Public Submission:

Worsley Mine Expansion – Revised Proposal – Public Environmental Review

the BEELIAR GROUP

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Glossary

Jarrah-Marri-Wandoo forest:	refers to the Northern Jarrah Forest subregion[1]
proposal:	Worsley Mine Expansion – Revised Proposal
proponent:	South32 Worsley Alumina Pty Ltd
ERD:	Environmental Review Document
EP Act:	*Environmental Protection Act 1986*
State Agreement Act:	*Alumina Refinery (Worsley) Agreement Act 1973*
State Agreement:	the Alumina Refinery (Worsley) Agreement

Note

This submission uses the term 'destruction' to refer to the clearing of native vegetation – and, specifically, to the 'clearing' of Jarrah-Marri-Wandoo forest. Use of 'destruction' to describe the manner in which mining operations for the proposal will remove native vegetation from land:

(a) is consistent with the definition of 'clearing' in section 51A of the EP Act, which includes the 'killing or destruction' of native vegetation; and

(b) accurately characterises the mining process, which requires the complete removal of native vegetation and removal or disturbance of the underlying substrate from areas to be mined or areas required for other mining-related purposes (eg for roads).

[1] A description of the subregion is available here:
https://www.dpaw.wa.gov.au/images/documents/about/science/projects/waaudit/jarrah_forest01_p369-381.pdf

Recommendation & Summary

Recommendation

The EPA conclude that the Worsley Mine Expansion Revised Proposal is environmentally unacceptable and should not be implemented.

Summary

Protecting the State's environment in a changing climate

1. The objective fact of climate change and its impact on the State's environment is now so substantial that the objective of the EPA is now to use its best endeavours to protect the State's environment *in a changing climate*.
2. This objective not only informs how the EPA carries out its environmental assessment function under Part IV of the *Environmental Protection Act 1986* (EP Act), but sets a boundary as to what may be considered reasonable in the EPA's considered opinion as to whether a proposal is environmentally acceptable, and thus whether the proposal is appropriate to be implemented.
3. Recommending that this proposal can be implemented exceeds this boundary of what is reasonable, both for climate change-related reasons but also for other reasons discussed in this public submission.
4. A recommendation by the EPA that the proposal not be implemented does not necessarily prevent the project being implemented. The EP Act allows the Minister to authorise the implementation of a proposal regardless of what the EPA concludes and recommends. In doing so, the Minister may have regard to both to environmental and non-environmental factors. However, a recommendation by the EPA that the proposal not be implemented would clearly communicate the environmental unacceptability of the proposal to the Minister, thus enabling the Minister to make a decision that more properly recognises the environmental factors relevant to the proposal.

Collapse of the northern Jarrah-Marri-Wandoo Forest ecosystem

5. The northern Jarrah-Marri-Wandoo Forest ecosystem is collapsing, as outlined by Bergstrom et al. (2021) in the excerpt contained in Appendix 1 of this submission and the references listed there (including extensive field studies in the northern Jarrah-Marri-Wandoo Forest).
6. This on-going collapse is an objective fact which must underpin the assessment of this proposal and the EPA's evaluation of whether the proposal can be managed to meet its objectives for the key environmental factors, having regard to cumulative impacts and in accordance with the object of the EP Act, the object of the EPA, and the EP Act principles.

The proposal requires broad-scale land clearing and is deforestation

7. Implementation of this proposal will require the broad-scale clearing of Jarrah-Marri-Wandoo forest. The proposal is deforestation, being the conversion of native forest to another land use.
8. The conversion will be permanent because (a) the proponent's rehabilitation creates an alternate vegetation state for mined land that differs in critical respects from the Jarrah-Marri-Wandoo forest that is cleared and the forest that remains in areas adjacent to mining, and (b) climate change, fire and associated processes will severely constrain what rehabilitation can achieve.

