FEELING THE HEAT:

The fate of nature beyond 1.5°C of global warming

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FOREWORD

TANYA STEELE
Chief executive

Climate change is already having an impact on people, nature and the one shared home we all rely on. This must be the year world leaders put our planet first.

In a single lifetime, we've seen the widespread destruction of our natural world: land cleared for agriculture, oceans stripped of life and polluted with waste, and our air filled with harmful emissions. This is creating a hotter, less stable planet for people and nature – putting our very survival at risk.

In this report, we highlight 12 species that are experiencing the devastating impacts of climate change, and we outline how their future depends on humanity's urgent response to the environmental crisis. Our list includes mammals, reptiles, amphibians, insects, birds, plants and corals – and it covers impacts across the globe, from here in the UK to the frozen wilderness of Antarctica and deep in the Amazon rainforest.

We share powerful voices from the frontline of the climate emergency, including those losing their homes to sea-level rise in the Fijian islands and Maasai farmers facing intense droughts in Tanzania.

Despite raised ambitions from political and business leaders to tackle climate change, the world is not on track to prevent catastrophic damage. Current climate pledges known as nationally determined contributions, or NDCs, and net-zero targets for 2050 will not deliver the Paris Agreement goal of limiting global warming to 1.5°C. In fact, they are projected to lead to a temperature rise of 2.4°C above pre-industrial levels by the end of the century.

As this report details, every fraction of a degree of additional warming can permanently damage many critical ecosystems and lead to the extinction of even more species. If we are to secure a future for some of our most iconic species and habitats, and indeed ourselves, then 2021 must be a turning point.

And there is hope. The UK's presidency of the UN climate conference known as COP26, later this year, provides a unique opportunity for us to lead the way. We must act to ensure we can keep global temperature rise to 1.5°C and make nature our 'climate hero'.

How we respond will determine the future prosperity and health of us all, and of our one shared home.

CLIMATE CHANGE: A GLOBAL EMERGENCY

Climate change and the loss of nature are the biggest environmental crises of our time – and we are the last generation that can stop their most devastating impacts.

The world's average surface temperature has risen by around 1°C since the Industrial Revolution. The impacts of this on people and nature are already measurable and will get a lot worse if we do not act urgently.

The impacts are felt everywhere – from tropical forests to remote mountaintops; from wetlands to the icy wilderness of the polar regions. We are experiencing more extreme events such as prolonged heatwaves and wildfires, warmer oceans and back-to-back coral bleaching events, retreating glaciers and rising sea levels.

Climate change has brought changes to all types of animal and plant life on every continent. Higher temperatures can shift the suitable range for species, disrupt the timing of their life cycle, and increase the frequency and intensity of extreme events that directly affect their natural habitats. These risks will all escalate as global temperatures rise.

Most species have evolved to survive in a particular environmental niche – and their historical distribution reflects this. Some may be able to adapt to higher heat and altered rainfall patterns. But others will need to shift their range to follow their preferred climates – typically moving to find more suitable cooler homes towards the poles and up hills. In the UK, the ranges of many species, including birds, butterflies, moths and dragonflies, have already shifted northwards over the last four decades. In the ocean, changing conditions have contributed to the range shifts of highly mobile species. A rapid shift in the distribution of the northeast Atlantic mackerel stock towards Greenland waters was seen earlier this century. But other species are unable to move because their habitat is too rare or fragmented, or too hard to reach because they face natural or human-made barriers.

In some parts of the world certain species may, at least temporarily, appear to do better – with more food available or as previously inhospitable areas become more suitable for colonisation. Threats to species are often complex, meaning different species, and even different populations of the same species, can display different responses. Shifts in temperature affect habitat and food availability dramatically for different species, including exerting a powerful influence over populations and distribution of Antarctica's penguin species. In west Antarctica, rapid warming has caused sea ice extent to decrease rapidly. As a result, populations of the ice-adapted Adélie penguin in this region are generally declining, whereas populations of the ice-averse gentoo penguin are increasing.

Increases in the frequency and intensity of extreme weather events are putting wildlife under additional pressure, leading to high mortality and reproductive failures. For example, extreme heatwaves have caused massive die-offs in flying fox populations in Australia.

Climate change can make existing habitats unsuitable and reduce the availability of natural resources such as water. When habitat and food become scarcer, wild animals may turn to livestock and crops, increasing the risk of conflict between people and wildlife.

Climate change is a threat to people and nature, and it exacerbates existing stresses. Many species cannot cope with the current rate of climate change, especially when their resilience has already been reduced by habitat destruction, overexploitation, disease, pollution and competition from invasive species. The UN estimates that one million species are threatened with extinction globally, many in the coming decades.

We have now entered a sixth mass extinction, and climate change is accelerating the crisis. The Bramble Cay melomys was the first species of mammal wiped out because of human-caused climate change. The small rat-like rodent, which was endemic to a tiny island at the northern tip of the Great Barrier Reef, saw its habitat destroyed by sea-level rise. More species will be pushed to the brink because of climate change.

The climate crisis is not simply about the disappearance of certain animals and plants from particular places, but about profound changes to ecosystems that provide vital services to hundreds of millions of people. Half of the world's warm-water coral reefs have already been lost, with impacts on other marine life and coastal communities. Sea levels have risen by 16cm since the start of the 20th century, and the continuing trend threatens the existence of entire communities in coastal and low-lying areas.

The increasing frequency and intensity of extreme events such as heatwaves, floods, droughts and wildfires driven by climate change is having a devastating effect on food security and livelihoods, with losses of crops and livestock production. Least developed countries are the worst affected.

With 2021 a critical year for climate action, world leaders must step up to deliver on ambitious targets that will put our planet on the path to recovery – protecting the health, wealth and security of future generations. These actions must be achieved without leaving anyone behind.

WHY DOES 1.5ºC MATTER?


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Half a degree might sound insignificant, but the projected harm to unique and threatened systems increases enormously between a 1.5°C limit and higher temperature rises. The Intergovernmental Panel on Climate Change (IPCC) *Special Report on Global Warming of 1.5°C* highlights many differences in climate risks at 1.5°C, 2°C and higher levels of warming on land and in the oceans.

Risks from droughts and heavy precipitation events are projected to increase. Vulnerable communities who depend on agricultural or coastal livelihoods are likely to suffer impacts and increasingly face food insecurity. They will clearly benefit from a strict implementation of the Paris targets. For example, at 1.5°C, there will still be reductions in the yields of maize, rice, wheat and other cereal crops, but they are projected to be smaller than at 2°C, particularly in sub-Saharan Africa, south-east Asia and Latin America.

Low-lying and coastal communities are highly vulnerable to sea-level rise. Global sea-level rise by 2100 is projected to be 10cm higher at 2°C than if we keep to 1.5°C. Such a difference would expose up to 10 million more people to risks.

A half-degree increase would also permanently damage a variety of ecosystems and lead to the extinction of even more species across the globe. For example, warm-water coral reefs are projected to decline by a further 70-90% at 1.5°C warming but would be virtually lost under a 2°C scenario. If emissions keep rising as they are today, all known emperor penguin colonies will decline and most will be quasi-extinct by the end of the century – but if we keep to 1.5°C their future can be secured.
A global assessment analysed the potential effects of climate change on the range sizes of more than 105,000 terrestrial species.


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It found that keeping temperature rise to 1.5°C rather than 2°C would halve the proportion of plants and vertebrates that are projected to lose more than 50% of their geographical range. Under the same scenario, the number of insects facing such range loss would decrease by two-thirds.

Time is of the essence. To save humanity's crucial life-support systems, the global community must act now. If we fail to limit global warming to 1.5°C, we will face even greater risks of a global decline of functioning ecosystems and an irreversible and catastrophic loss of species.


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CLIMATE RISKS:
1.5°C vs 2°C GLOBAL WARMING

Based on the *IPCC Special Report on Global Warming of 1.5°C* and *Special Report on Oceans and Cryosphere in a Changing Climate.*

SPECIES
1.5°C
6% of insects, **8%** of plants and **4%** of vertebrates will be affected
2°C
18% of insects, **16%** of plants and **8%** of vertebrates will be affected

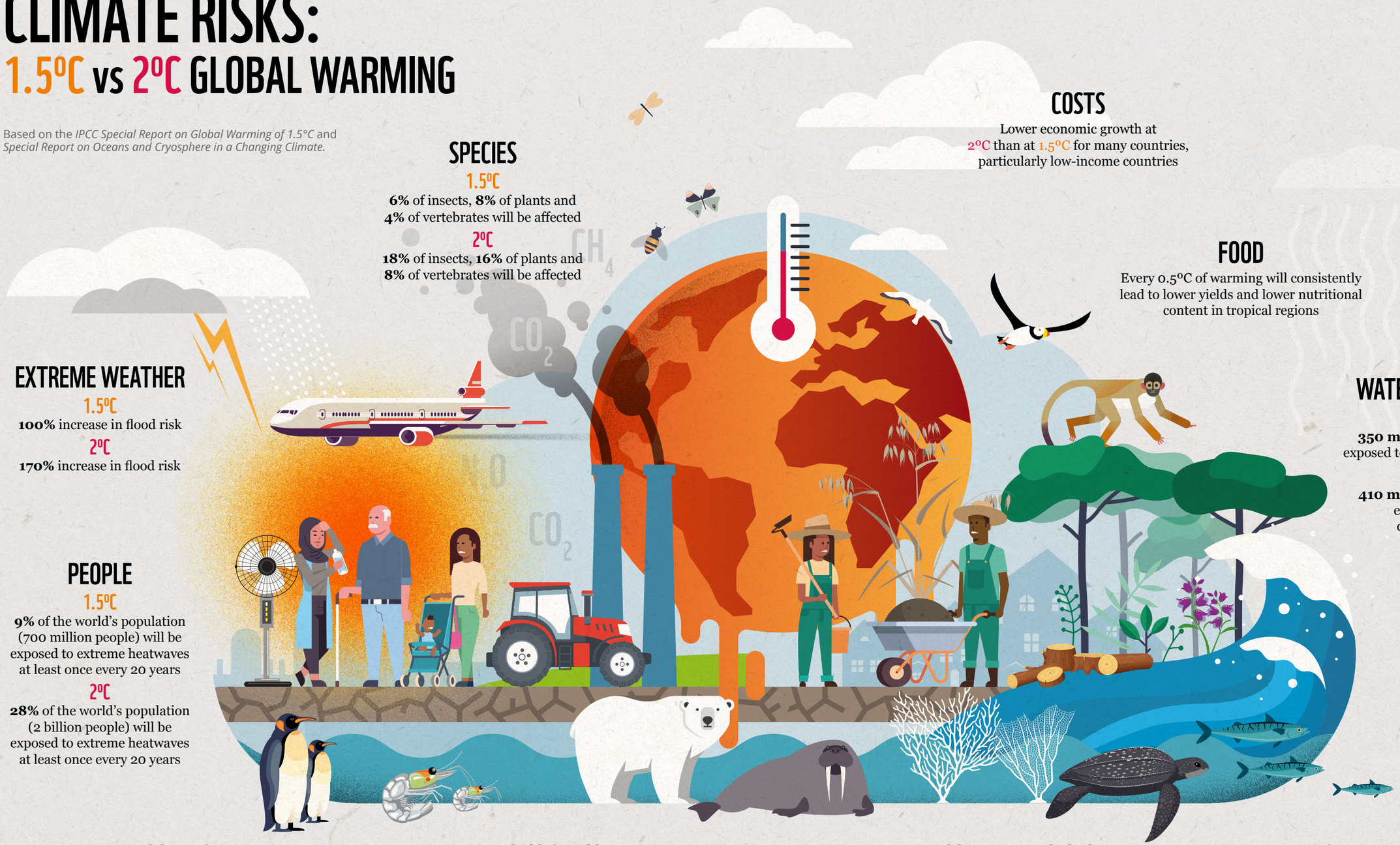
COSTS
Lower economic growth at 2°C than at 1.5°C for many countries, particularly low-income countries

