Mortality events of large macropods in Australia

Fact Sheet

September 2024

Key points

- Mortality events of large species of free-ranging macropods in Australia have been recorded sporadically since first official reports in the 1950s.
- The causes of the events vary, however there are often similar circumstances, such as extreme climatic conditions or weather events, high macropod population density and the presence of a parasitic, infectious or toxic agent.
- Significant events have been associated with heavy rainfall or flooding in inland areas of mainland Australia. Numbers affected are difficult to quantify but may be in the thousands or tens of thousands.
- When events occur in geographically isolated areas, investigation can be challenging, and in some of these events, a definitive diagnosis may not be reached.

This Fact Sheet provides a summary of available information, with a focus on mass mortalities of free-ranging species of large macropod (kangaroos), where causes are as yet unknown or unconfirmed. More work is required to understand the ecology and factors driving macropod mass mortalities, including those occurring in remote and inland areas. This Fact Sheet should not be relied upon as a sole source of information on the current situation.

One Health implications

Wildlife and the environment: these events generally occur in common and locally abundant free-ranging macropod species and may be a natural part of population ecology. However, without more detailed knowledge of the complex causal pathways leading to these mortality events, the true impact on populations and ecosystems cannot be understood.

Domestic animals: in almost all cases, there is no corresponding disease seen in nearby production or other domestic animals. In obvious cases such as drought, insufficient pasture and some toxins, other grazing animals may also be affected. There is no indication that any possible infectious causes impact domestic animals.

Humans: there are no recognised zoonotic risks related to the known infectious agents contributing to large macropod mortalities. Good hygiene and appropriate personal protective equipment are always recommended as regular best practice when investigating deaths or illness in wildlife.

Aetiology and host species affected

The cause of free-ranging macropod mortalities may not always be known, and in many cases, may be difficult to determine. However, a variety of different causes have been recognised, or hypothesised; the most common of these are associated with nutritional stress or infection (see Table 1 and *Epidemiology*). There may be multiple factors (many with synergistic effects) associated with occurrence of mortalities. There is a need for greater understanding of the inter-relationship between mortality events, normal population regulation and disease expression.

Red (*Macropus rufus*), eastern grey (*M. giganteus*), and western grey kangaroos (*M. fuliginosus*) and common wallaroos (*M. robustus*) are often involved.

Occurrences in Australia

Mortalities may occur in any location where there are large populations of susceptible free-ranging macropod species. Several notable events have occurred in inland areas of NSW and Qld, and often in areas subject to flooding after heavy rain (see Table 1) [1, 2]. There are earlier reports of large scale die-offs following major flooding in western Qld and western NSW [3]. Mortalities associated with malnutrition have occurred during winter in temperate areas of south eastern Australia [4-6].

Table 1: Examples of mortality events of large species of free-ranging macropods in Australia from 1970 to 2023

EGK Eastern grey kangaroo, RK Red kangaroo, CW Common wallaroo, WGK Western grey kangaroo, NR not recorded or presumed mixed species; BL Blindness or other severe ocular pathology; SC Subcutaneous haemorrhage/ bruising /oedema; JT Joint pathology (arthritis, oedema, haemorrhage); AT ataxia, stiff movements, recumbent; HT hepatic changes; NS Neurological signs; OT Other signs; # (estimated numbers only)

Year	Species	Location	No. dead#	Duration of event	Cause (confirmed or suspected)	Clinical and or pathological signs	Notes	Reference
2021	WGK	Brabham WA	>50	Several months	Starvation (suspected)	Emaciation and lethargy	Food shortage in the area	WHA 2024 [7]
2021	EGK	Halls Gap Vic	> 40	3 months	Yersiniosis (non pestis) and endoparasitism	Lethargy, emaciation, oedema		WHA 2024 [7]
2021	EGK	Newham Vic	>30	1 month	Endoparasitism (*Globocephaloides trifidospicularis, Wallabicestus ewersi*) and possible toxoplasmosis	Found dead	Followed wet weather, food shortage, high faecal contaminat-ion, high macropod density	WHA 2024 [7]

