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WILDLIFE UNDER CLIMATE CHANGE, A SYSTEMATIC REVIEW OF IMPACTS

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ABSTRACT

Background: The impact of climate change on wildlife and ecology is extensively described in this scientific literature. The relationship between biodiversity and climate is complex. Studies done in the past have demonstrated that both direct and indirect impacts of climate change on animals can be found. As the atmosphere warms, thermal optimum locations move to high latitudes and high altitudes. The last several years have seen a rise in global precipitation, which has an impact on wildlife. **Objective:** The main objective of this research is to assess the corpus of information on how climate change impacts wildlife. **Method:** To identify research gaps and document the state of the science regarding the impacts of climate change on wildlife systems, we carried out a systematic literature review. The method of selecting and excluding articles from consideration for the literature review is explained using the PRISMA statement idea. Finally, to close the theoretical gap on the impacts of climate change on wildlife, 56 articles are examined, chosen, and assessed. **Result:** The meta-findings indicate that climate change affects wildlife. The most significant effects of climate change on wildlife include metabolic and behavioral changes brought on by heat stress in wildlife, impairment of animal function, changes in water-soluble carbohydrates, disruption of leaching patterns in the land, decline in feeds like herbal production, rangeland, and fodder production, rise in diseases in wildlife, reduction in overall food security, loss of wildlife biodiversity, and negative impacts on species reproduction. Lower mammal populations have contributed to a larger rise in woody cover inside protected areas, whereas increased agricultural production, infrastructure development, and human settlement have contributed to a greater decline in woody cover outside protected areas. Conclusion: According to the results of the meta-analysis, wildlife all over the world has been profoundly impacted by climate change. If some species die extinct as a result of climate change, species may not typically suffer from it, according to research on how it affects animals. According to them, since tropical regions contain the richest biodiversity, warmer and increased precipitation may be good for the environment.

Keywords: Climate Change, Wildlife, Phenology, Species, Ecology, Range Shift.

INTRODUCTION

Climate changes are described as long-term shifts in abiotic elements such as temperature, precipitation, snowfall, and wind patterns (Hiura et al., 2019). The most frequent events are cloudbursts, dry spells, increasing sea levels, thawing permafrost, salinization, increased wildfires, decreased agricultural yields, water scarcity, and health problems brought on by high temperatures in cities, and ablation provides new concerns for people and species (Savo et al., 2016). Climate change alters the structure and function of the environment and the services that the natural system offers to society by affecting certain species and their habitat (Savo et al., 2017). The majority of the time, climatic change is localized, but occasionally it extends far and disrupts food chains, nutrient flow, and air circulation in other places. Solar energy is crucial to all biological processes (Roots, 1989). Most of the biomass is maintained by it, and primary production is aided. It maintains a stable biotic environment on the planet (Haberl et al., 2014). When talking about how climate change affects wildlife, it is mentioned that certain species have not been greatly impacted while others go distinct (Parmesan, 2007). Due to two key phenomena phylogenetic niche conservatism and ecological productivity, tropical regions have high biodiversity (Brown, 2014).

Climate change has had a variety of impacts on the ecosystem of the natural world and species. Natural disasters, climatic changes, and atmospheric physical conditions all dramatically changed Among the already-noticed effects of climate change are the development of wildlife diseases and the invasion of exotic species (Caminade et al., 2019; KAKAR et al.). When ecological resilience is already decreased by other anthropogenic stressors like development demands and resource extraction, these consequences are exacerbated (He & Silliman, 2019). The effects that have been reported so far include changes in species distributions, often along gradients of elevation, changes in the timing of life-history events, or phenology, for specific species, decoupling of coevolved interactions, like relationships between plants and pollinators, effects on demographic rates, like survival and fecundity, reductions in population size, and extinction or extirpation of range-restricted or isolated species and populations (J Gundale & Kardol, 2021; Rudgers et al., 2020). Numerous less well-known herb species, like the grass Microchloa till and other plants like Hibiscus aethiopicus and Rhamphicarpa sp., blossom after burning after the taller grasses have been eliminated, demonstrating that they are at least largely dependent on fire for existence (A. Plumptre et al., 2017).