FOOD
Every 0.5°C of warming will consistently lead to lower yields and lower nutritional content in tropical regions

EXTREME WEATHER
1.5°C
100% increase in flood risk
2°C
170% increase in flood risk

WATER AVAILABILITY
1.5°C
350 million urban residents exposed to severe drought by 2100
2°C
410 million urban residents exposed to severe drought by 2100

PEOPLE
1.5°C
9% of the world's population (700 million people) will be exposed to extreme heatwaves at least once every 20 years
2°C
28% of the world's population (2 billion people) will be exposed to extreme heatwaves at least once every 20 years



OCEANS
Lower risks to marine biodiversity, ecosystems and their ecological functions and services at 1.5°C than at 2°C

ARCTIC SEA ICE
1.5°C
Ice-free summers in the Arctic at least once every **100 years**
2°C
Ice-free summers in the Arctic at least once every **10 years**

CORAL BLEACHING
1.5°C
70% of world's coral reefs are lost by 2050
2°C
Virtually all coral reefs are lost by 2050

SEA-LEVEL RISE
10cm higher at 2°C than at 1.5°C in 2100. This difference would expose up to 10 million more people to risks

GLOBAL STATE OF PLAY


© Andre Dib / WWF-Brazil

Greenhouse gas emissions from human activities are the dominant cause of the climate crisis. The main drivers are carbon dioxide from burning fossil fuels for energy (for example in industry, transport and to heat buildings) and from releasing carbon stored in vegetation and soils (for example through deforestation to clear land for agriculture). Agriculture also contributes large amounts of the greenhouse gases methane and nitrous oxide.

To tackle climate change and its negative impacts, 196 countries (together with the EU) adopted the Paris Agreement on climate change in 2015. They agreed to pursue efforts to limit global temperature rises to 1.5°C above pre-industrial levels. All pathways to 1.5°C include rapid and deep cuts in greenhouse gas emissions, together with protecting and enhancing natural carbon sinks such as forests, soils and wetlands.

However, despite political statements and action to date, the world is not on track to slow climate change. Short-term country climate pledges – known as nationally determined contributions (NDCs) – and mid-century net-zero targets are estimated to lead to a temperature rise of 2.4°C by the end of the century.

In 2020 the global average temperature was 1.2°C above pre-industrial levels and the six years since the Paris Agreement have been the warmest on record. This only serves to reinforce the urgency of both high political ambitions and action on the ground.

To keep the long-term temperature goal of the Paris Agreement within reach, countries that have not done so must submit and implement new and more ambitious NDCs. All nations need to strengthen and implement policies to rapidly and deeply cut greenhouse gas emissions and restore nature.

Climate change is a hot topic in the UK this year, in part because Glasgow will host COP26 in November. If the future of some of our most iconic species is to be secured, world leaders must take more action in 2021 to close the emissions gap and put the world on a 1.5°C pathway.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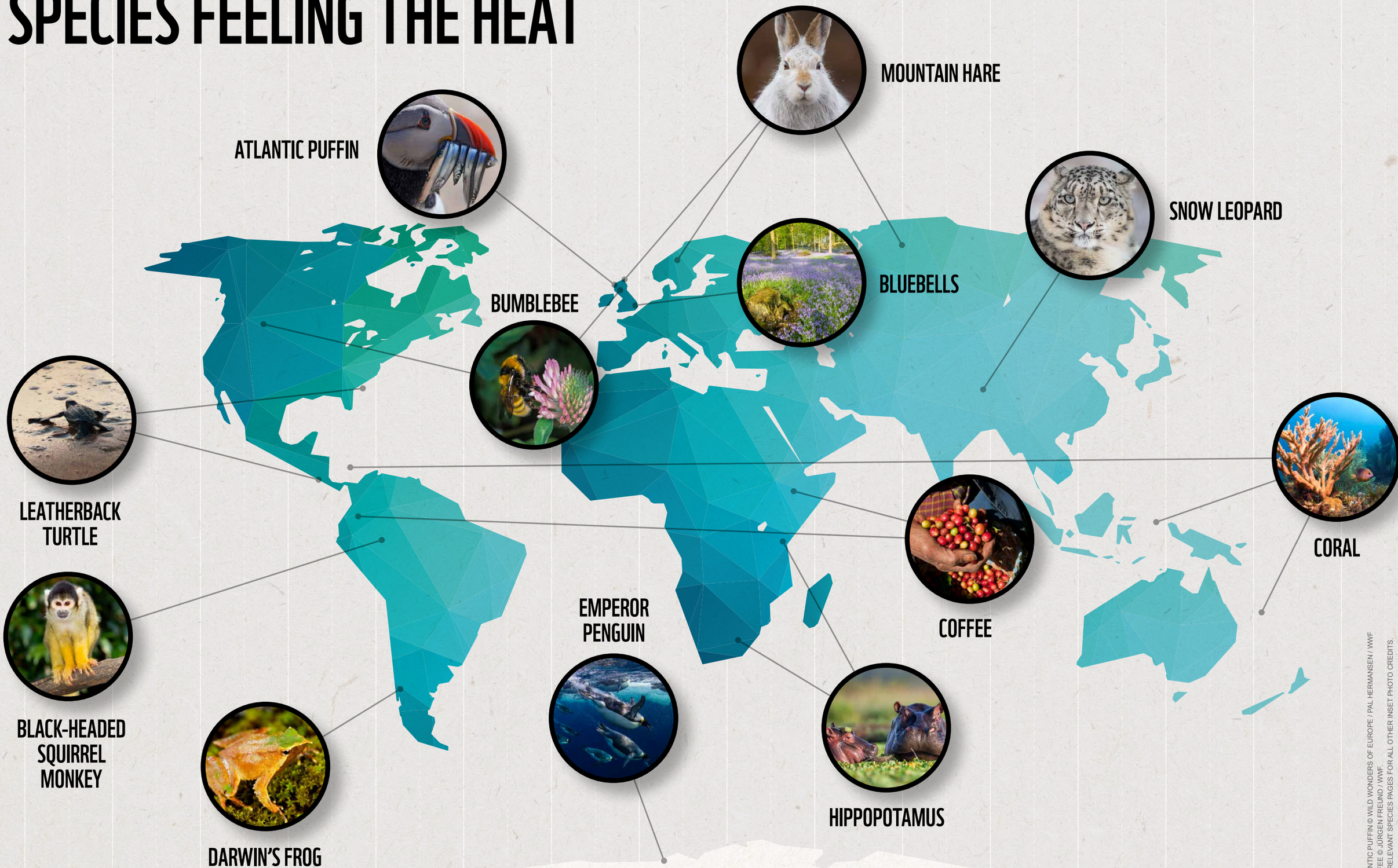
SPECIES FEELING THE HEAT



Species
Atlantic puffin
Fratercula arctica

Classification
Bird

Geographical range
North Atlantic Ocean – open sea and coastal regions for breeding, including around the UK

IUCN Red List status
Endangered – Europe
Vulnerable – global

ATLANTIC PUFFIN
TOO LATE FOR LUNCH

Sometimes called the 'clown of the sea', the Atlantic puffin may not delight bird lovers for much longer if ocean temperatures continue to rise. They lead a solitary life at sea, feeding and travelling. They return to land for a few months per year to breed. The UK provides vital nesting habitat for them in the summer.

Europe is home to over 90% of the Atlantic puffin population, but their numbers have been crashing in the last two decades.

Puffins face multiple threats. Overfishing has already severely reduced their food source. And since they are diving to catch fish, puffins are at risk of becoming entangled themselves in fishing gear.

Now climate change is driving drastic declines in puffin and other seabird numbers. Global warming leads to more severe and frequent weather events, which affects the puffins that spend most of their time at sea. High winds and heavy rainfall affect the birds' ability to dive and find food. During the breeding season, extreme weather chills the eggs while storms destroy nests with chicks.

All elements of the marine ecosystem are inter-connected, and rising sea surface temperatures disrupt the entire marine food web the birds rely on for their survival. Puffins eat a mix of small pelagic fish, such as herrings, sprats, capelins and sandeels. Sandeels eat tiny crustaceans called copepods that form dense swarms in certain places at specific times. Timing is everything, and sandeel larvae conveniently hatch close to the start of one such bloom in the spring. With plenty of food to eat, the baby sandeels can grow and become the meal of their top predators, puffins, who feed the nutritious fish to their growing chicks during nesting season.

