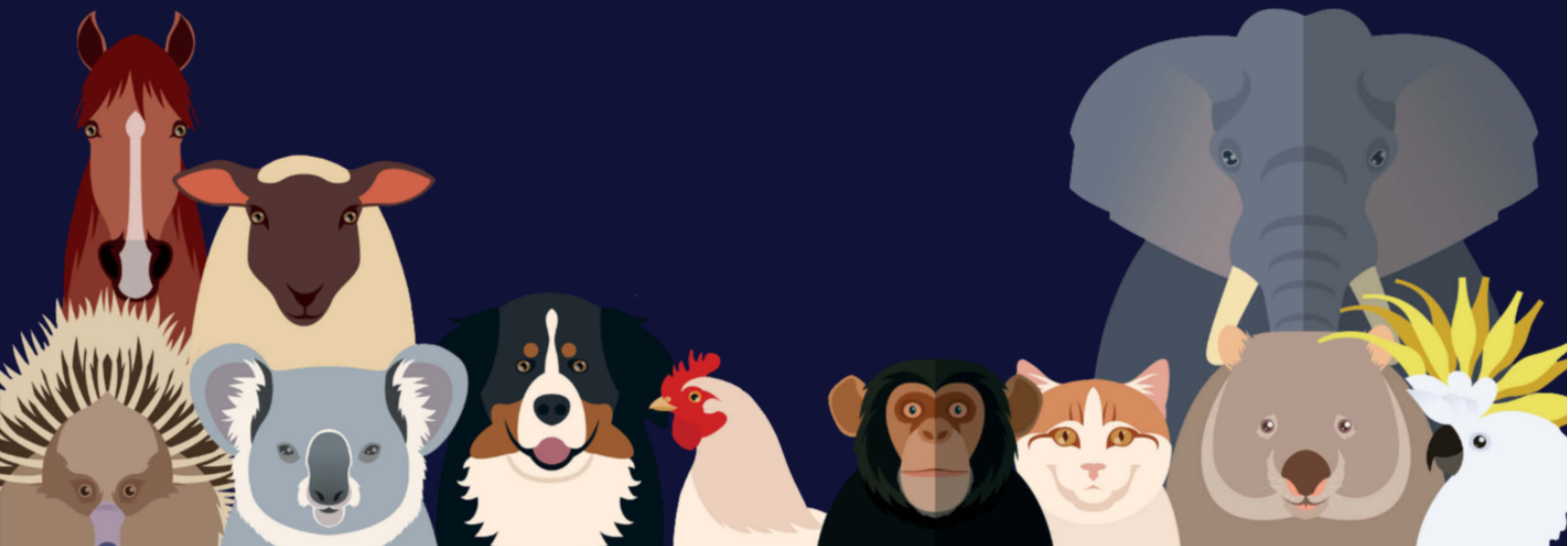


CLIMATE FACTS FOR VETS

Climate Change is an
Animal Welfare Problem



Climate Facts for Vets

Prepared for Vets for Climate Action (VfCA) August 2021

1. What is climate change?

- Australia has warmed on average by $1.44 \pm 0.24^{\circ}\text{C}$ since national records began in 1910, with most warming occurring since 1950 ⁽¹⁾.
- Increased temperature (global warming) is driving a climate of increasing heat waves, droughts, bushfires, floods and other extreme weather events (climate change). Climate change refers to the escalating and disruptive changes to the Earth's climate (and climate-dependent environments) associated with the increased temperature of our atmosphere and oceans. With more heat and energy in the atmosphere and oceans, our weather is becoming more extreme and unpredictable, with changes to ecosystems, sea levels and disease patterns.
- Each 1°C rise in atmospheric temperature increases atmospheric water vapour by 7% leading to a greater proportion of high intensity storms that extend further from the equator ⁽²⁾. Tropical cyclones now form in a climate that is warmer, wetter, and more energetic than before. This surplus of energy translates to cyclones that are faster both to develop and to intensify. The added heat also leads to greater windspeeds and water-carrying capacity, which means that cyclones are far more destructive.
- Climate change is affecting people who rely on animal production systems for their livelihood ^(3, 4). Veterinarians are able to play a key role in responding to the effects of climate change on animal health (including welfare, production and biosecurity) and in advocating for policies that will minimise global warming. Climate change is affecting food supply, whole ecosystems, and
- the geographical distribution and spread of diseases in animal and human populations, as well as the welfare of the animals themselves ⁽⁴⁾.

