproductive success and larval survival [12]. Similarly, in savannah ecosystems, large mammals such as elephants and wildebeests are highly dependent on consistent water availability and forage resources. Prolonged drought conditions can lead to the drying of water sources and reduced vegetation productivity, ultimately increasing the risk of starvation, reduced reproductive output, and higher mortality rates.

3.3. Extreme weather events.

The frequency and intensity of extreme weather events, including cyclones, floods, wildfires, and droughts, have increased significantly in recent decades due to climate change. These events exert both immediate and long-term impacts on wildlife populations and ecosystems. Direct effects include large-scale mortality resulting from heatwaves, fires, and flooding events. For example, the Australian “Black Summer” bushfires (2019–2020), driven by prolonged heat and drought conditions, burned millions of hectares of forest and grassland and led to the death or displacement of an estimated three billion animals [13]. In addition to direct mortality, extreme weather events cause substantial habitat destruction. Wildfires can eliminate vegetation cover and nesting sites, while floods can destroy breeding habitats, particularly affecting ground-nesting birds and wetland-dependent species. Long-term ecological consequences include altered species composition, disruption of food webs, and reduced ecosystem resilience. Repeated exposure to extreme events may hinder population recovery and increase extinction risk, particularly for species with limited dispersal capacity or specialized habitat requirements.

3.4. Ocean warming, acidification, and deoxygenation.

Climate change exposes marine ecosystems to three major stressors: ocean warming, acidification, and declining oxygen levels, each affecting marine taxa through distinct but interconnected mechanisms. Ocean warming primarily affects coral reef ecosystems by disrupting the symbiotic relationship between corals and zooxanthellae. Elevated sea surface temperatures induce coral bleaching, reducing energy acquisition and often leading to widespread coral mortality. This process is illustrated in Figure 2.

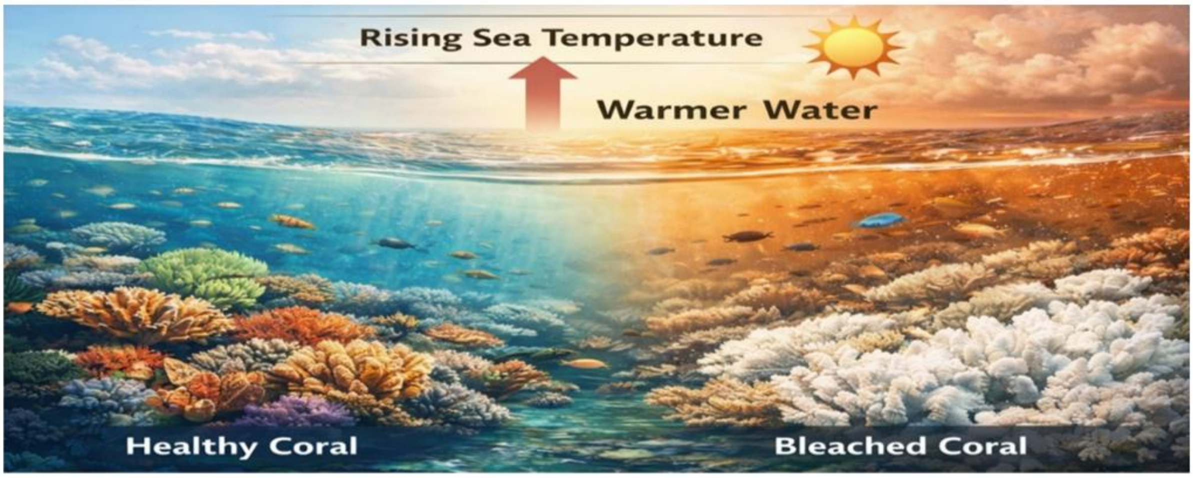

Figure 2. Coral bleaching as a consequence of ocean warming.