Warmer waters trigger this food chain to be out of sync. In what scientists call a 'trophic mismatch', copepods are blooming before sandeels hatch. This results in fewer sandeels for the puffins to feed their young, causing the failure of entire colonies. Between 2000 and 2016, the mismatch between sandeels and copepods was estimated to be 19.8 days, and this will increase with higher temperatures. If we want to keep puffins and other seabird species afloat, we need to act now and limit the rise in global temperatures.

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Species
Mountain hare
Lepus timidus

Classification
Mammal

Geographical range
The UK (mainly Scotland), northern Europe, the Alps and northern Asia – at altitudes of 250-3,700m

IUCN Red List status
Near threatened – UK
Least concern – global

MOUNTAIN HARE
WRONG COAT FOR THE CLIMATE

As the UK's only true native hares, mountain hares living in the Highlands of Scotland have evolved a brilliant strategy to escape predators. In the summer, they display a brown pelage that blends in with the environment. In October, they moult and switch to a white coat that keeps them well camouflaged in the snow. Then in March, they moult again and revert back to their summer outfit. But the strategy is not working so well in a warming climate. Annual snow cover in the Scottish Highlands has declined by over 37 days on average between 1960 and 2016.

If mountain hares could adapt to the change by moulting later in the autumn and earlier in the spring they would better match the change in snow cover. So far, the evidence shows this hasn't been happening, as climate change is occurring at a faster rate than the hares can adapt. They still keep their white coat on for roughly the same amount of time in the winter.

This means the hares' camouflage is now mismatched to their environment for more than a month each year longer compared to 1960. During that time, they exhibit striking white fur against a snowless background, which leaves them more vulnerable to predators who can spot them more easily on the dark mountainside.

The mismatch is dangerous not just for hares in Scotland: it is a risk for many species that rely on seasonal changes in coat as an adaptation to avoid predators. In North America, a study showed that the weekly survival of snowshoe hares decreased by up to 14% when they were mismatched against their surroundings. Mountain hare numbers have also fallen in parts of Norway, linked to increased predation in areas with fewer snow days.

The climate change threat is not limited to a coat colour mismatch. Hares thrive in cold conditions. Warmer temperatures will push them to move higher, into smaller and more fragmented territories. Researchers who have been tracking hares in the Swiss Alps have found that their alpine habitat will reduce by around 35% by 2100. Warmer weather at a critical time of year will shrink the environment suitable for successful reproduction.

It is essential to limit further temperature increases to maintain suitable hare habitat and so that the animals get more time to develop a climate-adapted wardrobe.

Species
Bluebell
Hyacinthoides non-scripta

Classification
Plant

Geographical range
Atlantic areas of Europe including the UK, often in woodlands

IUCN Red List status
Least concern

BLUEBELLS
SPRING BLOOM OUT OF SYNC

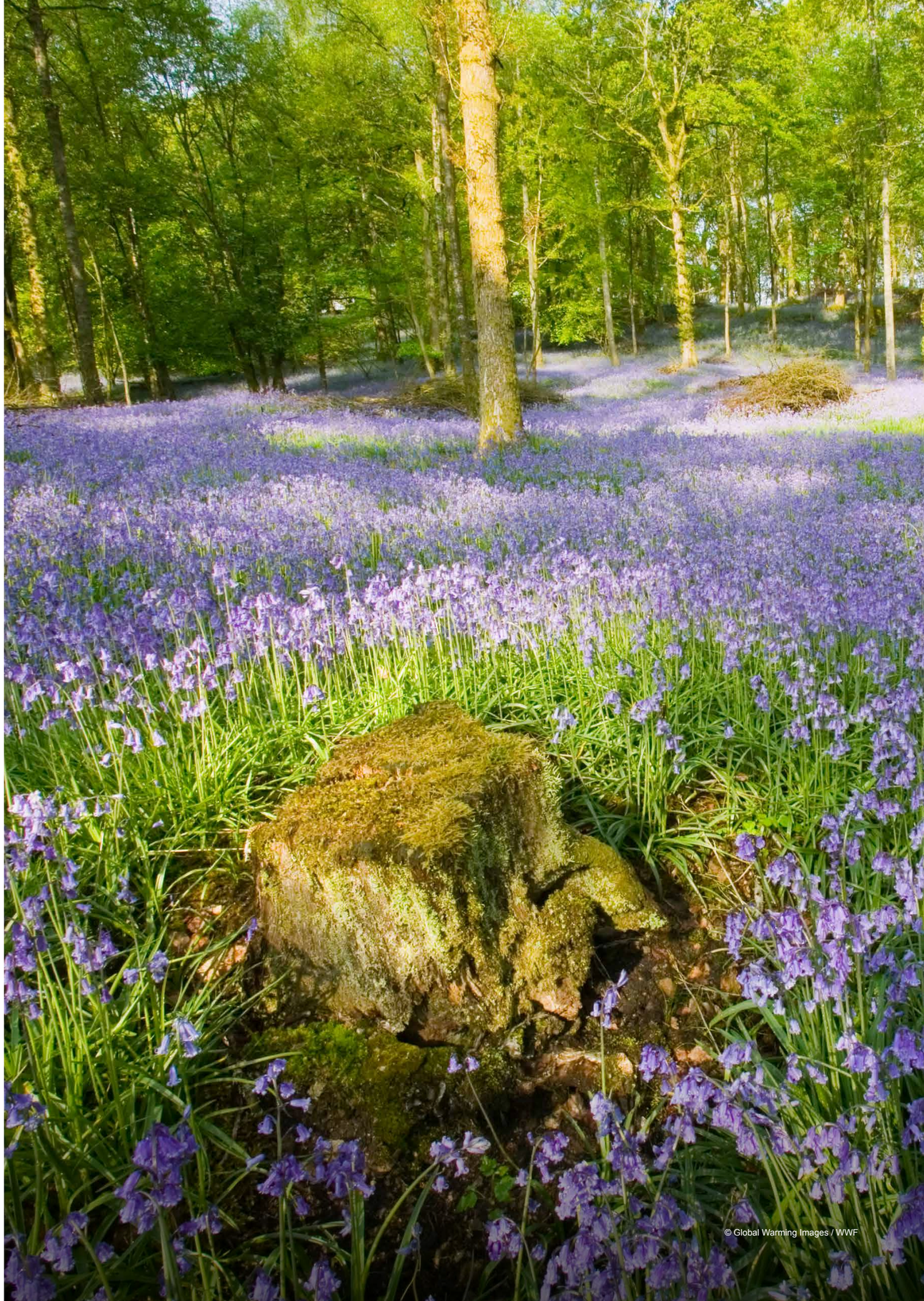
With deep blue colours and an enchanting perfume, bluebell woods in full bloom are one of most magical experiences associated with springtime in the UK. But the sight may become rarer in the future. With a warming climate, the bluebells, along with other countryside plant species, may have a hard time. Under the projection of global temperatures rising to 2°C, large parts of southern and central England are likely to be become inhospitable for bluebells.

A member of the lily family, the bluebell overwinters as a bulb and emerges in the spring to flower between mid-April and late May. Temperature controls plant development and flowering. In the spring and early summer, drought can reduce their growth. Warmer temperatures can impede germination and can shift timing of flowering to become out of sync with the seasons. A study based on 200,000 observations of seasonal cycles recorded by nature enthusiasts for the Woodland Trust revealed that the first leafing or flowering dates for bluebells and 21 other plant species across the UK were affected by warmer spring temperatures. For each 1°C temperature increase, the plants were leafing or flowering between three and eight days earlier than they used to.

Plants have an optimum time and conditions for developing leaves and flowers which give them the best chance to grow and reproduce. With warmer temperatures and drier conditions, their future may be compromised. Bluebells take advantage of the open canopy in early spring, growing and flowering before the canopy closes over as the leaves of beech, oak and other trees expand. If bluebells cannot time their growth and development to coincide with the changing seasons, they may lose out.

The native British bluebell is already under threat from pollution, the destruction of woodland habitat through urban development, and the invasion of the introduced Spanish bluebell varieties that are less colourful and fragrant than the native flowers, but more vigorous. If we do not limit the rise in global temperatures, climate change could make our beloved native bluebells only a countryside memory in parts of the UK.

PLANTS HAVE AN OPTIMUM TIME FOR DEVELOPING LEAVES AND FLOWERS.
WITH WARMER TEMPERATURES, THEIR FUTURE MAY BE COMPROMISED



IN THE LAST CENTURY THE POPULATION OF GREAT YELLOW BUMBLEBEES HAS DECLINED BY

80%

Species
Bumblebees – including the great yellow bumblebee
Bombus distinguendus

Classification
Insect

Geographical range
Bumblebees are widely distributed, mainly at higher latitudes. The great yellow bumblebee is widespread in the northern hemisphere but in the UK it is now restricted to the northern Highlands and Scottish islands

IUCN Red List status
Vulnerable

BUMBLEBEE

TOO WARM FOR THE FUZZY POLLINATORS

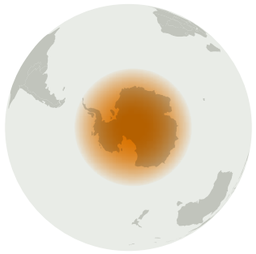
Among the most important pollinators, bumblebees can generate heat while flying and their fuzzy bodies act as a warm coat. With these special adaptations, they thrive in cold climates. But they are susceptible to overheating and a warming world is pushing them to temperatures they cannot tolerate.

A recent study of over half a million observations of 66 bumblebee species around the world, going back for more than a century, shows where the insects used to live and where they are found today – with evidence of rapid and widespread declines. The researchers discovered that the chances of spotting a bumblebee in any given area in North America have dropped by almost half from 1901-1974 to 2000-2014 and by 17% in Europe on average. Their disappearance from a region means they have either moved elsewhere or died. Bumblebees have been hit the hardest in warmer places, including Mexico and Spain, where they cannot cope with increasing temperatures. But even in relatively cool regions such as the UK, bumblebees have also been declining.

