Impacts of climate change on Australian wildlife

Fact sheet

August 2023

Key points

- Climate change can act as a "threat multiplier" of wildlife disease by altering the complex environment-host-agent-vector balance.
- The additional stress of climate change has the potential to be devastating to already threatened Australian wildlife, at both the individual and population level.
- Climate-associated illness is best categorised by exposure pathway.
- The seven key exposure pathways are temperature, extreme events, air quality, vector-borne diseases, water-related illnesses, safe and nutritious food and mental health and well-being.

Introduction

Anthropogenic climate change is altering the Australian environment in a variety of ways, many of which are impacting wildlife health. Wild animals' dependence on their natural habitat means that they are extremely vulnerable to environmental changes, more so than humans and domesticated animals which benefit from having a buffer between themselves and the natural world.

The mechanisms underpinning climate-associated illness in wildlife are multifaceted and interconnected. Climate change is unique as a driver of disease in that it can affect all body systems, impair immune response and exacerbate the frequency, severity and spread of disease agents [1]. Importantly, climate change does not inherently promote the proliferation of all disease, rather it disrupts the extremely complex balance between environment, host, agent and vector, thereby creating conditions that can alter overall disease dynamics [2].

The impacts of climate change do not exist in a vacuum but can act as a "threat multiplier" that compound the influence of other human-driven threatening processes such as habitat alteration, pollution, overexploitation, tourism and trade. As climate continues to change, novel conditions and disease risk factors will arise. Understanding Australian wildlife's current vulnerabilities and resilience to these changes will assist in future disease management and mitigation efforts. Tackling climate-associated illness in wildlife will require a multidisciplinary approach to address its many complexities, and resources must be dedicated to increasing scientific understanding and to communicating findings to stakeholders, policy members and the public in order to promote effective action.

Exposure pathways

The classification of climate-associated disease by exposure pathway rather than by traditional means (e.g. by affected body system) best addresses the complexities of climate change. This system also helps to simplify the development of exposure-specific mitigation strategies. Duncan et al. 2022 [1] identify the seven exposure pathways:

Temperature

Rising temperatures associated with climate change may result in heat-associated illness in wildlife, varying in severity from mild heat stress to fatal multisystem disease. The impairment of an animal's thermoregulatory capacity (resulting from environmental temperatures outside of their natural range) can cause blood vessel damage and body-wide inflammation [3]. Ecosystem level changes can also occur [4] e.g. from heat induced mass mortality events in pollinators [5].

Aquatic species may face the greatest threat, with sea temperatures having reached a 400,000-year high [6]. One of the best-established examples of the catastrophic impact of these rising temperatures on marine species is coral bleaching. Corals under stress will expel their symbiotic dinoflagellates (zooxanthellae) resulting in the characteristic "bleached" look visible in coral reefs around the world [7]. Without the photosynthesis services provided by the zooxanthellae, many bleached corals will starve. Australia's Great Barrier Reef has experienced four mass bleaching events since 2016 [8].

Extreme events

Climate change is associated with an increased incidence and severity of extreme events or "natural disasters" such as bushfires, floods, storms, heat waves, cold waves and droughts. Aside from the risk of direct injury to wildlife from an extreme event, long-term impacts can include loss of refugia, displacement, habitat fragmentation, food and water loss and contamination, increased predation risk and increased susceptibility to infectious disease outbreak. In the event of significant disasters, these impacts can cascade and result in population declines, local extinctions or even ecosystem collapse.

Australia's 2019-20 "Black Summer" bushfires are a clear example of a climate change induced event impacting wildlife health. Exacerbated by severe drought, record temperatures and high winds, the fires caused unprecedented destruction to wildlife and the environment. The reported figures of 18.6 million hectares burnt and almost three billion animals killed or displaced [9] are almost certainly underestimates.

Air quality

There is a rise in air pollutants (smoke, allergens, particulate matter, ozone) associated with increased bushfire and drought. These pollutants can result in lung disease and respiratory tract damage across a range of species, along with disrupting the defence barriers of respiratory tissue, leaving animals susceptible to secondary infections. The resultant scarring of the lungs from this damage can affect gas exchange and lead to chronic respiratory disease. Cardiovascular disorders (e.g. stroke) can also occur from poor air quality, where inhaled pollutants cross into the bloodstream.

Bushfire smoke inhalation caused a mortality event in a threatened species, smoky mice (*Pseudomys fumeus*), at a captive facility near Canberra in January 2020. The mice had significant pulmonary lesions, oedema and congestion [10].

Vector-borne diseases

Climate change is well-established as a significant driver of vector-borne disease [11]. Increased rainfall and longer warm seasons help to expand the geographic limits of many arthropod vectors such as mosquitos, flies, ticks and fleas (many of which act in the transmission of infectious disease) to higher latitudes and altitudes [12-14].