The leading international organization for the assessment of climate change, the Intergovernmental Panel on Climate Change (IPCC), released a synthesis report in 2007 that came to the conclusion that the warming of the climate system is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (Paglia & Parker, 2021). The greenhouse gases are increased by a number of human activities, which strengthens the greenhouse effect and contributes to global warming (Shen et al., 2020). Biodiversity is at risk from climate change, and communities that are unable to keep up with the speed of change are anticipated to suffer consequences (Pecl et al., 2017). This circumstance causes dangerous climate change by raising the temperature of the atmosphere and the ocean. In recent decades, the sea's surface temperature has grown (Mimura, 2013). According to forecasts made by the Intergovernmental Panel on Climate Change's climate model, the average sea surface temperature will continue to rise. The rate of climate change is extremely rapid for most species to adapt. The rate of change is a key factor in determining how well wildlife can adapt to climate change (Engelbrecht et al., 2015).

Focusing on animals is crucial because it causes serious disruptions to society, the relocation of people, economic misery, and ecological degradation (Willow, 2014). Therefore, it is important to recognize that climate change is a major contributor to the decline of ecological variety (Spijkers & Boonstra, 2017). Most species were unable to reestablish their habitats and phonological responses, and few species relocated to high latitudes or elevations as a means of coping with climate change (Muluneh, 2021). These differences in behavior among species in the same environment eventually cause the ecosystem's components to break down (G. Woodward et al., 2010).

Many parts of literature make it clear that food abundance and the impacts of climate change on wildlife are major global concerns. However, no global systematic literature assessment has been carried out on how the wildlife ecosystem would be impacted by climate change. As a result, the key points of the article make a measurement of the available information on how climate change is impacting wildlife. This study's primary goal is to evaluate the body of literature on the impacts of climate change on wildlife. The impacts of climate change on vulnerable species of birds and mammals were assessed using species features in a meta-analysis that focused on the effects of climate change.

1. METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria, which have previously been utilized in prior systematic reviews linked to climate science, were followed when we conducted a systematic review, which has the advantages of transparency, rigor, and replication.

2.1 Search Strategy

We conducted an electronic literature search to find pertinent papers that had been peer-reviewed and were solely available in the English language. There were no restrictions on the publication year, study design, or geographic scope. Only studies that specifically address climate change and its impacts on wildlife were included in our selection of literature. Since "climate change" can take many distinct forms (such as change, variability, and extremes), "wildlife" frequently forgets other keyword combinations that were utilized to fully cover the topic. A supplementary manual search was conducted as well because the terms "impact" (heat stress, pastures, feeds, reproduction, health, and vector-borne diseases) and "Climate change impacts" are closely related and also contain "risk," "resilience," and "vulnerability."