This loss of reef structure significantly diminishes habitat availability for reef-associated species, thereby affecting overall marine biodiversity. Ocean acidification, driven by increased atmospheric CO_2 absorption, reduces seawater pH and carbonate ion availability, impairing the calcification processes of shell-forming organisms such as molluscs, echinoderms, and reef-building corals. This weakens skeletal structures and can destabilize lower trophic levels, with cascading effects on marine food webs. Pelagic fish species respond to ocean warming by shifting their distribution toward cooler waters, which can alter predator–prey dynamics and fisheries productivity. Additionally, marine mammals are affected indirectly through changes in prey availability and habitat conditions, particularly in regions experiencing rapid environmental change. Declining oxygen levels, or ocean deoxygenation, lead to the expansion of hypoxic “dead zones” where aerobic marine organisms cannot survive. This reduces habitable space for fish and invertebrates and forces species into increasingly constrained ecological niches. Together, these stressors interact to intensify ecosystem-level impacts, highlighting the vulnerability of marine systems to multiple, overlapping climate-driven changes.

3.5. Shifts in species ranges.

When climate zones shift, many species move poleward or to higher elevations to maintain suitable climatic conditions. Some species can adapt rapidly, while others are constrained by habitat fragmentation or slow reproductive rates [15]. These shifts can disrupt established predator–prey interactions and create novel species interactions. In some cases, such changes can destabilize entire ecosystems, as illustrated in Figure 3.

Figure 3. Species range shifts in response to climate change.

3.6. Phenological changes and trophic mismatch.

Phenology refers to the timing of seasonal life-cycle events such as flowering, breeding, and migration and is highly sensitive to climatic conditions. Rising temperatures have led to earlier onset of biological events across many taxa, including earlier plant flowering, insect emergence, and shifts in migration timing. However, species do not respond uniformly to climatic cues. Differential rates of phenological adjustment among interacting species can lead to temporal mismatches across trophic levels. For instance, while primary producers and insect populations may advance their seasonal cycles in response to temperature, migratory birds often rely on photoperiod cues that remain unchanged, resulting in delayed arrival relative to peak food availability. This asynchrony disrupts predator–prey and plant–pollinator interactions, reducing resource availability during critical life stages. In birds, such mismatches have been associated with reduced chick survival and lower reproductive success. Similar patterns have been observed in pollination systems, where early flowering plants may not coincide with pollinator activity, affecting plant reproduction and ecosystem functioning [15]. Overall, trophic mismatches highlight the complex and uneven responses of species to climate change, emphasizing that shifts in timing alone are insufficient to predict ecological outcomes without considering species interactions and adaptive capacity.

3.7. Disease dynamics and parasite expansion.

Climate change affects wildlife health by altering the spread and severity of diseases. Warmer temperatures and changing precipitation patterns can expand the geographic range of disease vectors such as mosquitoes and ticks, exposing new wildlife populations to unfamiliar pathogens [16]. Amphibians have been heavily impacted by chytrid fungus, whose effects can worsen under climate-related stress. In marine environments, melting sea ice has facilitated the spread of novel diseases among previously isolated mammal populations.

3.8. Interaction with other stressors.

The impacts of climate change rarely occur in isolation. Instead, they often interact with habitat degradation and loss, pollution, overexploitation, and the introduction of non-native species, producing compound and synergistic threats. For example, habitat fragmentation may prevent species from shifting their distributions in response to warming, while pollution may weaken immune systems and increase susceptibility to climate-driven disease outbreaks. These cascading effects elevate extinction risk and reduce the resilience of wildlife populations [17].

4. Recent Case Studies (2020–2025)

This section presents selected case studies (2020–early 2025) that illustrate how climate change affects wildlife across a range of ecosystems. The cases were chosen to capture key climatic drivers—such as rising temperatures, altered precipitation patterns, extreme weather events, and oceanic changes—and their associated biological responses across different taxa. Together, these examples provide a comparative perspective on how species and ecosystems respond to multiple, interacting climate stressors. Table 1 summarizes selected case studies (2020–2025) demonstrating the impacts of climate change on wildlife.

Table 1. Selected case studies (2020–2025) demonstrating the impacts of climate change on wildlife across diverse ecosystems.