While some bumblebees have responded to the hotter temperatures by colonising cooler, more northerly regions, this has not been enough to compensate for the losses. The extent of their range expansion is far smaller than the extent of range lost, which could push some bumblebee species towards extinction.

Approximately 250 species of bumblebees exist in the world, and climate change is not the only factor driving their widespread decline. Bumblebees face multiple threats to their existence, including the destruction of habitat due to intensive agriculture and land-use changes, the spread of diseases, the use of harmful pesticides such as neonicotinoids, and the release of non-native bees for commercial pollination. For example, great yellow bumblebees used to be found throughout the UK. In the last century their population has declined by 80% because of climate change, pesticides, the loss of flower-rich meadows and the intensification of farming. They are now restricted to the northern Highlands and the islands of Scotland.

Bumblebees pollinate many types of wild plants as well as agricultural crops such as tomatoes, aubergines and blueberries. The loss of the important ecosystem services they provide threatens food security and overall biodiversity. If we do not act now to limit global temperatures, climate change could be the final straw for some bumblebee species.



Species
Emperor penguin
Aptenodytes forsteri

Classification
Bird

Geographical range
Circumpolar range, with breeding colonies located around the entire coast of Antarctica

IUCN Red List status
Near threatened

EMPEROR PENGUIN
THE SLIPPERY SLOPE TO EXTINCTION

Emperor penguins, the largest of all living penguin species, are uniquely adapted to living in the extreme conditions of Antarctica. They require stable, fast ice for at least nine months of the year as a platform to mate, incubate their eggs, raise their chicks, and replace their feathers during the annual moult. Although there is uncertainty about the magnitude of future sea ice decline, the loss of Antarctic sea ice due to rising global temperatures is now almost certain.

Emperor penguins are vulnerable to different kinds of change in sea ice. Their breeding success, and therefore the continued existence of their populations, depends on 'Goldilocks' conditions – the sea ice being just right for their needs.

The birds not only require gaps in the sea ice to access feeding grounds, but also a thick, stable platform for raising their chicks. Very extensive sea ice cover means adults must travel longer distances to reach the open water and their prey for feeding. This requires far more energy, which leads to reduced breeding success. Too little sea ice also has a dramatic impact, such as when sea ice forms late in autumn or breaks up too early in spring. At such times, the chicks have not had time to develop and acquire the waterproof plumage they need to survive in the cold Southern Ocean.

Although emperor penguins can relocate to other breeding sites, this will not protect them very far into the future, given projected decreases in sea ice. Emperor penguins are not very agile, so relocating onto land is not an easy option.

Only humans can change the fate of this iconic species.

Scientists have modelled future changes in emperor penguin populations under different climate scenarios. If greenhouse gas emissions continue rising as they are today, the total number of emperor penguins will decrease dramatically by 2100. All known colonies will decline and most will be quasi-extinct by the end of the century.

But global climate policy can help to safeguard the future of these icons on ice. If governments restrict greenhouse gas emissions now, average global temperature rises could be limited to 1.5°C, securing the future of emperor penguin populations.

THE LOSS OF ANTARCTIC SEA ICE DUE TO RISING GLOBAL TEMPERATURES IS NOW ALMOST CERTAIN

© Muhammad Osama / WWF-Pakistan

Species
Snow leopard
Panthera uncia

Classification
Mammal

Geographical range
Himalayas, Tibetan Plateau, and the mountains of central Asia, at 500m to 5,800m altitude

IUCN Red List status
Vulnerable

SNOW LEOPARD
ON THE EDGE OF THE WORLD

Highly adapted to harsh and cold conditions, snow leopards have roamed the high, remote mountains of central and south Asia for more than two million years. Currently threatened by poaching, habitat destruction and conflicts with people over livestock, it is estimated there are as few as 4,000 snow leopards left, across 12 countries.

Snow leopards are facing a major emerging threat in the form of climate change. Warming temperatures are altering the elusive felines' mountainous climates. Snow leopard habitat is projected to decline by 23% by 2070 if we don't take global action to cut greenhouse gas emissions. In countries such as Bhutan and Nepal, habitat loss will exceed 80%.

The increases in temperature and rainfall are expected to shift the tree line higher up the mountains, particularly in the Greater Himalaya region. The upward movement of the tree line drives the growth of plant species that do not provide ideal habitat and grazing for the snow leopard's prey. Furthermore, as the forest habitat expands at the expense of alpine meadows, the change might benefit other predators, better adapted to the forest than snow leopards – such as wolves and common leopards. This could result in intense competition for food and resources, with the snow leopard at risk of losing out.

Additionally, warmer conditions risk heightening other threats, such as enabling people and their livestock to move higher into the mountains, which will set the stage for increased conflict between snow leopards and humans. In some areas, people's livestock will directly compete with the leopard's prey, such as blue sheep, for grazing the remaining small pastures. As their prey is displaced, hungry snow leopards will increasingly turn to livestock, which places them at greater risk of being killed by herders.

The cascading consequences of climate change leave snow leopards in a vulnerable position. Researchers have identified three areas that account for about 35% of snow leopards' habitat in the high mountains of Asia and can act as climate refuges. To secure these resilient geographical areas and a long-term future for snow leopards, we must curb carbon emissions. And we must find ways for people and snow leopards to coexist in the ever-smaller habitats these elusive cats will rely on.

CURRENTLY THREATENED BY POACHING, HABITAT DESTRUCTION, AND CONFLICTS WITH PEOPLE OVER LIVESTOCK, IT IS ESTIMATED THERE ARE AS FEW AS

4,000

SNOW LEOPARDS LEFT, ACROSS 12 COUNTRIES

Species
Leatherback turtle
Dermochelys coriacea

Classification
Reptile

Geographical range
Wide range globally – nests on tropical sandy beaches and forages in temperate and sub-polar oceans

IUCN Red List status
Vulnerable

LEATHERBACK TURTLE
SURVIVAL IN THE HEAT OF THE SAND

Turtles and tortoises have been around for about 220 million years. They once lived with dinosaurs. Today, more than half of the 360 species of turtles and tortoises are threatened with extinction. These ancient reptiles are declining rapidly due to habitat destruction, poaching, plastic pollution, accidental capture in fishing gear, and now climate change. Six of the seven marine turtle species are threatened – and leatherback turtles are no exception.

Found in the Atlantic, Indian and Pacific oceans, leatherback turtles are the largest and deepest-diving of all living turtles. Adults can weigh more than half a tonne.

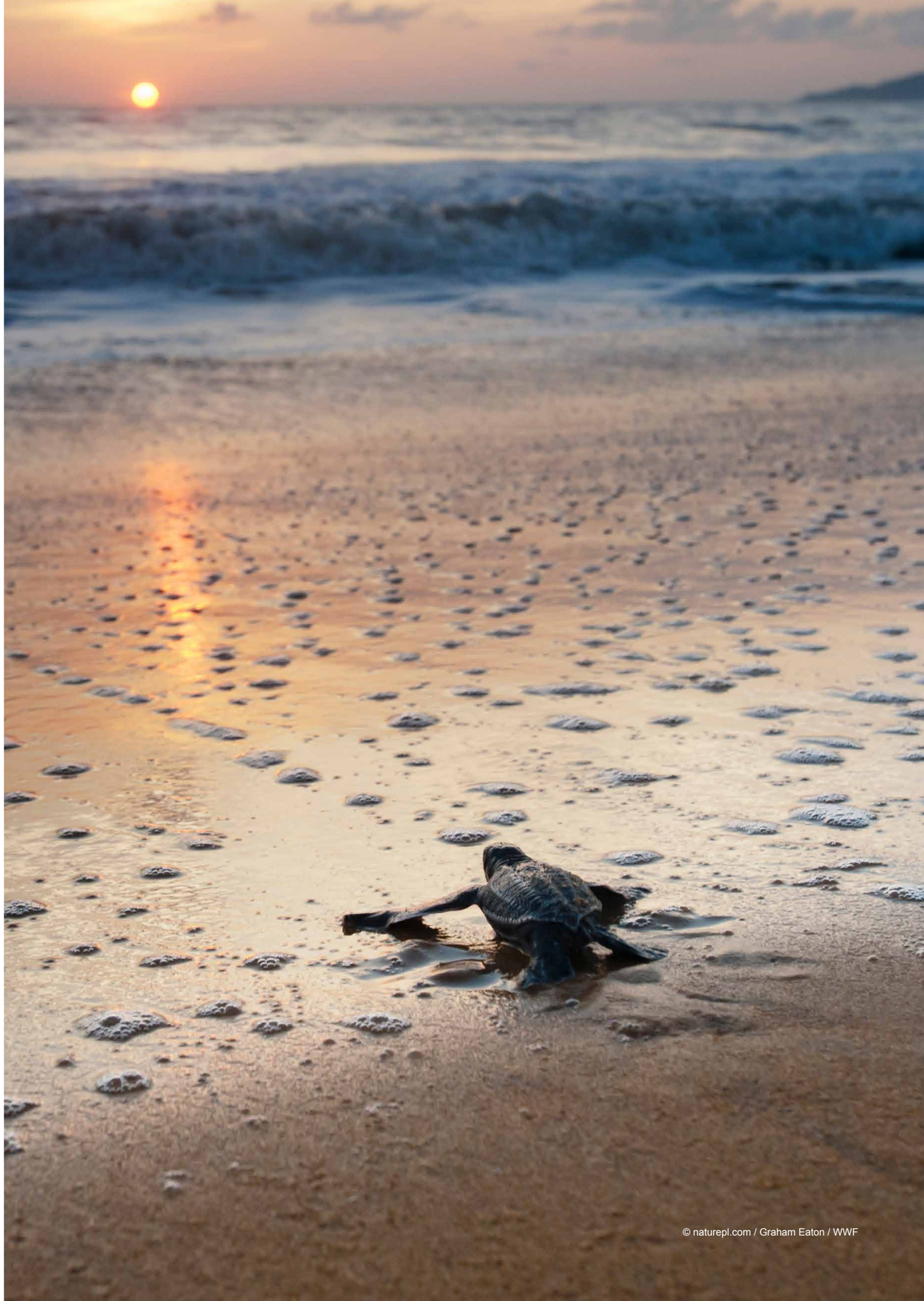
But these gentle giants are sensitive to the smallest change in temperature. The sex of a marine turtle is determined during the incubation of the egg on the nesting beach where it was laid, and the mix of males and females depends on the temperature of the sand. Hotter sand – which is consistent with global warming – leads to a disproportionately higher number of female turtles.