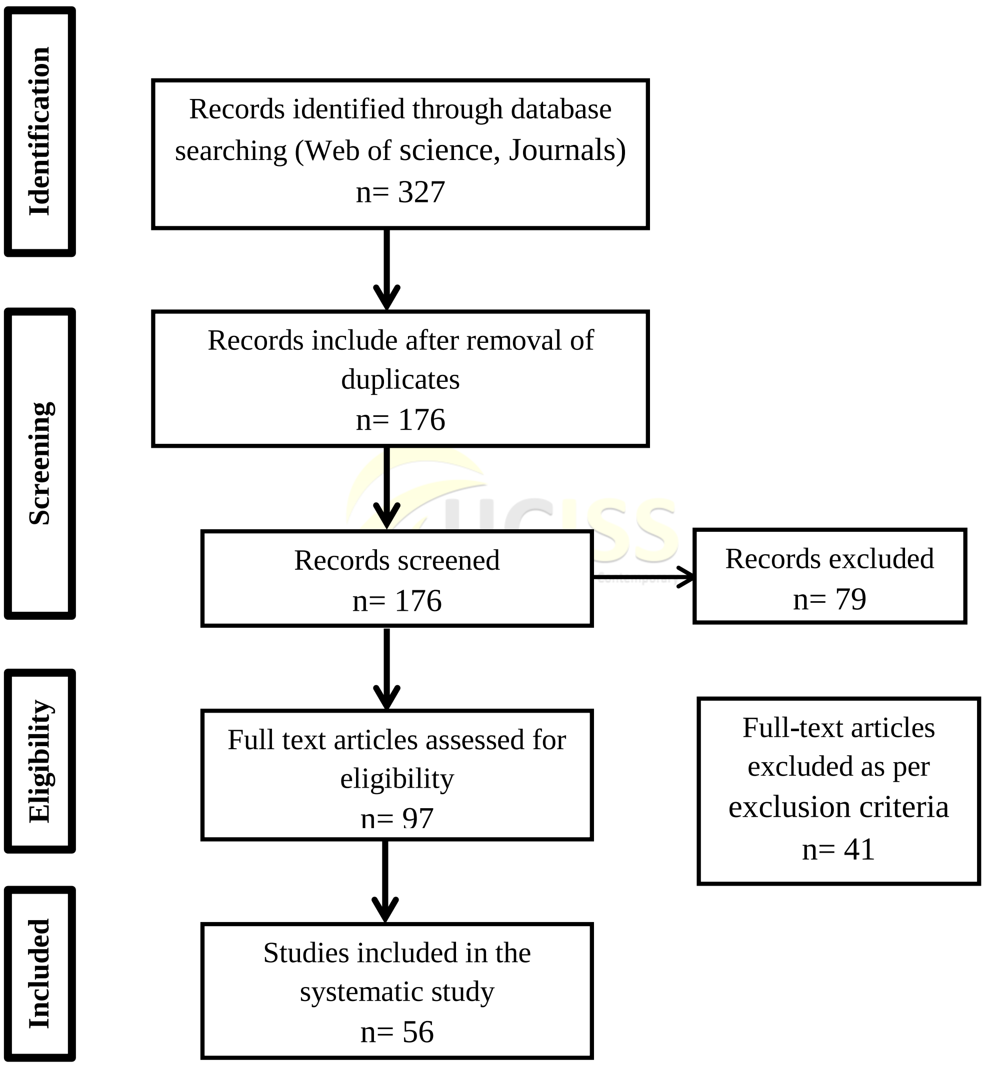

Figure 1 Publication's search methodology for meta-analysis

2.2 Eligibility and Inclusion Criteria

In order to increase the best possible articles for the procedure, the eligibility requirements for research articles are examined and pushed through very critical and closely observed approaches. The database's study article was picked from among important categories: social sciences, and environmental sciences. For more robust and high-quality findings, however, be careful to take into account publications from all the journals in the

database. The articles with open access are taken into consideration for the review.
A total of 327 articles, excluding duplicates, were found as a result of the search. After applying inclusion and exclusion criteria to these 327 papers, we ultimately retained 56 articles for additional analysis.

Table 1.1 Eligibility and Inclusion Criteria

Inclusion	**Exclusion**
Studies that address effect of climate change on wildlife	Studies that don’t focused on climate change effects, impacts,
Included were peer-reviewed works that were published in English.	We didn't include adaptations or writing done in another language.
It is either an article, a review, or a book chapter.	Other than an article, review, or book chapter, the publication type.
There is sufficient information in the text to analyze the data.	The text doesn't provide enough information to conduct data analysis.

2.3 Data Management and Analysis

We combined the extracted data using content analysis to further define the review's scope, derive contextual meanings, and synthesis the data. The descriptive approach of data analysis was utilized, together with data collection and data visualization, as analytical techniques. Additionally, thematic analysis was used to categories and divide impacts and adaption tactics into topics.

2. Result

There are several hazards to wildlife worldwide in response to climate change. Increasing temperatures decrease the chances of many species surviving as a result of modifications that lead to changes in the availability of food, the success of reproduction, and interference with the environment for nearby wildlife (Sundström et al., 2014). The ecosystem's capacity to support species and keep its equilibrium is threatened by climate change. When plants change their blooming periods or shift to colder places, the fauna that has adapted to the changing heat patterns will need to adapt to new settings (Khavarian-Garmsir et al., 2019).