Ecosystem	**Species/Group**	**Climate Driver**	**Documented Response**	**Location**	**Year**	**Reference**
Polar	Polar bears (*Ursus maritimus*)	Sea ice loss	Reduced hunting success; population decline; lower cub survival	Western Hudson Bay, Canada	2020	[8]
Marine	Coral reefs	Ocean warming	Widespread bleaching (>90% reefs affected); reduced reef resilience	Great Barrier Reef, Australia	2024	[20]
Terrestrial	Jaguars & giant anteaters	Drought; deforestation	Habitat loss; range contraction; increased human–wildlife conflict	Amazon Basin, South America	2024	[21]
Terrestrial	Migratory birds (*Ficedula hypoleuca*)	Phenological shifts	Mismatch with insect prey; reduced reproductive success	Europe	2021	[15]
Coastal	Sea turtles (*Chelonia mydas*)	Temperature rise	Female-biased hatchling sex ratios	Florida, USA	2020	[10]
Tropical	Amphibians	Climate stress; disease	Population decline linked to chytrid fungus and climate variability	Central & South America	2022	[12]
Marine	Seabirds (*Uria aalge*)	Marine heatwaves	Mass mortality due to prey collapse and starvation	North Pacific Ocean	2021	[18]
Alpine	Snow leopard (*Panthera uncia*)	Glacier retreat	Habitat reduction; prey decline; increased human–wildlife conflict	Himalayas (Nepal, Bhutan)	2023	[19]
Global	Multiple species	Heatwaves; extreme events	Increased mortality; range shifts; ecosystem disruption	Global	2024–2025	[1]

4.1. Polar bear declines in the arctic.

Polar bears (*Ursus maritimus*) are perhaps the most emblematic species currently impacted by climate change. They depend on sea ice to hunt their preferred prey, seals. As documented in Western Hudson Bay, Canada, sea ice now forms later in autumn and melts earlier in spring, thereby shortening the hunting season [8]. The authors further reported that the local population has declined by 27% over the past decade, largely due to reduced sea ice. This decline is accompanied by poorer body condition, reduced cub survival, and lower reproductive success, driven by longer fasting periods onshore. Furthermore, the status of polar bears in Southern and Western Hudson Bay is considered a sentinel for other Arctic subpopulations that are likely to experience similar physiological consequences under climate change in the coming decades.

4.2. Coral bleaching in the great barrier reef.

The Great Barrier Reef (GBR) has experienced multiple large-scale coral bleaching events over the past decade, with the 2022–2023 event being particularly severe. Surveys conducted by the Australian Institute of Marine Science reported that over 90% of reefs exhibited some level of bleaching during this period [20]. Marine heatwaves elevated sea surface temperatures beyond the thermal tolerance limits of corals, leading to the expulsion of symbiotic zooxanthellae and resulting in widespread bleaching. While bleaching primarily reflects physiological stress, it does not always result in immediate coral mortality; however, prolonged or repeated thermal stress can lead to partial or complete colony death. Long-term monitoring data indicate that the frequency of bleaching events has increased, reducing recovery intervals between disturbances. This has significant ecological consequences, including shifts in benthic community composition and declines in reef structural complexity. Such changes affect reef-associated species, including fish and invertebrates, by reducing habitat availability and altering trophic interactions.

4.3. Migratory bird phenological mismatches in Europe.

Long-term ecological monitoring in Europe has shown significant changes in the migration timing of birds such as the pied flycatcher (*Ficedula hypoleuca*). Many migratory birds are now arriving at their breeding grounds earlier, but not always in synchrony with the peak abundance of their insect prey. A 2021 multi-site study found that, in some areas, these mismatches led to reduced chick survival and lower breeding success. This problem is exacerbated when climate change affects insect emergence differently from bird migration cues, leading to ecological mismatches that can cascade through entire food webs.

4.4. Amazonian mammal range contraction.

In the Amazon Basin, climate change is interacting with deforestation to drive range contraction in key mammalian species such as jaguars (Panthera onca) and giant anteaters (*Myrmecophaga tridactyla*). Increased frequency and intensity of drought events, particularly over the past decade, have reduced water availability, altered vegetation structure, and decreased prey abundance. Satellite-based ecological studies have shown that habitat suitability for these species is declining in drier regions, forcing populations to shift toward wetter refugia or remain confined within increasingly fragmented forest patches [21]. This contraction in suitable habitat limits dispersal, reduces gene flow between populations, and increases the risk of local population isolation. Furthermore, as animals are forced into smaller and more fragmented habitats, they increasingly overlap with human-dominated landscapes, leading to elevated human–wildlife conflict. This demonstrates a clear causal pathway in which climate-driven drought, compounded by deforestation, leads to habitat degradation, range contraction, and increased ecological and conservation risks.