2. What is causing climate change?

¹ Bureau of Meteorology (2021) *Australia's climate in 2020*. Australian Government Bureau of Meteorology, Melbourne.
<http://www.bom.gov.au/climate/current/annual/aus/#:~:text=Australia's%20warmest%20year%20on%20record,C%20above%20average%20in%202013>. Cited in CSIRO (2020) *State of the Climate Report 2020*. CSIRO, Melbourne.

<https://www.csiro.au/en/research/environmental-impacts/climate-change/state-of-the-climate>

² IPCC (2013) *Climate change 2013: the physical science basis*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Stocker TF, Qin D et al. eds). Cambridge University Press, Cambridge and New York.

³ McMichael AJ and Lindgren E (2011) Climate change: present and future risks to health, and necessary responses. *Journal of Internal Medicine* 270: 401–413. [doi: 10.1111/j.1365-2796.2011.02415.x](https://doi.org/10.1111/j.1365-2796.2011.02415.x) or <https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1365-2796.2011.02415.x>

⁴ Porter JR, Xie L, Challinor AJ et al. (2014) Food security and food production systems. In: *Climate change 2014: impacts, adaptation, and vulnerability*. Part A: global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Field CB, Barros VR, Dokken DJ et al. eds.) Cambridge University Press, Cambridge and New York, pp. 485–533.

- Human activity is the primary cause of accelerating climate change. The United Nations' Intergovernmental Panel on Climate Change (IPCC) has concluded that anthropogenic-fuelled warming of the climate system is now unequivocal, with global temperatures increasing most years since 1992 in line with increasing levels of greenhouse gases (GHGs: ⁵).
- The World Veterinary Association's 'Position on the Global Climate Change Emergency' (⁶) reflects the increasing concern of the veterinary profession worldwide of the negative effects of climate change on animal health (including production, welfare and biosecurity) and the natural environment'.
- Similar statements on climate change and calls for climate action have been made by a wide range of scientific, industry and civil society organisations in Australia, including the Australian Academy of Science (AAS: ⁷), Australian Medical Association (AMA: ⁸), Australian Veterinary Association (AVA: ⁹), Royal Australian College of General Practitioners (RACGP: ¹⁰), Public Health Association of Australia (PHAA: ¹¹), Doctors for the Environment Australia (DEA: ¹²), Climate and Health Alliance (¹³), and Farmers for Climate Action (FfCA: ¹⁴).
- Earth's increasing temperature (also known as global warming) is caused by the increasing emissions of carbon dioxide and other carbon compounds, such as methane, and nitrogenous and sulphur compounds, collectively called GHGs, into the earth's atmosphere (¹⁵).

⁵ IPPC (2013) op. cit.

⁶ WVA (2020) Position on the Global Climate Change Emergency. World Veterinary Association. http://www.worldvet.org/uploads/news/docs/wva_position_on_the_global_climate_change_emergency.pdf

⁷ AAS (2021) *The Risks to Australia of a 3°C Warmer World*. Australian Academy of Science, Canberra. <https://www.science.org.au/files/userfiles/support/reports-and-plans/2021/risks-australia-three-deg-warmer-world-report.pdf>

⁸ AMA (2015) Position Statement on climate change. Australian Medical Association. <https://ama.com.au/position-statement/ama-position-statement-climate-change-and-human-health-2004-revised-2015>

⁹ AVA (2016) Climate change and animal health, welfare and production. Position statement, Australian Veterinary Association. *Currently under review*. <https://www.ava.com.au/policy-advocacy/policies/environment-and-conservation/climate-change-and-animal-health-welfare-and-production/#:~:text=Position%20statement,is%20contributing%20to%20climate%20change.&text=This%20will%20affect%20humans%20who.are%20vulnerable%20to%20climate%20change>

¹⁰ RACGP (2019) Climate change and human health. Position statement, Royal Australian College of General Practitioners. <https://www.racgp.org.au/FSDEDEV/media/documents/RACGP/Position%20statements/Climate-change-and-human-health.pdf>

¹¹ PHAA (2017) Safe Climate Policy. Public Health Association of Australia. <https://www.phaa.net.au/documents/item/2490>

¹² DEA (2017) Healthy Planet, Health People: doctors protecting our future. Doctors for the Environment Australia. https://www.dea.org.au/wp-content/uploads/2017/05/DEA10031-Brochure_Final.pdf