3.1 The Impact of Climate Change on Wildlife

Climate change that results in increased temperatures may have an impact on wildlife by driving species to relocate their ranges, usually toward the poles or higher elevations, or to grow, contract, or do all three (Van der Putten, 2012). Their phenologies might change as a result, causing incompatibilities with their food and habitat supplies. Additionally, it could result in habitat degradation and expose people to new infections. The ability of species to endure these changes could be affected negatively or favourably (Gallinat et al., 2015). The ability of a species to adapt to a certain extent of climatic change is somewhat influenced by the rate at which the change takes place. examples of species thought to be impacted by climate change in some way. Examples from published studies were used, and they were properly cited. The examples show the many kinds of alterations that have been noticed (Cavicchioli et al., 2019).

Shifts in Range

Few studies have examined how climate change has affected an entire species' range, in part because it is challenging to collect data from across a range over an extended enough time period to yield meaningful conclusions (Barve et al., 2011). In addition to white bark pine, the mountain pine beetle occasionally feeds on other species as well as lodge pole pine (Buotte et al., 2016). Up until recently, the beetle's inability to complete a full life cycle at higher elevations due to cold temperatures and a short growing season kept it under check (Alyokhin et al., 2015). According to research, beetles can complete their entire reproductive cycle in one year in the environment of whitebark pine thanks to winter temperatures that are warmer (Buotte et al., 2016).

I. Changes in phenology

Many species' life cycles depend on phonological cues in one way or another. Certain phonological occurrences typically change when global warming modifies the climate (Kushwaha et al., 2011). An ecological mismatch can happen when connected changes in one interdependent species do not match phonological changes in another (Schleuning et al., 2020). Predators and prey, herbivorous insects and host plants, pollinators and flowering plants, and other combinations might be mismatched (Brodersen et al., 2018). Climate change-related mismatches are being researched by scientists because they have the potential to interfere with many species' reproductive cycles (Birchenough et al., 2015).

II. Loss of Habitat Causes Population Decline

There are not many studies that directly link the loss of wildlife populations to climate change. There have been reports of indirect connections, such as species population losses brought on by habitat loss aggravated by climate change (Hoffmann et al., 2019). For instance, it has been shown that climate change has an effect on Antarctic krill. In the Southern Atlantic Ocean, Antarctic krill constitute a significant grazer and a food source for many fish species that are the targets of commercial fisheries (Cavan et al., 2019). Polar bear populations are also dropping as a result of the seasonal thinning of the ice cover. A warmer Arctic temperature is associated with decreases in ice cover (Stirling & Derocher, 2012).

a. Pathogens

Climate change may cause some viruses' ranges to expand, while others may have their ranges contract. For instance, the number of harlequin frogs is dwindling as a result of rising chytrid fungus epidemics (Granados-Martínez et al., 2021). The 110 species of harlequin frogs have lost 67% of their populations in the past 20 years. The promotion of chytrid fungus epidemics by climate change has been the subject of a mechanistic explanation (Lips, 2016). The thermal optimum for chytrid growth is being approached more frequently at night, while daytime cloudiness discourages frogs from seeking out thermal refuges (Glime & Boelema, 2017).

3.2 Globally Endangered and Climate Change-Vulnerable Wildlife Species

As a result of climate change, there have been observed shifts in species ranges, abundance, and seasonal activities, particularly in insects, birds, and mammals. climate change's consequences on ecosystems and species, for instance, directing new populations or unidentified species, analyzing the effects of land cover change, planning the translocation and reintroduction of threatened species, determining the risk of disease, and testing ecological theory, evolutionary theory, and biogeographical processes are all examples of conservation planning and prioritization (Vitasse et al., 2021). It will be challenging to find food for certain animals that is nutritious enough to support their current gut biomes (Kolodziejczyk et al., 2019). For instance, pollinators require earlier-blooming flowers to dine on. In some cases, other animals may discover that their surroundings can no longer sustain their physiology (Zariman et al., 2022). According to peer-reviewed research, African wildlife species are more impacted by climate change than those in Europe, Asia, and North America. Variations in weather patterns disrupt the natural ecosystem, which has an influence on wildlife either directly or indirectly and contributes to their fragility and decline. Most species become vulnerable in the Afrotropical region, some critically endangered in the Palearctic region, and it appears that some nearly threatened species are present in the Nearctic region. Table 1.2 Wildlife species including birds, mammals, and plants considered IUCN red list category (LC least concern, VU vulnerable, EN endangered, CR critically endangered, NT nearthreatened)