4.5. Sea turtle hatchling sex ratio skews in Florida.

Many sea turtle species exhibit temperature-dependent sex determination (TSD), where warmer nest temperatures produce more females. In Florida, sand temperatures during the nesting season have risen steadily over the past two decades. A 2020 study found that, in some green turtle (*Chelonia mydas*) nesting beaches, over 90% of hatchlings were female [10]. While female-biased ratios may temporarily increase the breeding population, severe long-term imbalances could threaten population viability by reducing the number of breeding males. Conservationists have tested measures such as shading nests and relocating them to cooler areas; however, these are temporary solutions that cannot offset the broader issue of global warming.

4.6. Amphibian declines linked to climate stress and disease.

Amphibians are among the most climate-sensitive vertebrates due to their permeable skin, complex life cycles, and dependence on aquatic habitats. The second Global Amphibian Assessment (2022) indicates that over 40% of amphibian species are threatened with extinction, with climate change emerging as an increasingly urgent driver. In Central and South America, rising temperatures and changing rainfall patterns have resulted in altered breeding seasons and reduced suitable breeding sites. These climate changes often interact with the spread of the chytrid fungus (*Batrachochytrium dendrobatidis*), a pathogen responsible for widespread amphibian declines [12]. For example, in highland regions of Panama and Costa Rica, warmer temperatures have coincided with fungal outbreaks, leading to the loss of previously stable endemic frog populations. Climate stress may also compromise immune responses, increasing susceptibility to infection and further destabilizing aquatic ecosystems.

4.7. Heatwave-induced mass mortality of seabirds in the North Pacific.

A prolonged marine heatwave occurred in the North Pacific Ocean during 2021, characterized by sustained sea surface temperature anomalies significantly above seasonal averages. Such events disrupt oceanic productivity and trophic dynamics. Elevated temperatures led to declines in forage fish populations, including sardines and anchovies, which serve as primary prey for many seabird species. As a result, seabirds such as the common murre (*Uria aalge*) experienced substantial population impacts across the region. Field observations along the coastlines of the United States and Canada documented tens of thousands of dead or emaciated individuals. Post-mortem examinations revealed severe depletion of fat reserves, indicating starvation as the primary cause of mortality rather than direct thermal stress [18]. These findings highlight an indirect mechanism whereby marine heatwaves alter prey availability, leading to trophic disruption and large-scale wildlife mortality. Similar events recorded during earlier heatwaves (2014–2016) suggest that increasing frequency and intensity of marine heatwaves may pose a growing threat to marine food web stability under climate change.

4.8. Glacier habitat loss for the Himalayan snow leopard.

The snow leopard (Panthera uncia) is already vulnerable to poaching and habitat fragmentation, but climate change introduces an additional threat through the rapid retreat of Himalayan glaciers. These glaciers play a critical role in sustaining alpine ecosystems by supplying meltwater that supports high-altitude vegetation and prey species. Recent modelling studies indicate that, under high-emission scenarios, up to one-third of current snow leopard habitat could be lost by 2070 due to glacier retreat and associated vegetation shifts [19]. This reduction in habitat quality and prey availability may force snow leopards to move to higher elevations or closer to human settlements, increasing the likelihood of human–wildlife conflict. Conservation strategies such as the establishment of habitat connectivity corridors (“climate corridors”) are being implemented in regions including Nepal and Bhutan. However, long-term population persistence will depend on both effective local conservation measures and broader climate mitigation efforts.

4.9. global heatwave impacts on wildlife (2024–2025).

Recent global assessments indicate that the increasing frequency and intensity of heatwaves continue to impact wildlife across multiple ecosystems. Reports from early 2025 highlight that prolonged temperature extremes are contributing to increased mortality, shifts in species distributions, and disruptions in ecological interactions worldwide. Heatwaves affect wildlife both directly, through physiological stress and dehydration, and indirectly by reducing food availability and degrading habitats. Species with limited thermal tolerance or restricted geographic ranges are particularly vulnerable to these rapid climatic changes. Recent synthesis studies suggest that repeated exposure to extreme heat events is reducing population resilience and increasing extinction risk, particularly in already stressed ecosystems such as arid regions, coral reefs, and polar environments [22].