¹³ CAHA (2016) Towards a national strategy on climate, health and well-being for Australia. Discussion paper, Climate and Health Alliance, Box Hill, Victoria. <https://s3-ap-southeast-2.amazonaws.com/caha-org/uploads/2016/06/CAHA-Discussion-Paper-v04.pdf>

¹⁴ FfCA (2018 CHECK DATE) *Our Vision: farming forever 2018–2021*. Farmers for Climate Action, Melbourne. https://farmersforclimateaction.org.au/wp-content/uploads/2020/07/FCA_2018-2021_Public_Strategy_Document_v06_SCREEN.pdf

¹⁵ GHGs are 'those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation

- These emissions come mainly from the burning of fossil fuels such as coal, gas and petroleum products.
- Deforestation and reduced ground plant cover from land use change reduces the amount of CO₂ drawn down naturally from the atmosphere, thus compounding increased emissions. A 2°C to 4°C rise in temperature since the start of industrialisation (about 1850) will have increasing negative effects and ultimately prove to be incompatible with civilisation as we know it.

3. How is climate change affecting Australians and Australian agriculture?

- Increased temperature is driving a climate of increasing extremes of heat waves, droughts, bushfires, floods and other extreme weather events.
- Each 1°C rise in atmospheric temperature increases atmospheric water vapour by 7% leading to a greater proportion of high intensity storms that extend further from the equator. Water vapour in the atmosphere also acts to augment the greenhouse effect.
- Bushfire periods in Australia have extended by four months and there are more high fire danger days. Australia has had 10 of its 11 hottest years since 2005.
- Australia has warmed on average by $1.44 \pm 0.24^\circ\text{C}$ since national records began in 1910, with most warming occurring since 1950. and every decade since then being warmer than the ones before. Australia's warmest year on record was 2019, and the seven years from 2013 to 2019 all rank in the nine warmest years ⁽¹⁶⁾.
- About 600 000 cattle in north Queensland died in 2019 after severe floods followed a drought.
- Some 3 billion animals died or were displaced in the 2019–20 fires in south-eastern Australia.
- In the Torres Strait islands and in south-western coastal Papua New Guinea (PNG) vegetable gardens are being moved inland because of increasing encroachment by seawater.
- Average temperatures in Australia have risen by more than 1.4°C since 1910. Every further increase will amplify the effects described above. Even one-tenth of a degree matters.

4. Australian agricultural emissions

- The energy sector continues to be the dominant source of Australia's GHG emissions, accounting for 74% of net emissions, including those associated with land use, land-use change and forestry. The sources of GHGs in Australia in broad terms are electricity 33%, stationary energy 19%, transport 19%, fugitive emissions from fuels 11%, agriculture 13%, industrial processes 6%, and waste 2% ⁽¹⁷⁾.
- Livestock emissions account for about 70% of GHG emissions from agricultural pursuits, contributing overall about 11% of Australia's national emissions.
- These emissions are methane and nitrous oxide that are largely derived from ruminant digestion.

emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄) and ozone (O₃) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the [Montreal Protocol](#). Beside CO₂, N₂O and CH₄, the [Kyoto Protocol](#) deals with the GHGs sulphur hexafluoride (SF₆), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). See IPCC ('Definition of terms used within the DDC Pages): https://www.ipcc-data.org/guidelines/pages/glossary/glossary_c.html

¹⁶ Bureau of Meteorology (2021) *op cit*.

¹⁷ Australian Government (2016) *Australia State of the Environment 2016*. Australian Government, Canberra. <https://soe.environment.gov.au/theme/climate/topic/emission-sources>

- The amount of methane emitted is primarily driven by cattle grazing rangelands.
- Ruminants are more efficient producers if they produce less methane:
 - This can be achieved with feed additives including ionophores, nitrates, grains, fats and by-product feeds.
 - Systems to improve pastures and provide supplementary feeds, additives and minerals to achieve better reproductive performance and reduced time to finishing need to be developed to overcome the logistical challenges in delivering these inputs.