Wild Bird Species			
IUCN Status	**Species**	**Distribution**	**Zoogeographical Region**
LC	Apalis argentea	East Africa	Afrotropical Region
VU	Balaeniceps rex	East Africa	Afrotropical Region
EN	Balearica regulorum	East & South Africa	Afrotropical Region
EN	Cryptospiza shelley	East Africa	Afrotropical Region

VU	Prionops alberti	East Africa	Afrotropical Region
VU	Pseudocalyptomena graueri	East Africa	Afrotropical Region
EN	Torgos tracheliotos	East & South Africa	Afrotropical Region
CR	Trigonoceps occipitalis	East & South Africa	Afrotropical Region
VU	Hirundo atrocaerulea	Sub-Saharan Africa	Afrotropical Region
CR	Vanellus gregarious	Russia	Palearctic Region
CR	Ardeotis nigriceps	Asia	Palearctic Region
CR	Numenius arquati	Europe/Asia	Palearctic Region
Wild Mammals Species			
IUCN Status	**Species**	**Distribution**	**Zoogeographical Region**
VU	Cercopithecus lhoesti	Central Africa	Afrotropical Region
VU	Crocidura lanosa	Africa/Europe/Asia	Palearctic Region
EN	Crocidura stenocephala	Central & East Africa	Afrotropical Region
CR	Gorilla beringei	Central & East Africa	Afrotropical Region
	Hippopotamus amphibious	Africa	Afrotropical Region
EN	Rhinolophus ruwenzorii	Africa	Afrotropical Region
VU	Ruwenzorisorex suncoides	Africa	Afrotropical Region
NT	Sylvisorex lunaris	Africa	Afrotropical Region
VU	Thamnomys kempi	East Central Africa	Afrotropical Region
EN	Myosorex blarina	East Africa	Afrotropical Region
NT	Lophuromys rahm	Sub-Saharan Africa	Afrotropical Region
EN	Dasymys montanus	Africa	Afrotropical Region
VU	Delanymys brooksi	Africa	Afrotropical Region
VU	Hybomys lunaris	Africa	Afrotropical Region
VU	Lophuromys medicaudatus	Sub-Saharan Africa	Afrotropical Region
NT	Lophuromys rahmi	Sub-Saharan Africa	Afrotropical Region
EN	Myosorex blarina	East Africa	Afrotropical Region
NT	Crocidura kivuana	Africa/Europe/Asia	Palearctic Region
LC	Gonostoma elongatum	Asia	Palearctic Region
NT	Hexanchus griseus	North & South America	Nearctic Region
LC	Pomatoschistus quagga	South Africa	Afrotropical Region
EN	Panther uncial	Asia/America/Africa	Nearctic Region
Wild Plants Species			

IUCN Status	Species	Distribution	Zoogeographical Region
LC	Tulipa Sylvestris	Europe/North Africa	Palearctic Region
VU	Afzelia bipindensis	Africa	Afrotropical Region
NT	Entandrophragma angolense	Tropical Africa	Afrotropical Region
VU	Entandrophragma cylindricum	Tropical Africa	Afrotropical Region
VU	Entandrophragma utile	Atlantic/ Africa	Palearctic Region
VU	Khaya grandifoliola	Africa	Afrotropical Region
VU	Ocotea kenyensis	Africa	Afrotropical Region
VU	Guarea cedrata	Africa	Afrotropical Region

i. Wildlife Birds

According to IPCC data many animal and plant species have adapted to the rise in air temperatures by delaying springtime activities like flowering and egg-laying. Studies at local regional scales, where temperature changes may actually be considerably smaller (or more) than the world average, provide the majority of the evidence for these phonological responses (Pittock, 2017). The majority of species react to temperature changes; however, some seem to be less sensitive (Williams et al., 2015). In addition to affecting a bird's metabolic rate (cold weather, for example, necessitates higher energy use for bodily maintenance), the weather also has additional indirect and direct factors that affect how birds behave (Fuller et al., 2016). Extreme climatic conditions, Long-term effects on entire cohorts can result from extreme weather events, such as prolonged freezing spells and droughts, on bird populations (Bhat et al., 2020).