There is already evidence that a major nesting site in north-western Costa Rica produced 90% female leatherback hatchlings. If temperatures climb too high, things get even worse and eggs fail to hatch. This can threaten the survival of leatherbacks and other turtle populations.

Furthermore, rising sea levels, higher tides and increased storm events, which are more likely as the climate changes, wash away turtle nests and permanently destroy nesting beaches in the long term. Without anywhere to lay their eggs, the turtles cannot reproduce.

Turtles have shown extraordinary resilience through time. They have experienced climatic changes and adapted through evolution. In the future, they could once again respond to a changing climate by choosing more favourable nesting sites and adjusting their breeding time to when the weather is cooler. However, the pace of climate change is likely to be faster than turtles can adapt to, unless we act now and limit temperature rises.

THE MIX OF MALE AND FEMALE MARINE TURTLES DEPENDS ON THE TEMPERATURE OF THE SAND. HOTTER SAND LEADS TO A DISPROPORTIONATELY HIGHER NUMBER OF FEMALE TURTLES



Species
Darwin's frog, northern Darwin's frog
Rhinoderma darwinii
Rhinoderma rufum

Classification
Amphibian

Geographical range
Both species are endemic to southern Chile. They're found in leaf-litter and small streams in temperate forests

IUCN Red List status
Endangered
Critically endangered (possibly extinct)

DARWIN'S FROG
SICK WITH CLIMATE CHANGE

Named after Charles Darwin, who encountered them in 1834, Darwin's frogs are only found in the temperate Austral forests and wetlands of Chile and Argentina. They display a unique behaviour not recorded in any other amphibian species, in which the males brood the offspring in their vocal sacs.

Unfortunately, in recent years Darwin's frogs have been disappearing – in part because of the destruction of their old-growth forest homes, but also because of a deadly emerging infectious disease and climate change. Global warming is predicted to reduce their existing habitat, while new areas that might become suitable will be too far for Darwin's frogs to reach naturally.

Northern Darwin's frogs have not been seen in the wild since 1981. They are iconic examples of the global amphibian crisis, with more than 40% of all amphibian species threatened with extinction.

In addition to the loss of habitat, rising temperatures are creating favourable conditions for deadly diseases that can push more amphibians to the brink. Darwin's frogs have been exposed to the chytrid fungus (Bd), a disease that has driven the declines of at least 500 amphibian species across the world, including 90 species now presumed extinct. This is the greatest recorded loss of biodiversity attributable to a disease.

With climate change, things are predicted to get even worse. While frog species that are adapted to living in cool climates do not tolerate increased heat, the chytrid fungus does not mind the higher temperatures and can survive. The frogs face an even more unequal battle to survive in the face of the powerful pathogen.

Other diseases fare well in a warming world. In the UK, researchers demonstrated that higher temperatures facilitate the propagation of the deadly ranavirus disease that impacts common frogs.

If carbon emissions are not reduced, it is projected that disease outbreaks will become more severe and will occur over larger areas in the UK – and over extended seasons, starting as early as April and lasting until October. In the spring, ranavirus outbreaks can kill a large number of tadpoles, which eventually leads to the disappearance of entire frog populations. For every 1°C rise in temperature, the proportion of common frogs that died because of ranavirus disease rose by more than 3%.

WARM-WATER CORAL REEFS
LIFE OR DEATH AT HALF A DEGREE

Species
Tropical corals – such as the staghorn coral *Acropora cervicornis*

Classification
Coral

Geographical range
Staghorn coral is found in shallow tropical reefs, slopes, and lagoons throughout tropical seas

IUCN Red List status
Critically endangered

Warm-water tropical coral reefs support some of the most biodiverse ecosystems on the planet, providing shelter, food and spawning grounds to thousands of marine species. In the last 30 years, half of the planet's tropical coral reefs have disappeared because of pollution, overfishing and unsustainable coastal development. More recently they have been affected by ocean acidification and extreme temperatures driven by climate change, which are leading to large-scale and back-to-back coral bleaching events.

IPCC projections show that even if we limit temperature rises to 1.5°C, coral reefs will suffer significant losses of area and local extinctions – with a further decline of 70-90% by 2050. At 2°C, more than 99% of corals will be lost.

Named for their antler-like appearance, and thought to have evolved 55 to 65 million years ago, staghorn corals are particularly sensitive to warming conditions. They account for approximately 160 species worldwide.

Staghorn corals, like other stony corals, have a symbiotic relationship with microscopic algae called zooxanthellae. Corals and their algae partners are extremely vulnerable to small temperature changes. Warming of just 1°C is enough to disrupt their delicate relationship. The algae begin producing toxic, reactive oxygen molecules during photosynthesis. To survive, the corals expel the zooxanthellae from their tissues. The algae give corals their colourful appearance and once they are gone the corals appear white, or 'bleached'.

If the water temperature returns to normal within a few weeks, bleached corals can regain their algae partners and recover. But each bleaching event weakens the overall health of the coral, and if high temperatures persist,or happen too frequently, the corals die.

When coral is lost, many finfish and shellfish species disappear as well. Millions of people who depend on reef fish and ecotourism for food security and income are affected.

Researchers have identified 50 resilient coral reef areas in seven countries that have the best chance of surviving climate change and may support overall coral regeneration in the future. However, the survival of these last refuges is entirely dependent on the goals of the Paris Agreement being met. They will not be spared if warming goes beyond the 1.5°C limit.

Species
Hippopotamus
Hippopotamus amphibius

Classification
Mammal

Geographical range
Sub-Saharan Africa, wetland habitats

IUCN Red List status
Vulnerable

HIPPOPOTAMUS
AN ECOSYSTEM ENGINEER OUT OF WATER

Found in rivers, lakes and wetlands in many parts of sub-Saharan Africa, common hippopotamus populations have been declining in the last few decades. Of the 36 countries where the hippo is known to occur, 20 have decreasing populations, seven have populations of unknown status, and three have experienced recent extinctions.

Hippos are known as ecosystem engineers, exerting a profound influence on the freshwater systems they depend on for their survival. Today they face multiple threats to their existence, including habitat destruction, poaching for meat and ivory, and persecution due to conflicts with people.

In Zimbabwe for example, human settlements and agricultural activities have encroached into the wetlands, lakes, rivers and ponds that hippos use. The construction of dams to meet increased water demands has also changed the structure of river systems, affecting the availability of shallow pools. At night, hippos graze on open spaces and can find themselves on agricultural lands. The increased proximity between people and hippos often results in conflicts.

Like many other African wildlife species, hippos are now threatened even further by climate change. Rising temperatures, prolonged periods of drought, erratic rainfall and high surface evapotranspiration reduce water levels and quality. High temperatures pose a threat to hippos. As large, primarily aquatic animals they are not well adapted to high temperatures out of water, making them vulnerable to drought conditions that can cause severe dehydration and even death.

Climate change is likely to deepen conflicts between people and hippos as the competition for scarcer water resources intensifies, or when unpredictable weather patterns bring the animals and humans closer. Unusually heavy rains in 2019 caused Kenya's Lake Naivasha to swell and grow to its largest size in nearly a century, flooding the land hippos rely on for grazing. The animals were pushed closer to the farms and houses surrounding the lake and found themselves in the same shallow waters that fishermen use, sparking deadly conflict.

Throughout the hippos' range, climate change is adding stress to freshwater systems that are already vulnerable because of deforestation and water-intensive agriculture. Since 1993, Tanzania's Great Ruaha River has ceased to flow during the dry season, affecting hippos and other species. Other rivers experience a similar pattern, and their resilience may not last for much longer with the combined impacts of accelerating climate change and continued water removal.

Species
Arabica coffee
Coffea arabica

Classification
Plant

Geographical range
Native to Ethiopia and South Sudan at altitudes of 900m-2,300m, domestic species are widely cultivated in the tropics

IUCN Red List status
Endangered

ARABICA COFFEE
THE LAST SHOT

Millions of people love waking up to the smell of freshly brewed coffee, but the true wake-up call is the urgent need to tackle climate change.

Coffee producers grow two main species, arabica and robusta, with the former accounting for about 60% of global production. Arabica thrives at average annual temperatures of between 18°C and 22°C and can tolerate temperatures up to 24°C. But the species does not cope well with warming conditions, low or unpredictable rainfall, or extreme events.

The wild species *Coffea arabica* in Ethiopia is threatened by climate change and is projected to decline by 50-80% by 2080. This could lead to genetic diversity loss for this important crop.

Exposure to elevated temperatures damages coffee plants, which become more vulnerable to pests and diseases that are thriving under a warming climate. For example, higher temperatures, intense rain and persistent humidity create a welcoming environment for the coffee leaf rust fungus that reduces the ability of plants to photosynthesize and produce coffee berries.

A study projects that by 2050, the total amount of land suitable for arabica coffee production in Latin America will fall by up to 88%. Coffee is one of the world's most traded products and those losses will affect the livelihoods of 100 million people.

Cooler, high-elevation locations are expected to become more suitable for coffee production in the future. However, this does not guarantee that coffee plants will do well there because they not only need the right climate but also pollinating insects. The problem is that climate change has an impact on the geographical distribution of bees. As a result, they might not be in the right place to pollinate coffee. The average number of bee species in areas suitable for coffee is projected to drop by as much as 18% by 2050.