Residual Impacts

9. The residual impacts of the proposal include this conversion of Jarrah-Marri-Wandoo forest to an alternate vegetation state. This conversion to an alternate vegetation state will occur (a) through the destruction of Jarrah-Marri-Wandoo forest, including the underlying substrate, and the post-mining revegetation of that land according to the proponent's rehabilitation protocols, and (b) in an environmental context of climate change and altered fire regimes characterised by declining rainfall, extreme climatic events (drought, heatwaves), regolith drying, intensified pressures from plant pathogens, and more intense fire.
10. Relative to the Jarrah-Marri-Wandoo forest that is cleared and that remains in areas adjacent to mining, this alternate vegetation state will:
    a. support substantially less biodiversity (i.e. less species richness and diversity, consistent with absence of suites of 'recalcitrant' genera and species)
    b. have substantially different ecological integrity (i.e. different composition, structure, function and processes, and differences in the range of variation of these elements[2])
    c. be substantially more likely to experience:
        i. plant mortality, crown dieback, reduced productivity, and other forms of ecosystem degradation in response to drought, regolith drying, heatwaves and other climate change-related processes (e.g. disease, more frequent or more intense fires);
        ii. catastrophic forest damage through broad-scale tree mortality and crown dieback events due to even agedness in the replanted species; and
        iii. biomass loss, and particularly catastrophic biomass loss, in intense fires;
    d. completely lack mature and hollow-bearing trees as planted species require 150 years or more to commence potential for hollow bearing and a drying climate will extend this period out further;
    e. have substantially weaker carbon security (i.e. has a higher probability of carbon reversal) because of greater probability of plant mortality and catastrophic biomass loss from climate-related processes and fire; and

[2] This is the definition for 'ecological integrity' in the *Environmental Factor Guideline: Flora and Vegetation*.

f. have soils whose chemical, physical, and biological characteristics are substantially less able to support ecosystem health values including biodiversity, water retention for biota, and seed banks.

11. Given this residual impact, the proponent cannot achieve an environmental outcome for the proposal that achieves the EPA's objectives for the flora and vegetation environmental factor and that is consistent with the EP Act's object and principles.
12. There are no reasonable conditions which could be applied to adequately mitigate these residual impacts. Adequate mitigation is not possible because climate change and associated processes, including fire and regolith drying, fundamentally constrain what rehabilitation of mined areas can achieve.
13. On that basis, these residual impacts of the proposal are not manageable.

Section 16(e) strategic advice for the northern Jarrah-Marri-Wandoo forest

14. The EPA should prepare strategic advice on the northern Jarrah-Marri-Wandoo Forest under section 16(e) before completing assessment of the proposal.

Rehabilitation

15. The EPA requires an independent review by experts in mine land restoration of rehabilitation completed to date and completion criteria and proven ability by the company to achieve a substantially higher standard of restoration in the proposed expansion.
16. The proponent has provided insufficient evidence to evaluate its ability to meet its existing rehabilitation commitments or to achieve the completion criteria.
17. Although the Environmental Review Document (ERD) and appendices contain some descriptions of the protocols the proponent applies for rehabilitation, there is almost nothing as to the efficacy of these protocols in achieving like-for-like reinstatement of forest ecosystem diversity and values. Among other issues, there is almost no discussion in the ERD and its appendices regarding the implications of climate change and other linked processes for rehabilitation of cleared Jarrah-Marri-Wandoo forest.
18. The ERD erroneously states, in Figures 5-14 and 5-15, that the mean number of native species per plot for the Forest Monitoring Plots is 60 species, when Table 5-21 reports that the mean number of native species per Forest Monitoring Plot is 70 species.

State Agreement and requirements for rehabilitation

19. Sections 5.3.7.3.1 and 5.3.7.3.2 of the ERD misconstrue the State Agreement as being the 'only existing requirement that currently applies to the relevant rehabilitation', and incorrectly assert (or imply) that the proponent has chosen, by its own volition, to rehabilitate cleared Jarrah-Marri-Wandoo forest to a 'higher standard'.

Offsets are not appropriate for the proposal

20. Offsets for the impacts are not appropriate because no offset is capable of achieving a benefit for the environment commensurate with the environmental value lost through the conversion of Jarrah-Marri-Wandoo forest to an alternate vegetation state with substantially less environmental value to ecosystem function on a bioregional basis and for support of threatened species.
21. Offsets are also not appropriate for this proposal because there is no additionality to the land parcels proposed for 'Habitat Protection' as an offset benefit for Direct Offset 1 and Direct Offset 2. The proponent owns the land parcels and there is no there is no real or appreciable risk of those lands being cleared of existing native vegetation or of the environmental degradation of those lands. As such, the maintenance of those lands in their current condition – even with a change in tenure such as a conservation covenant or their being added to the conservation estate – does not generate any appreciable or material gain that would not otherwise have occurred.