Table 1.3 Globally endangered and climate change-vulnerable wildlife Birds species

wildlife Birds species	Impacts	References
Apalis argentea	▪ According to speculation, the population is dwindling as a result of timbe and forest clearing for cultivation.	(Kröger & Nygren, 2020) (Bergius et al., 2020)
Balaeniceps rex	▪ Long dry spells cause wetlands to dry up, while intense rains cause the ecosystem to flood. ▪ Shoebill nests and young may be lost in floods, and the birds prefer to eat in shallow water.	(Gaudet, 2014) (Taylor, 2021)
Balearica regulorum	▪ The destruction of habitat and the unjustified capture of wild birds and their eggs	(Trouwborst & Somsen, 2020) (Rush et al., 2018) (Fox & Whiteley, 2015)
Cryptospiza shelley	▪ Water loss from bird eggs is affected by eggshell thickness. ▪ Possibly connected to ongoing forest degradation and deforestation across its range	(Cox, 2010) (Sodhi et al., 2011) (Vieco-Galvez et al., 2021)
Prionops alberti	▪ Throughout its range, woodland was cut down to make room for small-scale farming.	(Profile, 2012) (A. Plumptre et al., 2016) (Crawford & Kujirakwinja, 2016)

	▪ Itombwe is also at risk of forest clearing for cow pasture, especially at higher altitudes.	
Pseudocalyptomena graueri	▪ Forest deterioration and deforestation ▪ Agricultural clearance	(Ryan et al., 2012) (Bradshaw, 2012) (Mon et al., 2012)
Torgos tracheliotos	▪ A decreased supply of food ▪ Habitat destruction and excessive hunting	(Garbett, 2018) (Safford et al., 2019) (Girmay et al., 2020)
Trigonoceps occipitalis	▪ Indirect poisoning at jackal-killing baits placed in small-stock farming areas. ▪ Eco-system changes and persecution	(Edwards, 2015)
Hirundo atrocaerulea	▪ Habitats for grasslands and wetlands on both its breeding grounds and non-breeding grounds have been destroyed or degraded.	(Wakelin, 2006) (Evans et al., 2015)
Numenius arquata	▪ This species' mating season is anticipated to suffer greatly from climate change.	(Franks et al., 2017) (I. D. Woodward et al., 2021)
Vanellus gregarius	▪ Climate in its breeding and wintering range is becoming more arid.	(Nagy et al., 2022)
Ardeotis nigriceps	▪ Induced phenological changes	(Kher, 2019) (Silva et al., 2022)

ii. Wildlife Mammals

The rate of climatic change is too rapid for large mammals, who are renowned for their lengthy lifespans of many decades, to undergo genetic adaptation, leaving only the expression of latent phenotypic plasticity as a means of mitigating its impacts (Hetem et al., 2014). Additionally, human population growth and landscape fragmentation are both too common. The utilization of an animal's inherent physiological and behavioral capabilities that can protect it from the consequences of climatic change, as well as anatomical variation within the same species, are examples of how phenotypic plasticity is expressed (Gullan & Cranston, 2014). There have been changes During the past few decades, changes have occurred at all levels of ecological organization, including population and life cycle, phenology and geographic range, and species composition of communities, and structure and functioning of ecosystems (Damien & Tougeron, 2019).

Table 1.4 Globally endangered and climate change-vulnerable wildlife Mammals species

Wildlife Mammals Species	Impacts	References
Cercopithecus lhoesti	▪ Slightly affected behaviorally by the edge effects. ▪ There is a shift in arboreal lifestyle	(Costa, 2013) (Heldstab, 2017)
Crocidura lanosa	▪ Become endangered due to fragmentation and habitat loss, destruction of forest due to natural and human made destruction.	(McLean et al., 2016) (Scholier, 2017) (das Neves, 2019)
Crocidura stenocephala	▪ Become vulnerable due to carbon loss in soil, frequent drying or flooding.	(Ian, 2019)
Gorilla beringei	▪ Disease poaching. forest degradation, illegal hunting and habitat loss	(Maisels et al., 2016) (Estrada et al., 2017)