5. Effects on animal welfare

- Climate change is causing more extreme weather events, including droughts and an increased incidence and intensity of natural disasters such as bushfires, floods and storms. Companion animals (pets), animals in sport, farm animals, zoo and aquarium animals, and wildlife can be directly and indirectly affected by climate change across land, freshwater and saltwater environments ^(18, 19, 20).
- Mass mortalities involving the death of thousands of mammals, birds and fish have been linked to extreme weather events (e.g. heatwaves, bushfires) and more than 3 billion mammals, birds and reptiles were killed in bushfires in Australia in 2019–20 ⁽²¹⁾.
- Research to develop mechanisms to reduce GHG emissions from animals and to increase agricultural sustainability should include consideration of any animal welfare implications and seek to avoid any negative effects ⁽²²⁾.

6. Effects on humans, production animals and animal production

- Companion animals (pets), animals in sport, farm animals, zoo and aquarium animals, and wildlife can be directly and indirectly affected by climate change across land, freshwater and saltwater environments ⁽²³⁾.
- The role of agriculture in the production of greenhouse gases is complex. For example, cattle production contributes through emission of methane, yet can also mitigate negative effects of climate change through sequestration of carbon in soils and timber ⁽²⁴⁾.

¹⁸ RSPCA (2020) The impact of climate change on the welfare of animals in Australia. Research report, RSPCA Australia.
<https://kb.rspca.org.au/wp-content/uploads/2020/05/Climate-Change-and-Animal-Welfare-RSPCA-Australia-Research-Report-May-2020.pdf>

¹⁹ Lacetera N (2018) Impact of climate change on animal health and welfare. *Animal Frontiers* 9(1): 26–31. <https://doi.org/10.1093/af/vfy030>

²⁰ Shields S and Orme-Evans G (2015) The impacts of climate change mitigation strategies on animal welfare. *Animals* 5: 361–391. <http://www.mdpi.com/2076-2615/5/2/361/htm>

²¹ van Eeden LM, Nimmo D, Mahony M, Herman K, Ehmke G, Driessen J, O'Connor J, Bino G, Taylor M and Dickman CR (2020) Impacts of the unprecedented 2019–2020 bushfires on Australian animals. Report prepared for WWF-Australia, Ultimo NSW.
https://www.wwf.org.au/ArticleDocuments/353/WWF_Impacts-of-the-unprecedented-2019-2020-bushfires-on-Australian-animals.pdf.aspx

²² Shields S and Orme-Evans G (2015) The impacts of climate change mitigation strategies on animal welfare. *Animals* 5: 361–391. <http://www.mdpi.com/2076-2615/5/2/361/htm>

²³ RSPCA (2020) The impact of climate change on the welfare of animals in Australia. Research report, RSPCA Australia.
<https://kb.rspca.org.au/wp-content/uploads/2020/05/Climate-Change-and-Animal-Welfare-RSPCA-Australia-Research-Report-May-2020.pdf>

²⁴ Wittmann EJ and Baylis M (2000) Climate change: effects on *Culicoides*-transmitted viruses and implications for the UK. *Veterinary Journal* 160: 107–117.

- Modelling indicates that most animal-related production systems will be negatively affected — locally, nationally and globally (²⁵, ²⁶, ²⁷). Not only is food security an issue (²⁸), but increasing environmental temperatures are associated with an increased incidence of food-borne diseases (²⁹, ³⁰). The risks to food safety from increasing global temperatures are also exacerbated and should not be ignored (³¹, ³², ³³, ³⁴).
- Mortality increases during extreme weather events. Major heatwaves have caused more deaths of Australians since 1890 than have bushfires, cyclones, earthquakes, floods and severe storms combined. Like humans, elderly animals, young animals and those with diseases are more susceptible to heat stress and death.
- Heat stress on animals disrupts metabolism, suppresses immunity and reduces production.
- The quantity and quality of feed is reduced by high temperatures and by droughts.
- Climate change is a major factor in the changing epidemiology of vector-borne diseases that affect human and animal health, and in the spread of these diseases from equatorial regions (³⁵, ³⁶, ³⁷, ³⁸).
- The potential for parasites and vector borne diseases to spread south in Australia is increased by increasing environmental temperatures allowing increased survival of parasites and vectors).
- Changing climate (together with habitat destruction, changing animal use patterns etc.) has contributed to the emergence of a number of newly identified diseases in recent decades. Globally, 60–70% of newly emerged human diseases in recent decades have originated from

²⁵ Gunasekera D, Kim Y, Tulloh C et al. (2007) Climate change: impacts on Australian agriculture. *Australian Commodities: forecasts and issues* 14: 657–676.