Year	Species	Location	No. dead[#]	Duration of event	Cause (confirmed or suspected)	Clinical and or pathological signs	Notes	Reference
2021	EGK	Raymond Island Vic	>20	7 weeks	Endoparasitism (*Rugopharynx rosmariae, Torquenema toraloboformis)*	Found dead	Followed wet weather, food shortage, high faecal contaminat-ion, high macropod density	WHA 2024 [7]
2015	EGK	ACT, southern NSW		July - Sept	Malnutrition			Grillo et al. 2015 [5], Portas and Snape 2018 [6]
2014	EGK	Wacol Qld	30	Days to weeks	Malnutrition, fascioliasis	HT, OT		Grillo et al. 2014 [8]
2014	EGK	Wagga Wagga NSW	85	6 weeks	Plant toxins (saponins)	BL, HT, OT		Grillo et al. 2014 [9]
2014	EGK	Lake Macquarie NSW	300+		*Babesia* sp.	NS, SC, OT		Arthur 2014 [10], Donahoe et al. 2015 [11]
2011	EGK	ACT	<100		Endoparasitism *(Globocephaloides* sp.)			
2010	CW, RK, EGK	Tiboo-burra NSW SW Qld (around Quilpie and Cunna-mulla)	400-1200	6 weeks	Not identified	BL, SC, JT, AT, OT	Heavy rain and increased insect activity	Gordon et al. 2010 [1], Curran 2011 [12], Grillo et al. 2011 [13], Grillo and Post 2010 [14]
2010	EGK	Vic	<100		Endoparasitism *(Globocephaloides* sp.)			
2009	RK	Kunu-nurra WA	Not reported		Not identified			
2009	EGK	Vic	<100		Endoparasitism *(Globocephaloides* sp.)			
2006	RK	Alice Springs NT	Not reported		Not identified			
2006	EGK	NSW	<100		Endoparasitism *(Globocephaloides* sp.)			

Year	Species	Location	No. dead[#]	Duration of event	Cause (confirmed or suspected)	Clinical and or pathological signs	Notes	Reference
2005	RK	Meeka-tharra WA	3000		Presumptive starvation		Presumptive starvation; drought conditions	
2005	EGK	Vic	<100		Endoparasitism (*Globocephaloides* sp.)			
Oct 1998	RK, WGK, CW	Marree SA NW NSW Hunger-ford Qld	>1,000 (anecdot ally 50,000+)	Several days	Not identified (no samples)	Stiffness, lameness, loss of condition.	Followed heavy rains and increased insect activity	Curran et al. 1999 [15]
1994 -6	WGK, RK, EGK, CW	NSW, Vic, SA, WA, Qld	Not reported	Months	Wallal-Warrego blindness	Blindness or other severe ocular pathology	Notable insect activity.	Hooper et al. 1999 [16], Reddacliff et al. 1999 [17]; Curran et al. 1997 [18]
May 1990	CW, RK	Central western Qld	200+	Weeks	Not identified	Weakness, ataxia; meningo-encephalitis and pneumonitis	Followed severe rains, flooding and increase in black fly numbers	Clancy et al. 1990 [19], Speare et al. 1991 [20];
1983	NR	Western Qld	Not reported		Not identified	Not reported	Following extended drought	Speare et al. 1989 [3]
1970	EGK	Vic	Not reported		Endoparasitism (coccidiosis)	Haemorrhagic enteritis, hypo-proteinaemia	Following a flooding event	Barker et al. 1972 [21]
1957	EGK	Qld	<100		Endoparasitism (*Globocephaloides* sp.)	Thin, oedema, hydro-peritoneum	Orphaned subadults in care	Winter 1958 [22]

Epidemiology

The epidemiology of free-ranging macropod mortalities varies according to the cause. In most cases, multiple causal factors combine to result in a mass mortality event. Causes of previous macropod mass mortalities include:

- malnutrition (secondary to drought or seasonal scarcity of pasture, deaths may be age-dependent, most often occurring in subadults)
- heavy endoparasitic burdens (*Globocephaloides* spp., coccidia spp., fascioliasis)
- exposure to toxins, including plant toxins and anthropogenic toxins such those used for vertebrate pest control e.g. pindone.

- orbivirus infection (e.g. Wallal, Warrego or other serogroups)
- unidentified arbovirus infections
- protozoal infections (e.g. *Babesia* sp.)
- other unknown aetiologies.

Environmental stressors, including extreme climatic conditions, may predispose a population towards a mortality event by:

- depleting available resources
- creating localised overcrowding and competition for resources
- predisposing to heavy burdens of endoparasites
- encouraging grazing of toxic plants
- placing additional physiological stress on already compromised individuals.

Mortalities caused by *Globocephaloides* spp. gut parasites generally occur in juvenile and sub-adult animals during winter, influenced by high population density and depleted food supplies [23]. Deaths due to **intestinal coccidiosis** may occur after flooding, which may drive increased population densities and food shortages; damp conditions and the use of feed supplementation onto the ground may be other factors influencing outbreaks [21].

Winter mortality events appear to occur as a result of combined effects of endoparasitism, reduced food resources and thermal stress (cold) in sub-adult (i.e. growing, inexperienced, recently weaned) eastern grey kangaroos. These events mortalities most often occur when population density is considered high [4-6].

Factors driving **orbivirus outbreaks** are not well understood but probably include increase in vector numbers following rain in drier areas of the inland. For more information see WHA Fact Sheet 'Orbiviruses in macropods'.