The loss of pollination services is bad news for coffee production and agriculture in general, but there is a glimmer of hope. All areas that will be suitable for coffee are projected to retain at least five bee species. So if we can limit the increase in global temperatures to less than 1.5°C, we may have a last shot at saving the coffee culture that supports livelihoods across the globe, and maintains the vital social relationships created by the shared enjoyment of a cup of coffee.

Species
Black-headed squirrel monkey
Saimiri vanzolinii

Classification
Mammal

Geographical range
Endemic to a small range in the Brazilian Amazon, exclusively in flooded forests

IUCN Red List status
Endangered

BLACK-HEADED SQUIRREL MONKEY

TINY HOME AT RISK

The Brazilian Amazon has a high diversity of primate species that are found nowhere else on Earth. Primates play a critical role in maintaining biodiversity: by spreading the seeds of trees, they contribute to the growth of forests, helping with carbon storage and the regulation of global temperatures. But warming temperatures endanger the very existence of several species.

Climate change is predicted to make the homes of many Amazon primates inhospitable. In the face of this new reality, they will have to adapt or move to more suitable areas. In many cases, there might be little other habitat available – a situation often made worse by deforestation. Primates face challenges as they try to disperse, encountering barriers such as rivers and roads or discovering deforestation has left them isolated from the nearest habitat. If they are not able to find new homes, they will be forced to remain in deteriorating habitats and will be exposed to temperature and rainfall conditions for which they are not best adapted. If they cannot acclimatise, they face a grim future and eventually local extinction.

More than any other species, the black-headed squirrel monkey represents the struggles of Amazon primates in the face of climate change. It has the smallest known geographical distribution of all neotropical primates, residing in just one location within an area of 870 sq km in the Mamirauá Sustainable Development Reserve in Brazil.

The monkeys live in a floodplain forested ecosystem, called 'várzea', which is seasonally flooded by nutrient-rich white-water rivers. The monkeys' home is expected to be reduced by almost 100% due to a combination of increased water levels, increased temperatures and extreme flooding events driven by climate change.

Because the whole population live in the same floodplain, a single extreme seasonal flooding event could wipe out the entire range of the species. Habitat loss is expected to result in a decline of at least 50% of this monkey's population.

The future of the black-headed squirrel monkey and other Amazon primates depends on protecting wildlife corridors that allow animals to find new homes, but also on urgent climate action to limit temperature increases that will give primates time to adapt to changing environments.

ON THE FRONTLINE OF THE CLIMATE CRISIS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VANUA LEVU - FIJI

The island of Vanua Levu in Fiji is on the front line of climate change. Over the last 25 years, there has been a 6mm increase in sea levels here every year, despite this country being one of the lowest contributors to carbon emissions in the world. As the shoreline retreats further inland, homes and farmland are being destroyed and villagers are being forced to relocate.

Josateki Manatua remembers when rising sea levels first started to affect his village of Raviravi. The water gradually came closer and closer to buildings, engulfing trees and flooding farmland. It even overtook the local cemetery.

"About 30 years ago, we noticed the changes in our shoreline. The burial ground for the Tongans is now under water, as well as what's left of the big trees that used to grow on our shoreline. We had a village cooperative store near the burial ground, but now it's gone due to sea-level rise."

CHITTAGONG - BANGLADESH

Home to over five million people, the city of Chittagong in Bangladesh is highly vulnerable to the impacts of climate change. Severe flooding from tidal surges can affect the city as often as twice a day, having devastating impacts on the people living there. Climate change is predicted to lead to more extreme flooding in Bangladesh due to cyclonic storm surges and rising sea levels. Many communities could be left completely under water.

Jashim Salam is a photographer who lives in Chittagong. He lives in his parents' old home with his wife and daughter, six older brothers and their families. Jashim's work includes documenting the impacts flooding has on his community.

"I used to live on the ground floor but my house flooded every year. I tried to block my entrance but this wasn't enough. I didn't want to leave my parents' house – my house! I didn't think this flooding would happen every year, but still it keeps happening."


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NORTHERN TANZANIA

In the rangelands of Tanzania, many Maasai people depend on raising livestock for their livelihoods. Due to increasing livestock numbers, land conversion for grazing and the impacts of climate change these communities are facing a shortage of grass for their livestock to eat, with extended dry seasons leaving the ground bare.

Yohana Lesirkon and his fellow community members realised they needed to manage their pastures in a different way. He joined African People and Wildlife's Sustainable Rangelands Initiative, supported by WWF, which helps teams of community rangeland monitors to collect data on their grazing areas electronically. This allows them to access, visualise and share information about pasture quality in real time.

"We are seeing prolonged periods of drought, less rainfall and higher temperatures compared to previous years. This has been a big problem for me. Some of my livestock have died. I am hopeful that this project will help to educate future generations and prepare them for the challenges of climate change."

PORT HEIDEN - UNITED STATES

Along with many other coastal villages in Alaska, Port Heiden has been forced to adapt rapidly to the effects of climate change. Due to its exposed position on the Alaskan peninsula, the village is often hit with powerful storms which have left the coastline severely eroded. In 1981, villagers began relocating from their former town site, called Meshik, to higher ground.

Adrianne Christensen works for the village of Port Heiden and her family has lived in the area for generations. She feels that many people don't understand that for her community, climate change is very real. For her, it's not a question of just moving to the next town.


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"We don't want to move away. This is our place. And our culture is really tied to this land and to our food and so that's going to be really hard to hold onto. We're doing everything we can to keep that alive."

COLOMBIAN AMAZON

The Amazon is at the heart of global climate concerns. Not only does the destruction of rainforests add to carbon dioxide in the atmosphere, it creates a 'positive feedback loop' – where increased deforestation causes a rise in temperatures which in turn can bring about a drying of tropical forests and an increase in the risk of forest fires.

Marisela Silva Parra lives in Calamar, on the northernmost edge of the Colombian Amazon. She is a member of a community group called Los Exploradores (The Explorers) which is working to document, protect and restore the forest's natural resources, as well as coordinating local efforts with those of other organisations working throughout the Amazon.

"We know we need to put a stop to the deforestation, preserve what we have and reforest parts that were chopped down. The most difficult thing is the powerlessness, not being able to make people aware that the reality is bad, that we are harming not only ourselves, as individuals, but everyone else."


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HELPING NATURE'S CLIMATE HEROES

In the UK and around the world, nature can be our greatest ally in the fight against the climate crisis. A key focus for WWF is projects that demonstrate how nature-based solutions benefit people and biodiversity.

We're also helping to build momentum among businesses, governments and the public to achieve climate action and limit average global temperature rises to 1.5°C. In the UK, we're demanding a strong commitment from government to cut emissions, including from the agriculture, business and finance sectors, as well as boosting the investments needed to get us on track to meet our climate and nature targets.

Here are some of the ways we're working to help.

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PROTECTING COLOMBIA'S DIVERSE LANDSCAPE

Colombia's forests store the equivalent of 26 billion tonnes of carbon dioxide, an amount which is around one third of the entire carbon dioxide emissions from the UK since the Industrial Revolution. Working with the Colombian National Parks Agency and the Ministry of Environment, we support the Heritage Colombia programme, which will ensure the conservation of 250,000 sq km of natural landscapes by 2030 through substantially increasing long-term financial support for Colombia's national parks.

Through the Trillion Trees initiative, we're supporting efforts to raise US$200 million in new funding, including a commitment from the government of Colombia to allocate 5% of its carbon tax revenues to Heritage Colombia. The programme will work in landscapes linking protected areas to ensure local people benefit from sustainable forest use.

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PLANTING HOPE IN WALES

Seagrass is a flowering marine plant that grows in large underwater meadows. It can absorb carbon at 35 times the rate of tropical rainforests, locking it away in sediments. One hectare of seagrass can support up to 80,000 fish and 100 million invertebrates. It also benefits water quality and helps stabilise the shoreline. But the UK has lost up to 90% of its seagrass due to pollution, coastal development, fisheries activities and damage from boat propellers and chain moorings.

We have helped plant two hectares of seagrass in Pembrokeshire and we aim to plant 20 hectares in coastal areas around the UK by 2026. More than 2,000 volunteers, including local schoolchildren, helped to plant more than one million seeds. We hope our efforts will pave the way for large-scale seagrass restoration elsewhere.

PROTECTING THE KEY TO A HEALTHY SOUTHERN OCEAN

Krill are the centre of the food web in the Southern Ocean. These small, shrimp-like crustaceans support populations of penguins, seals, whales and other marine life. They also play an important climate role as they feed on phytoplankton, which absorb carbon dioxide. They then excrete the carbon through their faecal pellets and by shedding their exoskeletons, which sink to the sea floor. But these climate heroes are victims of the combined effects of an expanding fishery, ocean warming and the loss of sea ice.

We're pushing for a network of effectively managed marine protected areas surrounding Antarctica, and we're supporting research to identify potential refuges for krill in the area.

We helped to develop KRILLBASE, which compiles information about krill to help understand their distribution and abundance throughout the Southern Ocean. We also back the sustainable management of the krill fishery through the Commission for the Conservation of Antarctic Marine Living Resources.

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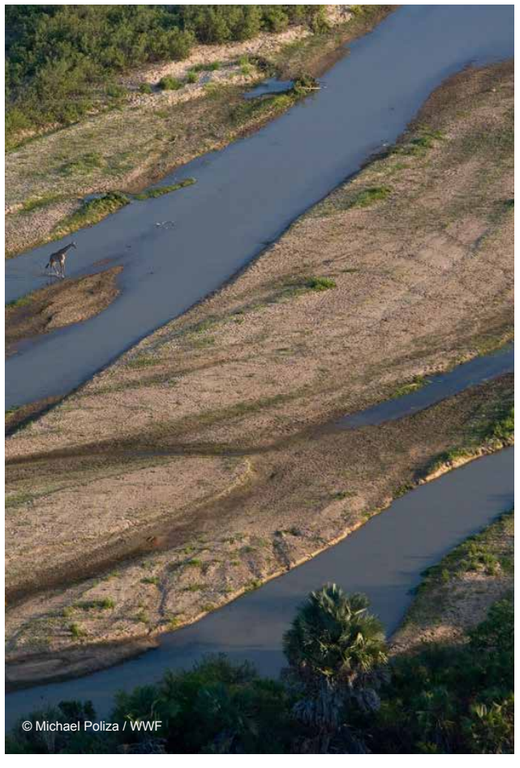
RESTORING WOODLANDS FOR WILDLIFE AND PEOPLE

Tanzania's Miombo woodlands are a biodiversity hotspot – they're home to elephants, rhinos, lions, giraffes and many other species. Such woodlands cover around 3.6 million sq km across southern and eastern Africa, making them perhaps the world's most extensive dry forests. They support the livelihoods of millions of people thanks to the goods and services they provide – such as wood, thatch, fuel and medicines. And their soils and vegetation sequester large amounts of carbon. But the woodlands are vanishing rapidly due to unsustainable agricultural practices, infrastructure development and unmanaged burning.