²⁶ Grace D, Bett B, Lindahl J et al. (2005) *Climate and livestock disease: assessing the vulnerability of agricultural systems to livestock pests under climate change scenarios*. CCAFS Working Paper no. 116. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. www.ccafs.cgiar.org

²⁷ Godde CM, Mason-D'Croz D, Mayberry DE, Thornton PK and Herrero M (2021) Impacts of climate change on the livestock food supply chain: a review of the evidence. *Global Food Security* 28: 100488. DOI: <https://doi.org/10.1016/j.gfs.2020.100488>

²⁸ Hughes L, Steffen W, Rice M and Pearce A (2015) *Feeding a Hungry Nation: climate change, food and farming in Australia*. Climate Council of Australia, Potts Point NSW. <https://www.climatecouncil.org.au/uploads/7579c324216d1e76e8a50095aac45d66.pdf>

²⁹ El-Fadel M, Ghanimeh S, Maroun R et al. (2012) Climate change and temperature rise: implications on food- and water-borne diseases. *Science of the Total Environment* 437: 15–21.

³⁰ WHO (2019) Food safety, climate change and the role of WHO. World Health Organization, Geneva. https://www.who.int/foodsafety/publications/all/Climate_Change_Document.pdf

³¹ Tirado MC, Clarke R, Jaykus LA et al. (2010) Climate change and food safety: a review. *Food Research International* 43:1745–1765. <http://ucanr.edu/datastorefiles/608-149.pdf>

³² Jaykuss LA, Woolridge M, Frank JM et al. (2008) *Climate change: implications for food safety*. A consultation paper. Food and Agriculture Organization, Rome.

³³ Hall GV, D'Souza RM, Kirk MD (2002) Foodborne disease in the new millennium: out of the frying pan and into the fire? *Medical Journal of Australia* 177: 614–618.

³⁴ Alders R, J de Bruyn J, Wingett K and Wong J (2017) One Health, veterinarians and the nexus between disease and food security. *Australian Veterinary Journal* 95(12): 451–453. DOI: [10.1111/avj.12645](https://doi.org/10.1111/avj.12645) or <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5725692/pdf/AVJ-95-451.pdf>

³⁵ Intergovernmental Panel on Climate Change (2013), *op. cit.*

³⁶ Porter JR, Xie L, Challinor AJ et al. (2014), *op. cit.*

³⁷ Gerber PJ, Steinfeld H, Henderson B et al. (2013) *Tackling climate change through livestock: a global assessment of emissions and mitigation opportunities*. Food and Agriculture Organization of the United Nations, Rome. <http://www.fao.org/docrep/018/i3437e/i3437e.pdf>

³⁸ Campbell-Lendrum D, Manga L, Bagayoko M et al. Climate change and vector-borne diseases: what are the implications for public health research and policy? *Philosophical Transactions of the Royal Society of London B Biological Sciences* (2015) 370. doi: 10.1098/rstb.2013.0552

animals, often as a result of changes in the contact between humans and animal reservoirs of viruses ⁽³⁹⁾.

7. Effects on pets and recreational animals

- Dogs have a temperature neutral zone of 20–30°C and suffer heat stress when the environmental temperature exceeds 30°C; on a 25°C day, footpath and road temperatures can exceed 50°C ⁽⁴⁰⁾.
- On days above 30°C, during racing the body temperature of horses increases by 1°C for every 1 minute of racing ⁽⁴¹⁾ and that of greyhounds increases by more than 2°C in less than 1 minute of racing ⁽⁴²⁾.
- There are significant welfare issues for animals racing on hot days and meetings were cancelled in 2019 and 2020.
- Heartworm of dogs has spread south from Brisbane in the 1970s to Hobart in the 2010s through spread of its mosquito vector.