Environmentally unacceptable– broad-scale land clearing

22. The EP Act's legislative scheme for clearing native vegetation includes a prohibition on clearing and a set of principles for when native vegetation should not be cleared. In enacting such a scheme, Parliament created a strong normative framework for the conservation of native vegetation in this State.
23. This normative framework informs the basic object of the Act and the EPA – 'to protect the State's environment' – the EP Act principles, and the standards of environmental acceptability the EPA must apply in assessing proposals and evaluating impacts on key environmental factors. Given this normative framework – and prevailing community standards regarding native vegetation – a proposal for the broad-scale clearing of native forest cannot be environmentally acceptable.

Welfare of wild animals

24. The destruction of Jarrah-Marri-Wandoo forest will harm individual wild animals. The harm that individual wild animals will experience because of the destruction of Jarrah-Marri-Wandoo forest is a relevant consideration and an environmental factor for the EPA to consider in its assessment of the proposal.
25. It is an objective fact that implementation of the proposal will have a significant effect on living things, their physical surroundings, and the interactions between living things and their physical surroundings because of the severity of the harm that will be caused (eg death, traumatic injury, other pathological conditions) and the numbers of animals that will be harmed.
26. The impact of a proposal on individual wild animals is relevant to the assessment of:
    a. the proponent's application of the mitigation hierarchy (e.g. to avoid and minimise actions that harm individual wild animals);

b. whether reasonable conditions to manage the impacts of the proposal on individual wild animals cannot be imposed to materially reduce inconsistency with the EPA objectives for the terrestrial fauna factor; and

c. the significance of the proposal's environmental impact and environmental acceptability as a whole (e.g. in terms of the number of animals that will be killed and injured, the nature and severity of harms to animals).

Submissions

Sections

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I. Protecting the State's environment in a changing climate

SUBMISSION 1

1. **Climate change and its impact on the State's environment – being 'living things, their physical, biological and social surroundings, and interactions between all of these'[3] – are an objective fact for the EPA to consider when carrying out its functions under the EP Act, including its environmental impact assessment function under Part IV.**
2. **The objective fact of climate change and its impact on the State's environment is now so substantial that it must be taken to inform the content of:**
    a. **the object of the EP Act, being 'to protect the environment of the State' having regard to the five principles in section 4A;**
    b. **the five principles in section 4A (the precautionary principle, the principle of intergenerational equity, the principle of the conservation of biological diversity and ecological integrity, principles relating to improved valuation, pricing and incentive mechanisms, and the principle of waste minimisation);**

[3] As defined in section 3 of the EP Act.

c. the objective[4] of the EPA, being to use its 'best endeavours' to (a) protect the environment and (b) to prevent, control and abate pollution and environmental harm;

d. the objectives of the EPA's environmental factors; and

e. the environmental acceptability of proposals.

3. That the objective of the EPA is now to use its best endeavours to protect the State's environment *in a changing climate*, not only informs how the EPA carries out its environmental assessment function, but sets a boundary as to what may be considered reasonable in the EPA's considered opinion as to whether a proposal is environmentally acceptable, and thus whether the proposal is appropriate to be implemented.

4. Recommending that this proposal can be implemented exceeds this boundary of what is reasonable, both for climate change-related reasons but also for other reasons discussed in this public submission.

5. A recommendation by the EPA that the proposal not be implemented does not necessarily prevent the project being implemented. The EP Act allows the Minister to authorise the implementation of a proposal regardless of what the EPA concludes and recommends. In doing so, the Minister may have regard to both to environmental and non-environmental factors.

6. Importantly, however, a recommendation by the EPA that the proposal not be implemented would clearly communicate the environmental unacceptability of the proposal to the Minister, thus enabling the Minister to make a decision that more properly recognises the environmental factors relevant to the proposal.