Gonostoma Elongatum	▪ Changes in depth occupancy that are ongoing, ▪ Migration patterns	(Woodstock et al., 2022) (Woodstock et al., 2022)
Hexanchus Griseus	▪ Elasmobranchs are particularly vulnerable in the Mediterranean Sea due to problems including habitat loss.	(Mulas et al., 2021)
Hippopotamus amphibious	▪ The main risks to hippo survival are poaching for their ivory canine teeth and flesh, as well as habitat loss brought on by human settlement, deforestation, and pollution.	(Abdel-Meguid, 2016) (Thomas, 2017)
Rhinolophus ruwenzorii	▪ *Foraging habitat loss due to land clearing and uncontrolled wildfires*.	(A. Plumptre et al., 2016)
Ruwenzorisorex suncoides	▪ Natural disasters, degradation, human interference, pollution	(Galabuzi, 2015) (Cormier-Salem et al., 2018)
Sylvisorex lunaris	▪ Natural forces like fire, drought, and storms damages large stretches of forest causing decline in specie population.	(Demos, 2014)
Thamnomys kempi	▪ They would do badly during the snap and suffer as a result of habitat loss and damage since larger species have fewer offspring and breed more slowly.	(Höglund, 2009)
Myosorex blarina	▪ Threatened by the destruction of natural habitat as a result of changing weather patterns.	(A. Plumptre et al., 2017) (Beca, 2021)
Lophuromys rahm	▪ *Threatened by reduction in ranges, loss of specific resource requirements* supplied, habitat conversion and fragmentation leads to genetic consequences.	(Kaleme, 2011)
Dasymys montanus	▪ *Fragmentation and ongoing loss of suitable wetland.*	(BYARUHANGA et al., 2011) (Ramesh & Downs, 2015)
Delanymys brooksi	▪ Destruction of habitat in its already small geographic range.	(Bitariho et al., 2015) (A. J. Plumptre et al., 2019)
Hybomys lunaris	▪ *Destruction, fragmentation, or degradation of habitat—is* the primary threat to the survival of this specie.	(Salzer, 2014) (A. Plumptre et al., 2017)
Lophuromys medicaudatus	▪ Altitudinal distribution and anthropogenic *influence*s	(Onditi et al., 2021)
Lophuromys rahmi	▪ *Continuing decline in the extent and quality of its montane forest habitat*.	(A. Plumptre et al., 2017)
Myosorex blarina	▪ Various constraints on natural resources are causing species to go extinct. due to demands from development and patterns in the rising tendencies of human population.	(Galabuzi, 2015) (Furió et al., 2010)
Pomatoschistus Quagga	▪ Induced phenological changes	(Engelen et al., 2015)
Panthera uncia	▪ Due to shifting tree lines and habitat loss	(Fast, 2019)
Crocidura kivuana	▪ Forest clearing and habitat loss	(Kaleme, 2011) (Demos, 2014)

iii. Wildlife Plants

The Arctic is the region of the world where warming is happening the quickest. The distribution of some Arctic plants is already being impacted by changes in snow patterns, ice cover, and temperatures. Some specialists believe that climate change may have an impact on the chemical composition and, ultimately, the survival of species (Descamps et al., 2017). Studies have shown that plants' secondary metabolites and other chemicals, which are typically the basis for their therapeutic efficacy, can be impacted by temperature stress (Li et al., 2020). Climate change may also have a particularly negative impact on plants that thrive in alpine environments (Cavaliere, 2009). Researchers from all over the world have noticed and documented the advancing tree lines and the extinction of populations of montane plants in recent years, which they attribute to the effects of climate change on alpine ecosystems (Inouye, 2020). Additionally, as a result of increasing competition for resources and space brought on by plant species' upward migration, alpine plant populations may experience additional stress (Lynn et al., 2021).

Table 1.5 Globally endangered and climate change-vulnerable wildlife Plants species

Wildlife Plants Species	Impacts	References
Tulipa sylvestris	▪ Are displaced by climate change, which causes habitat loss	(Efe et al., 2015) (Nowak et al., 2022)
Afzelia bipindensis	▪ *Species is becoming locally threatened in some areas due to selective logging for its timber*.	(Catarino et al., 2021) (Scalbert et al., 2022)
Entandrophragma angolense	▪ Slow growth rate and faster deforestation. ▪ limited *duration and decreased edema compared with guanine and control*.	(Jolivet & Degen, 2012) (Ivie et al., 2017)
Entandrophragma cylindricum	▪ *Commercial interest in this valuable timber has resulted in over-extraction of large individuals from the forest throughout its range.*	(Ichikawa, 2021)
Entandrophragma utile	▪ Overexploitation for timber and slow growth rate.	(Groenendijk et al., 2014) (Groenendijk et al., 2017)
Khaya grandifoliola	▪ Vulnerable due to overexploitation	(Mukaila et al., 2021)
Ocotea kenyensis	▪ Declining *as a result of harvesting pressures* ▪ *Bark harvesting*	(Tiawoun et al., 2018)
Guarea cedrata	▪ Endangered due to habitat loss	(Borokini, 2014)