8. Effects on the natural environment

- Climate change is affecting wildlife populations and ecosystems through the effects of climate-related natural disasters; effects on reproductive performance amongst climate sensitive-animals and their food sources ⁽⁴³⁾; shifting ranges of wildlife species and their food sources ⁽⁴⁴⁾; and exacerbating species extinction by loss of natural habitats (for example through deforestation, disappearance of habitats with a suitable temperature range for specific species and the impacts of droughts, bushfires, floods and extreme weather events ⁽⁴⁵⁾).
- Mass mortalities involving the death of thousands of mammals, birds and fish have been linked to extreme weather events (e.g. heatwaves, bushfires) and more than 3 billion mammals, birds and reptiles were killed in bushfires in Australia in 2019–20 ⁽⁴⁶⁾.
- Native animals suffer the same effects of heat stress as livestock and recreational animals.
- Many species of trees and other plants may not survive the effects of climate change in their current location, putting animals that depend on them for food and shelter at risk of local or

³⁹ Morse SS (2004) Factors and determinants of disease emergence. *Revue Scientifique et Technique de l'Office International des Epizooties* 23(2): 443–451.
<http://web.oie.int/boutique/extrait/443452morse.pdf>

⁴⁰ Harrison I (2017) Why dog owners should avoid pavements and fake grass on hot days. *Vets Now* [https://www.vets-now.com/2017/06/never-walk-dogs-hot-asphalt-tarmac-pavements-artificial-grass/#:~:text=Dogs%20can%20suffer%20burns%20to,mercury%20hits%2031C%20\(87F\)](https://www.vets-now.com/2017/06/never-walk-dogs-hot-asphalt-tarmac-pavements-artificial-grass/#:~:text=Dogs%20can%20suffer%20burns%20to,mercury%20hits%2031C%20(87F)).

⁴¹ Brownlow MA, Dar AJ and Jeffcott LB (2016) Exertional heat illness: a review of the syndrome affecting racing Thoroughbreds in hot and humid climates. *Australian Veterinary Journal* 94: 240–247.

⁴² McNicholl J, Howarth GS and Hazel SJ (2016) Influence of the environment on body temperature of racing greyhounds. *Frontiers in Veterinary Science* 3: 53. DOI: [10.3389/fvets.2016.00053](https://doi.org/10.3389/fvets.2016.00053)

⁴³ Holleley CE, O'Meally D, Sarre SD et al. (2015) Sex reversal triggers the rapid transition from genetic to temperature-dependent sex. *Nature* 523:79–82.

⁴⁴ Baltensperger AP and Huettmann F (2015) Predicted shifts in small mammal distributions and biodiversity in the altered future environment of Alaska: an open access data and machine learning perspective. *PLoS One* 10:e0132054. doi: 10.1371/journal.pone.0132054

⁴⁵ Urban MC (2015) Climate change. Accelerating extinction risk from climate change. *Science* 348: 571–573.

⁴⁶ van Eeden LM, Nimmo D, Mahony M, Herman K, Ehmke G, Driessen J, O'Connor J, Bino G, Taylor M and Dickman CR (2020) Impacts of the unprecedented 201–2020 bushfires on Australian animals. Report prepared for WWF-Australia, Ultimo NSW.
https://www.wwf.org.au/ArticleDocuments/353/WWF_Impacts-of-the-unprecedented-2019-2020-bushfires-on-Australian-animals.pdf.aspx

wider extinction. This, coupled with deforestation and land clearing, is threatening more and more species of animals and plants than at any other time in Australia's history.

- During the 2019–20 fires, NSW lost one-third of its population of koalas and Kangaroo Island lost half of its koalas.
- Species living at the tops of mountains have 'nowhere to go' as temperatures rise.
- Many introduced invasive species (e.g. weeds) do better under climate change scenarios, thus accelerating the extinction of native species.
- These ecosystem changes are also putting native animals under habitat stress and forcing closer contact with livestock and humans, leading to disease outbreaks in Australia such as:
 - Horses and humans acquiring infections with Hendra virus from flying foxes.
 - Humans acquiring infections with lyssavirus from bats.
- Ocean temperatures and sea levels are rising and threatening low areas and islands around Australia. Countless animals and plants dependent on the marine environment are directly threatened by increases in sea temperature and acidity from climate change.
 - Kelp forests have declined 95% off eastern Tasmania as a result of increased sea temperature.
 - Climate change is the most important threat to the health of tropical coral reefs.

9. What can we do to combat climate change?

- The key driver of climate change is the emission of GHGs into the atmosphere.
- Carbon dioxide is one of these gases and increased emissions from human activity and permafrost thawing are compounded by reduced drawdown from deforestation and land-clearing.
- Only sharply reducing these emissions and greatly increasing carbon drawdown can reduce the negative effects of climate change. This will require decarbonising Australia's and the world's economies, together with accelerating carbon drawdown.
- The Australian Government needs to lead the country's path of reducing emissions to net zero carbon emissions as soon as possible. Our country is falling behind the rest of the world in the race to reduce emissions.