SUBMISSION 2

1. The objective fact of climate change and its impact on the northern Jarrah-Marri-Wandoo forest is so substantial that that it strongly influences, limits, or affects:

a. the residual impacts of the proposal, being the impacts that remain after the application of the mitigation hierarchy, including mitigation through rehabilitation of mined land;

b. the environmental outcomes that the proponent can plausibly claim to achieve after the proposal has been implemented, in terms of the vegetation state that the proponent can plausibly claim to achieve through rehabilitation of mined land;

[4] As set out in section 15 of the EP Act.

c. the degree of inconsistency between the residual impacts of the proposal and the EPA's objectives for its environmental factors, notably flora and vegetation, terrestrial fauna, and terrestrial environmental quality; and

d. the cumulative impacts on the area affected by the proposal and on the northern Jarrah-Marri-Wandoo forest; and

e. the appropriateness of offsets.

Contextual information for Submissions 1 and 2

1. The *Independent Legal and Governance Review into Policies and Guidelines for Environmental Impact Assessments under the Environmental Protection Act 1986 (WA)*[5], undertaken by Peter Quinlan SC (now Chief Justice Quinlan), Eric Heenan, and Sunili Govinnage in 2016, made the following points about the environmental impact assessment of proposals by the EPA under Part IV of the EP Act:

    a. Whether the EPA recommends that a proposal be or not be implemented is not a matter of a discretionary choice, but the expression of the EPA's considered opinion as to whether the proposal is appropriate to be implemented.

    b. The EPA's decision whether to recommend implementation of a proposal must be made in accordance with the objective facts identified in the course of the assessment and by reference to the key environmental factors identified by the EPA in accordance with the objective and principles of the EP Act, and the objective[6] of the EPA.

    c. The EPA's function does not include weighing the competing social, commercial or economic benefits of a proposal against the environmental impacts of the proposal.

    d. The scheme of the EP Act as a whole clearly recognises that, in a particular case, environmental impacts may be outweighed by the social or economic benefits to be gained by the implementation of a proposal. However, the weighing of those competing factors is to be carried out by the Minister (or the Governor in Council), not by the EPA.

    e. The structure of Part IV makes it clear that the Minister may allow the implementation of a proposal, notwithstanding that the EPA has recommended that it not be implemented. In so determining the Minister may have regard to both to environmental and non-environmental factors.

[5] Available at: https://www.epa.wa.gov.au/legal-and-governance-review
[6] The EPA is to use its 'best endeavours' to (a) protect the environment and (b) to prevent, control and abate pollution and environmental harm: section 15.

f. The overriding consideration for the EPA, in performing any of its functions, including the environmental impact assessment function, must always be the terms of the EP Act. Any policy, procedure or guideline developed by the EPA must have, as its touchstone, the requirements of the EP Act and the purposes and objectives set out in it.

II. Collapse of the northern Jarrah-Marri-Wandoo forest ecosystem

SUBMISSION 3

The northern Jarrah-Marri-Wandoo Forest ecosystem is collapsing.[7]

Bergstrom et al. (2021) define collapse as 'a change from a baseline state beyond the point where an ecosystem has lost key defining features and functions, and is characterised by declining spatial extent, increased environmental degradation, decreases in, or loss of, key species, disruption of biotic processes, and ultimately loss of ecosystem services and functions' (page 693).

Appendix 1 for this submission contains an excerpt from Bergstrom et al. (2021) relating to the northern Jarrah-Marri-Wandoo forest.

SUBMISSION 4

This on-going collapse of the northern Jarrah-Marri-Wandoo Forest ecosystem is an objective fact which must underpin the assessment of this proposal and the EPA's evaluation of whether the proposal can be managed to meet its objectives for the key environmental factors, having regard to cumulative impacts and in accordance with the object of the EP Act, the object of the EPA, and the EP Act principles.

SUBMISSION 5

The conversion of a substantial area of Jarrah-Marri-Wandoo forest to an alternate vegetation state is inconsistent with the imperatives to ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations and to treat the conservation of biological diversity and ecological integrity as a fundamental consideration.

[7] See Bergstrom, D. M. et al. (2021). 'Combating ecosystem collapse from the tropics to the Antarctic'. 27(9) *Global Change Biology*: 1692-1703, doi:10.1111/gcb.15539.