Discussion

This systematic review demonstrates a rise in study interest in how climate change impacts wildlife in various geographical, agro ecological, and production system contexts. The breadth and scope of the research demonstrate the value of wildlife to different nations and areas as well as the critical need to address the documented implications of climate change. It's critical to systematically document these many impacts in order to identify the aspects of wildlife production that are most threatened and, as a result, require the most pertinent adaptation.

The IUCN also used species trait data to assess climate change's potential impact on recognized species of mammals, birds, reptiles, amphibians, fish, and plants in the Albertine Rift (Ayebare et al., 2018). Based on a species' ecological, life history, genetic, and physiological characteristics, the sensitivity and adaptive capacity components of its response were calculated, while the exposure component was determined by measuring the temperature and precipitation variability across a species range (Crozier et al., 2019). The three components of the climate change vulnerability assessment were resilience (ability to bear impacts), adaptive capacity (ability to dissipate shocks or go through micro evolutionary change), and sensitivity (ability to survive in place) (Aubin et al., 2016). Exposure (the level of climatic change to which a species will be subjected) (How much of a chance does the species have of surviving climate changes) species that are harmed by climate change and are also employed to produce food, be used as pets, for medical purposes, and to harvest timber (Maxwell, 2018). Due to shifting habitats, a loss of connectedness, and vulnerability to climate change, changes in land cover and land use are already occurring and are anticipated to have a considerable impact on wildlife behavior show in the Table (1, 3) (Selwood et al., 2015).

Since the 1970s, researchers have been examining how localized climate change and harsh weather affect wild species. Paleoclimatic research has demonstrated that species have occasionally adapted to climate change without causing global extinctions (Kiesecker, 2011). Numerous studies show that the effects of climate change on species and their habitat occur in conjunction with those of other causes. It is challenging making broad assumptions about the whole effects of climate change on biodiversity, wildlife, and ecosystems due to this and the variances across biomes and species (Waller et al., 2017). Due to reduced mammal populations, there has typically been a greater rise in woody cover within of protected areas, and a greater fall outside of protected areas as a result of rising agricultural production, expanding infrastructure, and human habitation. (Table 2) (Angourakis et al., 2022).

As a result of their geographic isolation and often inability to move or adjust to changing climatic conditions, some species are particularly susceptible to climatic changes (Constable et al., 2014). Increased climate variability and longer and more frequent extreme weather events have been linked to a number of adverse impacts, including alterations in stress hormone levels, reproductive output, survival, fledging success, and population growth (Sonnenberg et al., 2022). When discussing how climate change impacts animals, some people argue that even if certain species go extinct, generally, climate change may not be detrimental for species (Gilg et al., 2012). They assert that since tropical regions have the highest biodiversity, warming and more precipitation may be beneficial for the environment (Nobre et al., 2016). Furthermore, they contend that species may acquire features or behaviors that will help them adapt to various environmental conditions as a result of climate change (Davoudi et al., 2012).

Conclusion

Climate change will likely have an impact on the existing status of wildlife populations. Concerns about how climate change and environmental change will impact wildlife typically focus on things like food production and availability, water sources, habitat loss, changes in phenology, shifts in range, the effects of extreme weather events, sea levels, and vegetation patterns. Global climate change has had a significant influence on wildlife. According to them, since tropical regions have the greatest diversity of species, warmer temperatures and more precipitation may be beneficial for the environment even if some species become extinct due to climate change. Lower mammal populations have caused a bigger increase in woody cover inside protected areas, whereas increased agricultural production, infrastructure construction, and human settlement have caused a greater loss of woody cover outside protected areas.

DECLARATIONS

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