***Babesia** macropus* infection has been associated with a syndrome of anaemia and debility in hand-reared and free-ranging juvenile eastern grey kangaroos (*Macropus giganteus*) and other macropods from coastal NSW and south-eastern Qld [11, 24, 25]. Stress of handling and captivity may contribute to the development of disease.

Chronic phalaris toxicity has been reported in kangaroos, in particular eastern grey kangaroos, but also in western grey kangaroos, red kangaroos and wallabies [26, 27]. Phalaris grass is used as pasture in south-eastern Australia and chronic toxicity seems to occur after animals graze rapidly growing young plants, particularly following rain after a prolonged dry spell. Multiple animals are usually affected, and may be euthanased for welfare reasons, however mass mortalities rarely occur [28, 29].

Pindone toxicity has been reported in macropods. Pindone is used as a toxin to control feral rabbit populations and macropods appear to be highly sensitive to pindone toxicity [30].

The causes of the large inland NSW and Qld mortality events have not been identified. Some events appear to be associated with heavier than average rainfall and flooding, and concurrent increased insect (possible viral vector) populations. Individual events also occur in relatively confined geographical areas. Deaths typically occur over a 1-2 week period (sometimes longer) [12]. The extent of mortalities is difficult to quantify or even estimate with any accuracy, particularly in

remote areas. Anecdotal reports of the number of deaths range from hundreds to more than 50,000 animals.

Clinical signs

Clinical signs will vary dependent on the causal factors.

Endoparasitism: animals affected by *Globocephaloides* sp. or coccidiosis are generally weak (due to severe anaemia and hypoproteinaemia) or found dead.

Starvation: animals dying during drought or winter mortality events are thin with depleted fat and muscle stores. Animals appear unwell, with a poor coat condition. They are reluctant to move away from humans and continue to graze when disturbed.

Drought: animals are characteristically clustered around shade trees, in caves or near dried-up water sources.

Orbiviruses (Wallal/Warrego viruses): affected macropods are blind, appear confused and have few other obvious clinical signs.

Babesia: anaemia, lethargy and neurological signs, often leading to death. There may be polydipsia, polyuria, and tendency to bleed excessively from venipuncture and tick attachment sites.

Plant toxicities: macropods display varying signs, dependent on the toxins involved. Chronic phalaris toxicity in kangaroos presents with neurological signs including ataxia, head tremors and collapse. Sometimes animals are found dead [26].

In some **large mortality events associated with rain** (but of unknown aetiology), animals may appear stiff, reluctant to move, with signs of lameness and blindness. Animals may be found dead despite abundant food resources. Some individuals in the 2010 Qld event had floppy ears and swollen joints.

Diagnosis

The logistic and diagnostic challenges of confirming an aetiological diagnosis for macropod mass mortalities should not be underestimated. It is always challenging to investigate diseases of unknown aetiology, but additional challenges include:

- The remote geographical location of many events and low human population density may make detection and notification of events challenging. It may be difficult to get suitably experienced investigators to the scene, and notifications may not be made until the event is well-underway or even resolved, making it difficult to examine and sample affected animals early in the course of the disease.
- Wild macropods are cryptic in nature and it may be difficult to observe animals for signs of disease and abnormal behaviours.
- Sourcing a suitable number of fresh carcasses, or affected live animals, is often difficult in free-ranging populations, particularly in remote areas and when climate is harsh.
- There may be issues with appropriate storage and transportation of samples, including continuity of a cold chain, which reduce the diagnostic value of samples.

- A lack of resources may compound a lack of available diagnostic tests, or validated tests for non-domestic species.
- There is a lack of baseline information on health and disease in free-ranging populations, particularly those in remote areas, which makes interpretation of findings challenging.

Whenever practical, thorough investigation by experienced wildlife veterinarians, including post-mortem investigation and sampling, gives the best chance of determining a diagnosis for macropod mass mortality events [2].

Laboratory diagnostic procedures and specimens

Many macropod mortality events remain undiagnosed in spite of investigation. The best chance of diagnosis lies in:

- a structured epidemiological approach to identify and record of risk factors
- collection of representative, high quality diagnostic samples
- involvement of experienced wildlife veterinary practitioners to enable systematic disease investigation.

A wide range of procedures may be necessary for investigation of mortality events.

Where possible, live affected animals should be examined by an experienced wildlife veterinarian. Video and photographs, and detailed clinical records may assist if this is not possible.

Samples may be collected from live affected individuals, or at point of euthanasia, including blood for haematology, biochemistry, serology, PCR, virology and toxicological investigation. Full post-mortem investigation and sampling should be undertaken on euthanased or freshly dead individuals. Ideally, investigation should be undertaken by trained and experienced field personnel. If necessary, appropriately trained and authorised lay staff may undertake post-mortem investigation, under the supervision of a veterinarian. Detailed written protocols will assist this process.