III. The proposal requires broad-scale land clearing and is deforestation

SUBMISSION 6

1. **Implementation of this proposal will require the broad-scale clearing of Jarrah-Marri-Wandoo forest.**
2. **The proposal is deforestation, being the conversion of native forest to another land use.**
3. **The conversion will be permanent because:**
    a. **the proponent's rehabilitation creates an alternate vegetation state for mined land that differs in critical respects from the Jarrah-Marri-Wandoo forest that is cleared and the forest that remains in areas adjacent to mining; and**
    b. **Climate change, fire and associated processes will severely constrain what rehabilitation can achieve.**[8]

This submission is discussed further under *Residual Impacts*.

Contextual information for Submission 6

1. The vegetation to be cleared for the Revised Proposal comprises 5341 ha of native vegetation (including previously approved 942 ha), 605 ha of rehabilitation vegetation, and 86 ha of plantation.[9] Of this, 4826 ha (80%) will be rehabilitated concurrent with mining operations and 1206 ha (20%) will be rehabilitated only at mine closure.
2. Tables 5-18 and 5-19 indicate that the approval of the additional 4399 ha of native vegetation clearing sought would bring the total approved native vegetation clearing as a result of the Revised Proposal to 9662 ha and 8400 ha in the Extended Mining Areas, which is 18062 ha.

IV. Residual Impacts

SUBMISSION 7

The residual impacts[10] of the proposal include the conversion of Jarrah-Marri-Wandoo forest to an alternate vegetation state.

[8] See, eg, Wardell-Johnson, G.W. et al. (2015. 'Integrating rehabilitation, restoration and conservation for a sustainable jarrah forest future during climate disruption.' 21(3) *Pacific Conservation Biology*: 175-185.
[9] See pages 396 and 407 of the ERD.
[10] Being 'the impact(s) of a proposal that are expected to remain after the application of the mitigation hierarchy', as defined in the EPA's *Environmental outcomes and outcomes-based conditions – Interim Guidance* document.

SUBMISSION 8

This conversion to an alternate vegetation state will occur:

a. **through the destruction of Jarrah-Marri-Wandoo forest, including the underlying substrate, and the post-mining revegetation of that land according to the proponent's rehabilitation protocols; and**
b. **in an environmental context of climate change and altered fire regimes characterised by declining rainfall, extreme climatic events (drought, heatwaves), regolith drying, intensified pressures from plant pathogens, and more intense fire.**

SUBMISSION 9

Relative to the Jarrah-Marri-Wandoo forest that is cleared and that remains in areas adjacent to mining, this alternate vegetation state will:

a. **support substantially less biodiversity (i.e. less species richness and diversity, consistent with absence of suites of 'recalcitrant' genera and species);**
b. **have substantially different ecological integrity (i.e. different composition, structure, function and processes, and differences in the range of variation of these elements[11]);**
c. **be substantially more likely to experience:**
    i. **plant mortality, crown dieback, reduced productivity, and other forms of ecosystem degradation in response to drought, regolith drying, heatwaves and other climate change-related processes (e.g. disease, more frequent or more intense fires);**
    ii. **catastrophic forest damage through broad-scale tree mortality and crown dieback events due to even agedness in the replanted species; and**
    iii. **biomass loss, and particularly catastrophic biomass loss, in intense fires;**
d. **completely lack mature and hollow-bearing trees as planted species require 150 years or more to commence potential for hollow bearing and a drying climate will extend this period out further;**
e. **have substantially weaker carbon security (i.e. has a higher probability of carbon reversal) because of greater probability of plant mortality and catastrophic biomass loss from climate-related processes and fire; and**

[11] This is the definition for 'ecological integrity' in the *Environmental Factor Guideline: Flora and Vegetation*.

f. have soils[12] whose chemical, physical, and biological characteristics are substantially less able to support ecosystem health values including biodiversity, water retention for biota, and seed banks.