We're working with communities to help strengthen forestry governance, which will lead to improved management and the FSC certification of timber. We're also supporting efforts to clamp down on the illegal timber trade. This means more income for local communities, which can fund development activities such as maternal health and education support. With Trillion Trees, we have supported Tanzania's government to commit to restoring 52,000 sq km of land by 2030. This will remove 2.4 billion tonnes of carbon dioxide from the atmosphere.



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ACTION FOR COP26

Climate change is already having measurable impacts on people and nature around the world. With the future of our survival in the balance, 2021 must be a turning point. While we can't stop warming in its tracks, we can limit how much warmer our planet gets through rapid and deep cuts to fossil fuel use and by protecting and restoring nature.

The climate and nature crises are two sides of the same coin. By protecting and restoring nature, transforming our agricultural systems, and rethinking the way we use our land, we can tackle these twin crises, limit warming, and create better lives for future generations. As the UK prepares to host COP26, where world leaders will decide the course of action for our planet, we must seize this chance to build a greener, fairer future – one with nature at its heart.

At WWF, we're calling on the UK government to:

KEEP 1.5°C ON THE TABLE

Current commitments from governments and businesses would see the world warm by more than 2°C. As this report shows, the difference between 1.5°C and 2°C of warming – for people and for wildlife – is stark. As COP26 hosts, the UK government must ensure the global ambition to limit warming to 1.5°C is maintained.

- **Urgently publish a detailed action plan, showing step by step how we will decarbonise each sector of the UK, and get to work immediately.**
  Delivering net zero by 2050 doesn't mean waiting until 2049 to act, or even until 2025. What we do in the next decade, starting right now, is vital. By publishing a detailed, binding Long-Term Strategy that delivers net zero by 2050 at the absolute latest, we can raise global ambition.

- **Ensure investments from the finance sector are flowing towards projects needed to create a greener future, and away from the dirty industries harming our planet.**
  This should be done by committing to develop the world's first finance sector that aligns with the 1.5°C goal of the Paris Agreement. All companies that are already signed up to 1.5°C targets with the Science Based Target initiative (SBTi) should widely publicise it and help recruit others to sign up.

- **Make sure public money is spent on building towards the greener, cleaner future we all want.**
  This must include introducing a 'net zero test' requiring the Treasury to measure all future recovery spending plans against the UK's climate and environment commitments.


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MAKE NATURE OUR CLIMATE HERO

Nature can be one of our greatest allies in the fight against the climate crisis. We must champion and embrace nature's vital role in helping to deliver a 1.5°C world. The UK government must use its leadership role at COP26 to put land use, agriculture and nature-based solutions at the forefront of global plans to address emissions and tackle the climate crisis.

- **Get the destruction of nature out of the products on our shelves.**
  The UK government must pass world-leading new laws at home and lead an international coalition that rids our supply chains of products that cause deforestation and land conversion. This includes protecting critical places like the Amazon.

- **Support and invest in nature's recovery.**
  In support of government, global business and financial institutions should take bold action by joining restoration, rehabilitation and zero-conversion plans in key deforestation landscapes. Companies should also act to halve their environmental footprint by 2030, eliminate deforestation and conversion from their supply chains, and invest in nature-based solutions.

- **Request countries to include land use, agriculture and nature-based solutions in their national climate plans.**
  As countries around the world upgrade their national climate plans and increase their ambition, the UK government must introduce a clear request to ensure new plans maximise the potential of nature to be a climate hero.

GLOSSARY, TERMS AND REFERENCES

Conference of the Parties (COP)
The annual meeting of the supreme decision-making body of the UNFCCC; the 26th annual summit will be held in Glasgow in November 2021, giving it the name COP26.

Intergovernmental Panel on Climate Change (IPCC)
The UN body that assesses the science and knowledge related to climate change.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)
An independent body to strengthen the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity.

International Union for Conservation of Nature (IUCN)
Combines the efforts of its 1,400 government and civil society organisation members (including WWF) and 18,000 experts to conserve nature and accelerate sustainable development.

IUCN Red List of Threatened Species™
The world's most comprehensive information source on the extinction risk of animals, fungi and plants. Assessors place species into one of the IUCN Red List Categories, based on a series of assessment criteria.

Nationally determined contributions (NDCs)
Paris Agreement pledges by countries to reduce greenhouse gas emissions and adapt to the impacts of climate change. Current NDCs are typically for 2030.

Nature-based solutions
Defined by IUCN as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits"

Niche
The combination of factors such as temperature and precipitation that determines where a species can survive, feed and breed.

Paris Agreement
A legally binding international treaty on climate change adopted at COP21 in Paris, the goal of which is to limit global warming to well below 2°C and preferably to 1.5°C compared to pre-industrial levels.

Pre-industrial levels
The period 1850–1900 is often used to approximate pre-industrial global mean surface temperature as the reference for global warming targets such as 1.5°C.

Trophic mismatch
The lack of synchrony between food and consumer due to the availability of food shifting in response to global warming.

United Nations Framework Convention on Climate Change (UNFCCC)
The international multilateral environmental treaty that addresses climate change.

Advani, N. K. (2014) 'WWF Wildlife and Climate Change Series: Snow leopard', World Wildlife Fund, Washington, DC.

Azat, C. et al. (2021) 'A flagship for Austral temperate forest conservation: an action plan for Darwin's frogs brings key stakeholders together', Oryx. 2020/07/17. Cambridge University Press, 55(3), pp. 356–363. doi: https://doi.org/10.1017/S0030605319001236

Birkeland, C. (2015) 'Coral reefs in the anthropocene', Coral Reefs in the Anthropocene, pp. 1–271. doi: 10.1007/978-94-017-7249-5.

Bongase, E. D. (2017) 'Impacts of climate change on global coffee production industry: review', African Journal of Agricultural Research, 12(19), pp. 1607–1611. doi: https://doi.org/10.5897/AJAR2017.12147

Burns, F. et al. (2020) 'The state of the UK's birds 2020', The RSPB, BTO, WWT, DAERA, JNCC, NatureScot, NE and NRW, Sandy, Bedfordshire.

Burthe, S. J. et al. (2014) 'Assessing the vulnerability of the marine bird community in the western North Sea to climate change and other anthropogenic impacts', Marine Ecology Progress Series. Inter-Research Science Center, 507, pp. 277–295. doi: https://doi.org/10.3354/meps10849

Ceballos, G., Ehrlich, P. R. and Raven, P. H. (2020) 'Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction', Proceedings of the National Academy of Sciences, 117(24), pp. 13596–13602. doi: https://doi.org/10.1073/pnas.1922686117

Climate Action Tracker – Warming Projections Global Update (May 2021) https://climateactiontracker.org/publications/global-update-climate-summit-momentum/

Cordier, J. M. et al. (2020) 'Climate change threatens micro-endemic amphibians of an important South American high-altitude center of endemism', Amphibia-Reptilia. Leiden, The Netherlands: Brill, 41(2), pp. 233–243. doi: https://doi.org/10.1163/15685381-20191235

Daunt, F. et al. (2017) 'Seabirds', Marine Climate Change Impacts Partnership: Science Review, (July), pp. 42–46. doi: https://doi.org/10.14465/2017.arc10.004-seb

Davis, A. P. et al. (2012) 'The impact of climate change on indigenous arabica coffee (Coffea arabica): predicting future trends and identifying priorities', PLoS One, 7(11), p. e47981. doi: https://doi.org/0.1371/journal.pone.0047981

Davis, A. P. et al. (2021) 'Arabica-like flavour in a heat-tolerant wild coffee species', Nature Plants. Springer US, 7(April), pp. 413–418. doi: https://doi.org/10.1038/s41477-021-00891-4

Durant, J. M., Anker-Nilssen, T. and Stenseth, N. C. (2003) 'Trophic interactions under climate fluctuations: the Atlantic puffin as an example', Proceedings of the Royal Society B: Biological Sciences. Royal Society, 270(1523), pp. 1461–1466. doi: https://doi.org/10.1098/rspb.2003.2397

Farrington, J. D. and Li, J. (2016) 'Chapter 8 - Climate change impacts on snow leopard range', in McCarthy, T. and Mallon, D. B. T.-S. L. (eds) Snow leopards. Academic Press, pp. 85–95. doi: https://doi.org/10.1016/B978-0-12-802213-9.00008-0

Folden, W. B. and Stuart, S. N. (2009) Species and climate change: more than just the polar bear. Gland, Switzerland.