5. Conservation Responses and Mitigation Strategies

5.1. Global climate mitigation.

The most fundamental action to safeguard wildlife against climate change is to reduce greenhouse gas emissions and limit global warming. Global agreements such as the Paris Agreement aim to maintain warming well below 2 °C, preferably at 1.5 °C, relative to pre-industrial levels [23]. Lower warming scenarios significantly reduce extinction risk for many species by maintaining climatic conditions within their adaptive range. Global mitigation strategies include transitioning to renewable energy, improving energy efficiency, restoring carbon-dense ecosystems such as forests and wetlands, and adopting sustainable agricultural practices. Without substantial emission reductions, even the most robust local conservation efforts will be insufficient to prevent widespread biodiversity loss.

5.2. Protection and expansion of climate-resilient habitats.

The protection and expansion of protected areas are essential for maintaining biodiversity under changing climatic conditions. Climate-resilient habitats, such as high-altitude refugia, intact wetlands, and old-growth forests, can serve as critical refuges for species as local conditions shift. The post-2020 Global Biodiversity Framework (GBF) includes the “30×30” target, which aims to protect at least 30% of the world’s terrestrial and marine areas by 2030 [24]. Importantly, protected areas must be designed with future climate projections in mind to ensure their continued effectiveness as species distributions shift geographically.

5.3. Wildlife corridors and connectivity.

Species require the ability to move in response to changing climates. Establishing wildlife corridors, continuous habitat networks, or strategically placed stepping-stone habitats enables species to expand or shift their ranges [25]. In India, for example, tiger and elephant corridors facilitate the movement of large mammals between fragmented forests. In North America, initiatives such as the Yellowstone-to-Yukon Conservation Initiative aim to connect ecosystems across thousands of kilometers, allowing species to adapt to climate-driven range shifts.

5.4. Assisted migration and species translocation.

Where natural dispersal is limited by geographic barriers or human-induced fragmentation, assisted migration has been proposed as a conservation strategy to relocate species to areas projected to remain climatically suitable. While this approach may provide a potential safeguard for species with limited dispersal capacity, it remains highly controversial. The feasibility of assisted migration depends on factors such as the accuracy of climate projections, species-specific ecological requirements, and the availability of suitable recipient habitats. Empirical evidence suggests that although some plant translocation efforts have been successful under controlled conditions, broader application across taxa remains limited and context-dependent. Importantly, assisted migration carries significant ecological and governance risks. Translocated species may become invasive, outcompete native species, or disrupt existing ecosystem processes [26]. Additionally, uncertainties related to long-term monitoring, regulatory frameworks, and stakeholder acceptance pose further challenges. Given these risks, assisted migration should be considered a last-resort strategy, implemented only after rigorous risk assessment, pilot testing, and adaptive management. A precautionary approach is essential to balance potential conservation benefits against unintended ecological consequences.

5.5. Community-based and indigenous-led conservation.

Local and Indigenous communities possess extensive ecological knowledge that can be integrated into conservation strategies. In Canada’s boreal forests, Indigenous Guardian programs combine traditional stewardship practices with modern monitoring technologies, yielding measurable biodiversity benefits. In sub-Saharan Africa, community conservancies manage wildlife and habitats while generating income through ecotourism, thereby creating incentives for conservation. Empowering communities through legal rights, financial support, and capacity building is critical for achieving long-term conservation success.

5.6. Ecosystem-based adaptation (EBA).

Ecosystem-based adaptation involves managing ecosystems to support both wildlife and human adaptation to climate change. For example, restoring mangroves preserves coastal biodiversity while protecting human settlements from storm surges. Similarly, watershed reforestation enhances water security and provides habitat for climate-sensitive species. These strategies offer multiple co-benefits, including carbon sequestration, biodiversity conservation, and disaster risk reduction [27,28].

5.7. Managing local stressors to build resilience.

Although global climate change cannot be mitigated in the short term, reducing local stressors can enhance ecosystem resilience. Actions such as controlling invasive species, reducing pollution, enforcing sustainable fishing practices, and combating illegal wildlife trade can improve species' ability to withstand climate impacts. For instance, reducing sediment and nutrient runoff into coral reef ecosystems can increase their resistance to bleaching events.