SUBMISSION 10

1. **Given this residual impact, the proponent cannot achieve an 'environmental outcome'[13] for the proposal that achieves the EPA's objectives for the flora and vegetation environmental factor and that is consistent with the EP Act's object and principles.**
2. **There are no reasonable conditions which could be applied to adequately mitigate these residual impacts. Adequate mitigation is not possible because climate change and associated processes, including fire and regolith drying, fundamentally constrain what rehabilitation of mined areas can achieve.**
3. **On that basis, these residual impacts of the proposal are not manageable.**

SUBMISSION 11

1. **The Residual Impact Significance Model expressed in table 5-52 is fundamentally misconceived because it evaluates impacts on the Part IV environmental factors by reference to the Part V clearing principles.**
2. **This reflects an error in the design of the EPA in the 'Preliminary offset triggers – Residual Impact Significance Model' template document contained in the EPA's instruction document *How to prepare an Environmental Review Document – Instructions*.**
3. **The clearing principles in Schedule 5 of the EP Act apply to certain decisions made under Part V of the Act. They do not apply to any decision-making by the EPA in Part IV.**
4. **Applied here, in the proponent's Residual Impact Significance Model, the clearing principles operate to improperly constrain the range of considerations relating to residual impacts and offsets (ie to constrain these considerations only to the 'categories' relating to the Schedule V clearing principles).**

[12] Being the 'the layer of organic and inorganic weathered material that accumulates at the Earth's surface' as defined in the *Environmental Factor Guideline: Terrestrial Environmental Quality*.
[13] The EPA's *Environmental outcomes and outcomes-based conditions – Interim Guidance* document defines an environmental outcome, in the context of environmental impact assessment, as 'the state of the environment at a point in time during the implementation or after a proposal has been implemented', and provides that an environmental outcomes are associated with the achievement of one or more of the EPA's objectives for environmental factors.

5. **In accordance with section 44 of the EP Act, the proper context for applying the mitigation hierarchy and the consideration of residual impacts and offsets is the key environmental factors that the EPA has identified as relevant for the assessment.**

V. Section 16(e) strategic advice for the northern Jarrah-Marri-Wandoo forest

SUBMISSION 12

1. **The EPA should prepare strategic advice on the northern Jarrah-Marri-Wandoo Forest under section 16(e) before completing assessment of the proposal.**
2. **The Minister for Environment, and the EPA, require such advice because of:**
   - **the cumulative impacts affecting the northern Jarrah-Marri-Wandoo forest including multiple mining operations and climate;**
   - **large-scale past disruption due to extensive logging, disease and drought impacts;**
   - **evidence the northern Jarrah-Marri-Wandoo forest is collapsing; and**
   - **the coincidence of the EPA's assessment of the Worsley Mine Expansion – Revised Proposal and Alcoa of Australia Limited's Pinjarra Alumina Refinery Revised Proposal.**

VI. Rehabilitation

SUBMISSION 13

1. **The EPA requires an independent review by experts in mine land restoration of rehabilitation completed to date and completion criteria and proven ability by the company to achieve a substantially higher standard of restoration in the proposed expansion.**
2. **An independent review is particularly important because the completion criteria have not been finalised and are therefore not available for public review or for assessment by the EPA.**

SUBMISSION 14

1. **The proponent has provided insufficient evidence to evaluate its ability to meet its existing rehabilitation commitments or to achieve the completion criteria.**

2. **The ERD provides little empirical information on the efficacy of the rehabilitation conducted by the proponent to date.**
3. **Specifically, there is insufficient evidence and analysis for the community (in this public consultation process) and the EPA (in its assessment) to evaluate the proponent's ability to rehabilitate cleared Jarrah-Marri-Wandoo forest (a) to date and (b) in the implementation of the proposal.**
4. **Although the ERD and appendices contain some descriptions of the protocols the proponent applies for rehabilitation, there is almost nothing as to the efficacy of these protocols in achieving like-for-like reinstatement of forest ecosystem diversity and values.**
5. **Among other issues, there is almost no discussion in the ERD and its appendices regarding the implications of climate change and other linked processes for rehabilitation of cleared Jarrah-Marri-Wandoo forest.**
6. **There is no indication in the ERD of how such a large footprint for expansion will address ecosystem dysfunction given there is no documented evidence of the proponent's rehabilitation being on a stable trajectory towards maturity in 150 years.**

SUBMISSION 15

Climate change, fire and associated processes constrain what rehabilitation can achieve.[14]