10. What is Australia doing to alleviate global warming?

- The National Farmers' Federation (NFF) and Meat and Livestock Australia (MLA) have set targets of 2040 and 2030, respectively (⁴⁷, ⁴⁸) to attain carbon neutrality for their industries. The Red Meat Advisory Council (RMAC) has also developed information on climate-proofing Australia and the Australian Beef Sustainability Framework (⁴⁹).

⁴⁷ NFF (2020) Climate change policy. National Farmers' Federation, Canberra.

https://nff.org.au/wp-content/uploads/2020/08/2020.08.06_Policy_NRM_Climate_Change.pdf

⁴⁸ MLA (2020) Becoming carbon neutral by 2030. Meat and Livestock Australia, North Sydney.

<https://www.mla.com.au/globalassets/mla-corporate/research-and-development/documents/cn30-information-sheet-final.pdf>

⁴⁹ The Red Meat Advisory Council (RMAC) and partners have developed information on 'Climate Proofing Australia' (see climateproofingaustralia.com.au) and on the red meat industry's 'Carbon neutral 2030' program and related work to manage the risks from climate change (see the Australian Beef Sustainability Framework: <https://www.sustainableaustralianbeef.com.au/the-framework>).

- There is an urgent need to reduce energy production from the burning of fossil fuels and replace with renewable resources such as solar, wind and green hydrogen energy ⁽⁵⁰⁾, backed up by battery storage including pumped-storage hydroelectricity ('pumped hydro').
- Reforestation, reducing methane production from ruminants and increasing soil carbon sequestration, will contribute to Australia's target of net zero carbon emissions.
- The Australian beef and dairy industries are reducing methane production, but much more can be done.
- The most powerful factor reducing methane production from ruminants is to increase efficiency of production. In northern Australia, improved reproductive efficiency is vital, as is finishing progeny on temperate pastures or feedlots. In southern Australia, beef production efficiency is enhanced by younger calving ages and the use of crops, improved pastures and supplements to reduce time to finish.
- In the southern beef system, dairy production and feedlot finishing, use of supplements allows delivery of many products that reduce GHGs including ionophores, fats, grains and byproducts of human food that reduce GHG production markedly. New technologies such as 3-NOP and seaweed show promise.
- An increasing number of piggeries, feedlots and dairies are capturing and producing energy from effluent.

11. When has this to be done?

- The United Nations Paris Agreement of 2015 ⁽⁵¹⁾ estimated the temperature rise could be held to 1.5°C in 2050 in the world achieving net carbon emissions in 2050.
- However, GHG emissions have continued to rise since 2015, so that to achieve the target 1.5°C temperature rise, net zero carbon emissions need to be achieved globally by 2030.
- This is a huge challenge and a focus of the United Nations Climate Change Conference (COP26) in Glasgow in November 2021.

12. What can vets do?

- Climate change solutions are already well known and each of us can help.
- Make yourself aware of the emissions mitigation strategies that are relevant to your practice, whether in metropolitan or rural areas.
- Encourage livestock and pet owners to undertake carbon mitigation and climate change adaptation strategies that will increase the production and welfare objectives for their animals.
- Encourage livestock owners to undertake agricultural practices that increase soil carbon and forestation projects that will sequester carbon from the atmosphere.
- Strategies need to be applied to reduce deforestation. Adoption of methods that improve production efficiency and sustainability of existing cleared lands are vital to reduce land-clearing.

⁵⁰ Steffen W, Hughes L, Bradshaw S, Arndt D and Rice M (2021) *Aim High, Go Fast: why emissions need to plummet this decade*. Climate Council of Australia Limited, Potts Point NSW. <https://www.climatecouncil.org.au/wp-content/uploads/2021/04/aim-high-go-fast-why-emissions-must-plummet-climate-council-report.pdf>

⁵¹ The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at the United Nations Climate Change Conference (COP 21) in Paris, on 12 December 2015, and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels. See <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

- Make yourself familiar with the tools that primary and secondary industries use to reduce carbon emissions.
- Engage your community with the VfCA Climate Smart program.
- Take up solar- and/or wind-generated energy, with or without battery storage from the grid (or go off-grid), to help reduce the demand for energy generated by coal and gas plants.

13. Conclusion

- Planet Earth continues to warm and much more needs to be done sooner for the sake of future generations.



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