Water-related illness

Contamination of water sources by toxins and infectious disease agents can be exacerbated by increased precipitation and temperature. Periods of high rainfall can introduce terrestrial pathogens to aquatic species via runoff, as well as contributing to the growth, survival and toxicity of aquatic microorganisms. Warming waters may further promote harmful algal blooms. Increased rainfall and water temperature also favours the growth of many waterborne disease agents such as bacteria and fungi, as well as potential arthropod vectors as described above.

Conversely, climate change can also lead to periods of decreased rainfall, driving drought conditions. There are direct threats of dehydration and starvation. In addition, when water sources for wildlife are limited, animals will congregate at greater densities around available water, increasing the risk of predation and aggression interactions. Reduced water availability can have particularly devastating impacts on semiaquatic species, such as platypuses (*Ornithorhynchus anatinus*) which have demonstrated low reproductive rates in the absence of freshwater refugia, after periods of severe drought and associated bushfires [15].

Safe and nutritious food

Climate change presents a threat to wildlife food security, a key determinant of animal health [16]. Altered temperature and moisture in the environment impacts the growth and persistence of many food contaminants and toxins. Elevated atmospheric CO_2 associated with climate change can lower the levels of nutrients in plants, notably protein, iron and zinc, thereby reducing the quality of herbivorous wild species' diets [17]. Declines in prey species as a result of climate change impacts are likely to alter the diets of their predators. Changes to predator populations are felt throughout entire food webs and can impact the structure of ecosystems and nutrient cycling.

Mental health and wellbeing

Animal welfare is typically understood using the Five Domains model, where four physical or functional domains (nutrition, physical environment, health and behavioural interaction) all impact domain five: mental / affective state, thereby giving a comprehensive assessment of an animal's wellbeing [18]. As described above, climate change infringes upon each of the first four domains and will inevitably have significant consequences for wild animals' mental health and therefore overall welfare.

Human physical and mental health is also affected by climate change and this has the potential to impact wildlife welfare where it affects our capacity to provide animals with care and protection.

For example, the growing stress and burden of climate change compounds the already significant mental health challenges experienced by many in the fields of veterinary medicine [19] and wildlife rescue and rehabilitation [20].

Impact on infectious disease

Climatic change can act on any or all of the mechanisms underpinning the dynamics of disease expression. Altered environmental thermal profiles and extreme weather events produce habitat changes, challenges to species thermal tolerances and changes to other environmental parameters (e.g. salinity, ice cover, UV light penetration). These changes in turn cause changes to wildlife behaviour, fitness and survivorship. The resultant impacts on agent-host-vector dynamics will be circumstance-dependent, with positive, negative or no effects on disease expression all possible. This topic is extremely complex and further information is provided by Vitali and Jackson (2022).

The case of Hendra virus (HeV) in Australia provides an example of how climate change can affect infectious disease dynamics [2, 21-25]:

Reservoir host (bats) impacts

- Geographic range expands southward as bats seek climate-dependant food sources, increasing their overlap with new and larger spillover host populations.
- Dependence on urban food sources limits bats' migratory behaviour, resulting in permanent camps in close proximity to humans and their horses.
- Increased viral shedding due to stress-induced immune changes caused by heat, habitat loss and starvation.
- Heat affected bats spend more time on the ground, putting them in closer proximity with spillover hosts.
- Large bat aggregations around limited food sources increases pathogen transmission.

Spillover hosts (horses and humans) impacts

- Expansion into previously wild areas increases overlap with bat colonies.
- Higher temperatures cause increased shade-seeking behaviour in horses, leading them to spend more time under trees where bats are excreting HeV. Humans are then affected via association with horses.

Pathogen (HeV) impacts

- Higher intensity of epidemics and levels of viral shedding due to the reduced connectivity of bat populations preventing HeV immunity maintenance.
- Changes to environmental persistence and limitations to spillover transmission due to altered microclimate factors (e.g. temperature, UV, humidity, dust particles).

Surveillance

Wildlife Health Australia administers Australia's general wildlife health surveillance system, in partnership with government and non-government agencies. Wildlife health data is collected into a national database, the electronic Wildlife Health Information System (eWHIS). Information is

reported by a variety of sources including government agencies, zoo based wildlife hospitals, sentinel veterinary clinics, universities, wildlife rehabilitators, and a range of other organisations and individuals. Targeted surveillance data is also collected by WHA. See the WHA website for more information https://wildlifehealthaustralia.com.au/Our-Work/Surveillance and https://wildlifehealthaustralia.com.au/Our-Work/Surveillance/eWHIS-Wildlife-Health-Information-System.

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Wildlife Health Australia recognises the Traditional Custodians of Country throughout Australia. We respectfully acknowledge Aboriginal and Torres Strait Islander peoples' continuing connection to land, sea, wildlife and community. We pay our respects to them and their cultures, and to their Elders past and present.

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