5.8. Monitoring, early warning, and rapid response.

Long-term biodiversity monitoring is essential for detecting early signs of climate impacts and enabling timely intervention. Technologies such as remote sensing, environmental DNA (eDNA) analysis, and automated acoustic monitoring are transforming wildlife observation and data collection. Early warning systems for extreme weather events can help conservation managers implement rapid responses, such as relocating vulnerable species or protecting critical breeding habitats. While a wide range of conservation strategies has been proposed to address climate change impacts on wildlife, their effectiveness varies depending on ecological, socio-economic, and geographic contexts. Global mitigation efforts remain the most impactful long-term solution, as reducing greenhouse gas emissions directly limits climate-driven biodiversity loss. However, these efforts depend heavily on international cooperation and consistent policy implementation.

Habitat protection and connectivity strategies are strongly supported by empirical evidence, particularly for species capable of dispersal, but their effectiveness is constrained in highly fragmented landscapes and regions undergoing rapid land-use change. Assisted migration offers potential benefits for species unable to shift ranges naturally; however, it carries ecological risks, including unintended species interactions and ecosystem disruption. Community-based and ecosystem-based approaches provide cost-effective and socially sustainable solutions, especially in biodiversity-rich regions, although their success depends on governance structures, funding, and local participation. In contrast, strategies targeting local stressors can enhance short-term resilience but cannot compensate for large-scale climatic changes. Overall, no single strategy is sufficient in isolation. Effective conservation under climate change requires integrated, multi-scale approaches that combine mitigation, adaptation, and local management actions tailored to specific ecological and socio-economic contexts.

6. Policy and International Agreements

6.1. Paris Agreement (2015).

The Paris Agreement, adopted under the United Nations Framework Convention on Climate Change (UNFCCC), forms the foundation of global climate policy. Its primary objective is to limit global warming to well below 2 °C, with efforts to restrict it to 1.5 °C above pre-industrial levels [23]. Achieving these targets is critical for biodiversity conservation, as assessments by the Intergovernmental Panel on Climate Change (IPCC) indicate that each incremental reduction in warming significantly lowers extinction risk for many species. The Agreement requires countries to submit and periodically update Nationally Determined Contributions (NDCs), which increasingly incorporate biodiversity-related adaptation measures such as habitat restoration, ecosystem conservation, and climate-resilient land-use planning. However, despite its global importance, the effectiveness of the Paris Agreement in protecting biodiversity is constrained by gaps in implementation and enforcement. NDCs are largely voluntary and vary widely in ambition and scope, with many lacking specific, measurable biodiversity targets. As a result, the translation of climate commitments into tangible conservation outcomes remains inconsistent across regions.

6.2. Kunming–Montreal Global Biodiversity Framework (2022).

Adopted at the 15th Conference of the Parties (COP15) to the Convention on Biological Diversity (CBD), the Kunming–Montreal Global Biodiversity Framework establishes ambitious conservation goals for the coming decade [24]. Its most prominent target is the “30×30” goal, which aims to protect at least 30% of the world’s land and sea areas by 2030. The framework also emphasizes ecosystem restoration, halting species extinctions, and integrating biodiversity into national and local planning. It further recognizes Indigenous peoples and local communities as key stewards of biodiversity and advocates for their equitable participation in conservation governance. Despite its ambition, implementation faces several challenges. Achieving the “30×30” target requires substantial financial investment, yet many countries—particularly in the Global South—face funding constraints and competing development priorities. Moreover, the effectiveness of protected areas depends not only on their extent but also on management quality, ecological representativeness, and enforcement, which vary widely across regions. Monitoring and accountability also remain limited, as many countries lack the capacity to generate reliable biodiversity data and track progress consistently.

6.3. Convention on migratory species (CMS).

The Convention on Migratory Species (CMS), also known as the Bonn Convention, provides a framework for international cooperation in conserving migratory species that cross-national borders [25]. Climate change considerations are increasingly integrated into CMS action plans, particularly as migration routes and breeding habitats shift. For example, current CMS initiatives focus on protecting critical stopover sites for migratory birds affected by climate-driven changes in timing and distribution.

6.4. Ramsar convention on wetlands.

Wetlands are among the most productive and biodiverse ecosystems but are highly vulnerable to climate change [28, 29]. The Ramsar Convention promotes the conservation and sustainable use of wetlands through a globally recognized network of Ramsar sites. These ecosystems serve as climate refugia for waterbirds, amphibians, and aquatic plants, and play a key role in flood and drought regulation. Increasingly, integrating climate resilience into Ramsar site management has become a priority.