Forrest, J. L. et al. (2012) 'Conservation and climate change: assessing the vulnerability of snow leopard habitat to treeline shift in the Himalaya', Biological Conservation, 150(1), pp. 129–135. doi: https://doi.org/10.1016/j.biocon.2012.03.001

Fox, N. and Jönsson, A. M. (2019) 'Climate effects on the onset of flowering in the United Kingdom', Environmental Sciences Europe, 31(1), p. 89. doi: https://royalsocietypublishing.org/doi/10.1098/rspb.2003.2397

Fretwell, P. T. and Trathan, P. N. (2019) 'Emperors on thin ice: three years of breeding failure at Halley Bay', Antarctic Science. 2019/04/25. Cambridge University Press, 31(3), pp. 133–138. doi: https://doi.org/10.1017/S0954102019000099

Imbach, P. et al. (2017) 'Coupling of pollination services and coffee suitability under climate change', PNAS, 114(39), pp. 10438–10442. doi: https://doi.org/10.1073/pnas.1617940114

IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. In Press. https://www.ipcc.ch/sr15/

IPCC, 2019: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. In press. https://www.ipcc.ch/srocc/

Jenouvrier, S. et al. (2020) 'The Paris Agreement objectives will likely halt future declines of emperor penguins', Global Change Biology. John Wiley & Sons, Ltd, 26(3), pp. 1170–1184. doi: https://doi.org/10.1111/gcb.14864

Jensen, M. P. et al. (2018) 'Environmental warming and feminization of one of the largest sea turtle populations in the world', Current Biology. Elsevier Ltd., 28(1), pp. P154-159.E4. doi: https://doi.org/10.1016/j.cub.2017.11.057

Kanga, E. M. et al. (2011) 'Population trend and distribution of the vulnerable common hippopotamus Hippopotamus amphibius in the Mara Region of Kenya', Oryx. 2011/02/01. Cambridge University Press, 45(1), pp. 20–27. doi: https://doi.org/10.1017/S0030605310000931

Kerr, J. T. et al. (2015) 'Climate change impacts on bumblebees converge across continents', Science, 349(6244), pp. 177–180. doi: https://doi.org/10.1126/science.aaa7031

Hayhow, D. B. et al. (2019) 'The State of Nature 2019', The RSPB, BTO, WWT, DAERA, JNCC, NatureScot, NE and NRW, Sandy, Bedfordshire.

IUCN (2009) 'Leatherback Turtles and Climate Change: Turtle-y Exposed to Climate Change', The IUCN Red List of Threatened Species.

Li, J. et al. (2016) 'Climate refugia of snow leopards in High Asia', Biological Conservation, 203, pp. 188–196. doi: https://doi.org/10.1016/j.biocon.2016.09.026

MCCIP (2018) 'Climate change and marine conservation: Sandeels and their availability as seabird prey' (Eds. Wright P, Regnier T, Eerkes- Medrano D and Gibb F) MCCIP, Lowestoft.

MCCIP (2020) 'Marine Climate Change Impacts: Marine Climate Change Impacts Report Card 2020' (Stoker, B., Turrell, W. R. , Robinson, K. A., Howes, E. L., Buckley P., Maltby, K. and Matear L., eds.) Summary Report, MCCIP, Lowestoft, 28pp. doi: https://doi.org/10.14465/2020.arc00.000-000

Natural England and RSPB (2014) 'Climate Change Adaptation Manual'
Miller-Struttmann, N. E. et al. (2015) 'Functional mismatch in a bumble bee pollination mutualism under climate change', Science, 349(6255), pp. 1541–1544. doi: https://doi.org/10.1126/science.aab0868

Mitchell, I. et al. (2020) 'Impacts of climate change on seabirds , relevant to the coastal and marine environment around the UK', Marine Climate Change Impacts Partnership: Science Review, pp. 382–399. doi: https://doi.org/10.14465/2020.arc17.sbi

Neely, W. J. et al. (2020) 'Synergistic effects of warming and disease linked to high mortality in cool-adapted terrestrial frogs', Biological Conservation, 245, p. 108521. doi: https://doi.org/10.1016/j.biocon.2020.108521

Paim, F. P. et al. (2019) 'Long-term population monitoring of the threatened and endemic black-headed squirrel monkey (Saimiri vanzolinii) shows the importance of protected areas for primate conservation in Amazonia', American Journal of Primatology. John Wiley & Sons, Ltd, 81(e22988), pp. 1–10. doi: https://doi.org/10.1002/ajp.22988

Pedersen, S., Odden, M. and Pedersen HC (2017) 'Climate change induced molting mismatch? Mountain hare abundance reduced by duration of snow cover and predator abundance', Ecosphere, 8(March), pp. 1–8. doi: https://doi.org/10.1002/ecs2.1722

Price, S. J. et al. (2019) 'Effects of historic and projected climate change on the range and impacts of an emerging wildlife disease', Global Change Biology. John Wiley & Sons, Ltd, 25(8), pp. 2648–2660. doi: https://doi.org/10.1111/gcb.14651

Rasmont, P. et al. (2015) 'Climatic risk and distribution atlas of European bumblebees', BioRisk. Pensoft Publishers, 10, pp. 1–236. Available at: https://doi.org/10.3897/biorisk.10.4749

Ratnayake, H. U. et al. (2019) 'Forecasting wildlife die-offs from extreme heat events', Animal Conservation, 22(4), pp. 386-395. doi: https://doi.org/10.1111/acv.12476

Régnier, T., Gibb, F. M. and Wright, P. J. (2019) 'Understanding temperature effects on recruitment in the context of trophic mismatch', Scientific Reports, 9(15179), pp. 1–13. doi: https://doi.org/10.1038/s41598-019-51296-5

Rehnus, M. et al. (2018) 'Alpine glacial relict species losing out to climate change: the case of the fragmented mountain hare population (Lepus timidus) in the Alps', Global Change Biology. John Wiley & Sons, Ltd, 24(7), pp. 3236–3253. doi: https://doi.org/10.1111/gcb.14087

Sales, L. et al. (2020) 'Multiple dimensions of climate change on the distribution of Amazon primates', Perspectives in Ecology and Conservation, 18(2), pp. 83–90. doi: https://doi.org/10.1016/j.pecon.2020.03.001

Santidrián Tomillo, P. et al. (2012) 'Climate driven egg and hatchling mortality threatens survival of Eastern Pacific leatherback turtles', PLoS One. Public Library of Science, 7(5), p. e37602. Available at: https://doi.org/10.1371/journal.pone.0037602

Santidrián Tomillo, P. et al. (2014) 'High beach temperatures increased female-biased primary sex ratios but reduced output of female hatchlings in the leatherback turtle', Biological Conservation, 176, pp. 71–79. doi: https://doi.org/10.1016/j.biocon.2014.05.011

Santidrián Tomillo, P. et al. (2015) 'Global analysis of the effect of local climate on the hatchling output of leatherback turtles', Scientific Reports, 5(16789), pp. 1–12. doi: https://doi.org/10.1038/srep16789

Santidrián Tomillo, P. et al. (2017) 'High and variable mortality of leatherback turtles reveal possible anthropogenic impacts', Ecology. John Wiley & Sons, Ltd, 98(8), pp. 2170–2179. doi: https://doi.org/10.1002/ecy.1909

Sharma, R. K. and Singh, R. (2020) 'Over 100 Years of Snow Leopard Research: A Spatially Explicit Review of the State of Knowledge in the Snow Leopard Range', WWF, Gland, Switzerland.

Sindorf, N., Forrest, J., Arakwiye, B. (2014) 'Guardians of the Headwaters: Snow Leopards, Water Provision, and Climate Vulnerability: Maps and Analysis' produced by WWF's Asia High Mountains project with support from the United States Agency for International Development (USAID).

Soroye, P., Newbold, T. and Kerr, J. (2020) 'Climate change contributes to widespread declines among bumble bees across continents', Science, 367(6478), pp. 685–688. doi: https://doi.org/10.1126/science.aax8591

Soto-Azat, C. et al. (2013) 'The population decline and extinction of Darwin's frogs', PLoS One. Public Library of Science, 8(6), p. e66957. Available at: https://doi.org/10.1371/journal.pone.0066957

Stanford, C. B. et al. (2020) 'Turtles and tortoises are in trouble', Current Biology, 30(12), pp. R721–R735. doi: https://doi.org/10.1016/j.cub.2020.04.088

Stears, K. et al. (2018) 'Effects of the hippopotamus on the chemistry and ecology of a changing watershed', Proceedings of the National Academy of Sciences, 115(22), pp. E5028–E5037. doi: https://doi.org/10.1073/pnas.1800407115

Tansey, C. J., Hadfield, J. D. and Phillimore, A. B. (2017) 'Estimating the ability of plants to plastically track temperature-mediated shifts in the spring phenological optimum', Global Change Biology. John Wiley & Sons, Ltd, 23(8), pp. 3321–3334. doi: https://doi.org/10.1111/gcb.13624

Trathan, P. N. et al. (2020) 'The emperor penguin - Vulnerable to projected rates of warming and sea ice loss', Biological Conservation, 241(108216), pp. 1–11. doi: https://doi.org/10.1016/j.biocon.2019.108216

Utete, B. (2020) 'A review of some aspects of the ecology, population trends, threats and conservation strategies for the common hippopotamus, Hippopotamus amphibius L, in Zimbabwe', African Zoology. Taylor & Francis, 55(3), pp. 187–200. doi: https://doi.org/10.1080/15627020.2020.1779613

Warren, R. et al. (2018) 'The projected effect on insects, vertebrates, and plants of limiting global warming to 1.5°C rather than 2°C', Science, Vol. 360, Issue 6390, pp. 791-795 doi: https://doi.org/10.1126/science.aar3646

Williams, P. H., Araújo, M. B. and Rasmont, P. (2007) 'Can vulnerability among British bumblebee (Bombus) species be explained by niche position and breadth?', Biological Conservation, 138(3), pp. 493–505. doi: https://doi.org/10.1016/j.biocon.2007.06.001

Williams, P. H. and Osborne, J. L. (2009) 'Bumblebee vulnerability and conservation world-wide', Apidologie, 40(3), pp. 367–387. doi: https://doi.org/10.1051/apido/2009025

WWF. 2018. Living Planet Report - 2018: Aiming Higher. Grooten, M. and Almond, R.E.A.(Eds). WWF, Gland, Switzerland. pp82-84. https://www.wwf.org.uk/updates/living-planet-report-2018

Ziegler, M. et al. (2019) 'Coral bacterial community structure responds to environmental change in a host-specific manner', Nature Communications, 10(3092). doi: https://doi.org/10.1038/s41467-019-10969-5

Zimova, M. et al. (2020) 'Lack of phenological shift leads to increased camouflage mismatch in mountain hares', Proceedings of the Royal Society B: Biological Sciences. Royal Society, 287(1941), p. 20201786. doi: https://doi.org/10.1098/rspb.2020.1786

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