A number of animals, comprising a representation of species, ages and sexes affected, should be sampled from each site. A minimum sample set of ten individuals (more where possible) will allow for more robust interpretation and analysis of results. Whenever possible, samples should be collected from a number of unaffected individuals as well, to provide baseline and allow for comparison.

For a thorough investigation, when there is no clear cause, samples collected should include:

- representative samples of all organs - both fixed in formalin and stored fresh (chilled)
- faeces - fresh, held chilled for faecal floatation
- gastrointestinal contents – fresh, chilled and fixed in formalin
- gastrointestinal tract parasites - relaxed in water then into 70-90% ethanol
- a range of swabs, collected using aseptic technique, in transport medium for bacteriology, virology and additional investigation
- additional samples, where possible, of brain, lung, and liver - fixed in glutaraldehyde for electron microscopy and frozen in liquid nitrogen for bacteriology, virology and toxicology
- a sterile sample of aqueous humour for toxicology

- specimens of insects (in liquid nitrogen or 70% ethanol), plants and water (in sterilised sealed containers) should be collected at each site, where possible.

Clinical pathology

Clinical pathology changes, if present, will vary according to the aetiology of the event.

Changes due to **endoparasitism** include anaemia and hypoproteinaemia. ***Babesia*** organisms may be visible in peripheral blood smears. For most other causes of macropod mass mortality, there are no known consistent clinical pathology changes.

Pathology

Gross and histopathological changes, if present, will vary according to the aetiology of the event.

Starvation (drought or winter mortality): depleted fat stores, reduced muscle mass, indicative of chronic starvation.

Endoparasitism: *Globocephaloides* - no fat stores and large numbers of red worms in the proximal duodenum. Coccidiosis - extensive haemorrhagic enteritis and identifiable coccidial life stages.

Orbiviruses (Wallal/Warrego viruses)**:** non-suppurative panuveitis and retinitis, optic neuritis, and (in about 45% of cases) a non-suppurative meningoencephalitis [31].

Babesia: anaemia, intravascular haemolysis, hypoproteinaemia, thrombocytopaenia, neutropaenia, azotaemia and bilirubinaemia [24]. Necropsy findings include diffuse pallor, thin blood, widespread petechiae, ecchymoses, tissue oedema, splenomegaly and generalised lymphadenomegaly [11].

Toxicity: changes will vary depending on the toxins involved. In chronic phalaris toxicity, there is greenish discolouration in the grey matter of the brain and spinal cord with intracytoplasmic accumulations of pigment granules in the neurons [26].

Pathology is variable in mortality events of unidentified cause. There is often no consistent clinical or pathological presentation within or between events. Changes reported across events are diverse in nature. Reported changes (which may not be present in each individual or event), include:

- severe polyarthritis of limbs
- subcutaneous haemorrhage
- congestion of bone marrow and body fat
- splenomegaly and pericardial effusion, myocardial necrosis, dermal vasculitis, myositis, anaemia (2010)
- parasitic larval tracts through hindlimb muscles (1998)
- focal necrosis of heart, liver and spleen, intravascular thrombi, mild acute mononuclear meningoencephalitis, choroid hyperplasia, interstitial pneumonitis, and chronic dermatitis consistent with bites from blackfly (*Austrosimulium pestilens*) (1990).

Prevention, control and treatment

In most cases of macropod mass mortality, prevention and control methods are generally not feasible. Treatment of individual macropods involved in mortality events is rarely undertaken but will be dependent on the cause. Euthanasia may be required for welfare reasons. Prevention and control will depend upon identification of causal factors and the ability for management actions to be applied. For arboviruses, control of vectors may be of use, but this presents logistical difficulties in field situations.

Research

Key research questions include:

- what are the proximate causes of macropod mortality events?
- what are the perspectives and cultural knowledge of Indigenous Custodians of Country, with respect to mass mortality events of large macropod species?
- should there be management actions to attempt to mitigate or prevent these events, or are they part of the normal ecology of large macropods in Australia?
- if infectious agents are involved, what are they, how are they transmitted and what risk factors are associated?
- what other causal factors contribute to mortality events?

Surveillance and management

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.

Kangaroo meat processors closely monitor animal health through observation and carcass inspection to ensure that diseased animals do not enter the meat supply chain. Food safety is a priority of state, territory and commonwealth governments in Australia. All export and domestic establishments processing kangaroo carcasses for human consumption must comply with the Australia Standard for the Hygienic Production of Wild Game Meat for Human Consumption. This standard includes a post-mortem assessment of every carcase for abnormalities and evidence of disease to determine whether the meat is fit for human consumption.

Unusual mass mortality events of free-ranging macropods can be reported to the WHA Coordinator in your state or territory, see https://wildlifehealthaustralia.com.au/Incidents/Report-An-Incident

The national wildlife health information system (eWHIS) contains details of mortality events in large macropod species around Australia.

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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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