6.5. CITES (convention on international trade in endangered species).

Although primarily focused on regulating international wildlife trade, CITES contributes indirectly to climate adaptation by reducing exploitation pressures on vulnerable species. For instance, the listing of several shark species under CITES, in response to overfishing and climate-related habitat degradation, can help stabilize populations and enhance their adaptive capacity. However, its effectiveness in addressing climate change is limited by enforcement challenges and its primary focus on trade rather than habitat protection.

6.6. National adaptation plans (NAPs).

Many countries are incorporating biodiversity and ecosystem considerations into their National Adaptation Plans under the UNFCCC [23]. For example, Kenya’s NAP includes measures to protect climate-vulnerable ecosystems such as montane forests and mangrove systems, while Costa Rica integrates biodiversity corridors into its climate adaptation strategy. These plans help ensure that climate policies are informed by ecological considerations and support both biodiversity conservation and human well-being.

6.7. Role of regional agreements and initiatives.

Regional agreements often provide more targeted and adaptive approaches to addressing climate and biodiversity challenges. Examples include the Coral Triangle Initiative in Southeast Asia, which supports marine protected areas and sustainable fisheries, and the African Elephant Coalition, which coordinates cross-border conservation efforts in response to climate and habitat pressures [26]. While international and national policy frameworks are essential for addressing climate change and biodiversity loss, significant gaps remain in their implementation and effectiveness. Many agreements rely on voluntary commitments, resulting in uneven progress and limited accountability. Strengthening policy coherence, improving cross-sectoral coordination, and ensuring adequate financial and institutional support are critical to translating these commitments into measurable biodiversity outcomes under accelerating climate change.

7. Conclusion

The rapidly intensifying climate crisis is no longer a distant threat; its impacts on the natural world are evident across all biomes. From polar bears losing their hunting platforms in the Arctic to widespread coral bleaching in tropical oceans, species are being forced to respond to environmental change at rates that often exceed their adaptive capacity. The case studies synthesized in this review highlight the intensity, variability, and global extent of these impacts, demonstrating that no ecosystem, terrestrial, freshwater, or marine, is exempt. This review contributes to the current understanding of climate change impacts on wildlife by integrating mechanistic pathways with recent empirical evidence (2020–2025). The synthesis shows that climate change affects wildlife through multiple interacting mechanisms, including thermal stress, altered precipitation regimes, extreme weather events, oceanic changes, and phenological mismatches. Importantly, these drivers do not act in isolation but interact with existing anthropogenic pressures such as habitat loss, overexploitation, and pollution, creating compounded “threat multiplier” effects that accelerate biodiversity decline. While a range of conservation strategies from global climate mitigation to local ecosystem-based adaptation, can reduce vulnerability, their effectiveness depends on coordinated implementation, strong governance, and alignment with international frameworks such as the Paris Agreement and the Kunming–Montreal Global Biodiversity Framework. Measures such as maintaining habitat connectivity, protecting climate refugia, and integrating Indigenous and local knowledge systems are particularly critical for enhancing ecosystem resilience. However, as a review, this study is constrained by the availability and geographic distribution of published literature, with certain regions and taxa remaining underrepresented. In addition, variability in methodological approaches across studies limits direct comparison of ecological responses and introduces uncertainty in generalizing findings. Future research should prioritize long-term, cross-taxa monitoring, improved integration of climate projections with ecological data, and the development of predictive models that incorporate multiple interacting stressors. Interdisciplinary approaches combining ecology, climatology, socio-economic analysis, and policy research, will be essential for generating actionable insights and informing adaptive conservation strategies. Ultimately, the fate of global biodiversity will depend on the scale and urgency of human responses in the coming decades. Limiting warming to 1.5 °C, alongside the effective implementation of conservation policies, offers a critical window of opportunity to safeguard wildlife. Failure to act will not only result in irreversible biodiversity loss but also undermine the ecological systems that sustain human well-being.

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Author Contribution

Conceptualization was carried out by Deon David and Dr. V. Pushpa Rani. Literature search and screening were performed by Deon David. Data curation and synthesis were undertaken by Deon David and Jofy Francis. Visualization (figures and table preparation) was completed by Deon David. Writing of the original draft was done by Deon David. Writing—review and editing were performed by Dr. V. Pushpa Rani and Jofy Francis. Supervision was provided by Dr. V. Pushpa Rani.

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