SUBMISSION 16

1. **The ERD erroneously states, in Figures 5-14 and 5-15, that the mean number of native species per plot for the Forest Monitoring Plots is 60 species, when Table 5-21 reports that the mean number of native species per Forest Monitoring Plot is 70 species.**
2. **This error means that the ERD overstates the species richness of Rehabilitation Monitoring Plots relative to the Forest Monitoring Plots – both the text in section 5.2.5.1 and Figures 5-14 and 5-15 are incorrect and therefore fundamentally misleading about the efficacy of the proponent's rehabilitation of cleared Jarrah-Marri-Wandoo forest to date.**

VII. State Agreement and requirements for rehabilitation

SUBMISSION 17

[14] See, eg, Wardell-Johnson, G.W. et al. (2015. 'Integrating rehabilitation, restoration and conservation for a sustainable jarrah forest future during climate disruption.' 21(3) *Pacific Conservation Biology*: 175-185.

Sections 5.3.7.3.1 and 5.3.7.3.2 of the ERD misconstrue the State Agreement as being the 'only existing requirement that currently applies to the relevant rehabilitation', and incorrectly assert (or imply) that the proponent has chosen, by its own volition, to rehabilitate cleared Jarrah-Marri-Wandoo forest to a 'higher standard'.

Contextual material for Submission 17

1. The State Agreement works in conjunction with the EP Act.
2. This is reflected in clause 17 of the State Agreement[15], which provides

   Environmental Protection

   17. Nothing in this Agreement shall be construed to exempt the Joint Venturers from compliance with any requirement in connection with the protection of the environment arising out of or incidental to the operations of the Joint Venturers hereunder that may be made by the State or any State agency or instrumentality or any local or other authority or statutory body of the State pursuant to any Act for the time being in force.

3. It is also reflected in the previous Part IV EPA assessments completed for proposals arising from under the State Agreement, and to the implementation decision made and implementation conditions imposed, as communicated in the Ministerial statements for those assessments.
4. Under clause 7 of the State Agreement, which deals with aspects of the Mineral Lease, sub-clauses (9)-(14) relate to arrangements for mining on private land:

   Mining on Privately Owned Land[2]

   (9) The Joint Venturers will not commence any mining or related operations for the purposes of this Agreement on any privately owned land within the mineral lease unless and until —

   (a) they have entered into a written agreement with the owner and occupier of such land for the purpose of providing for adequate restoration of the land after mining and that agreement has been approved by the Minister; and

   (b) they have entered into a written agreement with the owner and occupier of such land for compensation arising out of their operations or proposed operations on the land, and within fourteen (14) days after the date thereof or (in the case of an agreement entered into before the date hereof) after the execution of this Agreement lodge a true copy of the agreement with the Minister for Mines.

   (10) The Joint Venturers will by means of contour ploughing, concrete or earth sills, diversion channels, settling ponds and drainage or other approved method as the case may require take all reasonable steps to prevent damage being caused to privately owned land by water runoff and will by every reasonable means prevent soil erosion on such land.

   (11) The Joint Venturers will within thirty (30) days after ceasing mining operations on any area of privately owned land commence to restore the mined area and continue to restore it until the restoration is

[15] See also clause 7 of the Fourth Supplementary Agreement.

completed to the satisfaction of the Minister who in considering any matter relating to such restoration shall have regard to the reasonable requirements of the relevant local authority.

(12) Notwithstanding any rule of law or provision of any agreement referred to in subclause (9)(a) of this Clause to the contrary a reference to mining or mining operations in any such agreement shall be read and construed as including the restoration of any mined area and for that purpose and for the purposes of subclause (11) of this Clause the term "restoration" means the battering and smoothing of pit walls, the spreading of previously removed topsoil, the ground ripping and planting of vegetation of or in a mined area and the verb "to restore" has a corresponding meaning.

(13) Notwithstanding the provisions of subclause (11) of this Clause where the owner of the privately owned land satisfies the Minister that the excavation of any mined area is capable (with or without modification) of being used and should be used for the purpose of water storage or other approved purpose the Minister will by notice to the Joint Venturers relieve them of the obligation imposed by that subclause with respect to that particular mined area.

(14) For the purposes of subclauses (10) (11) and (13) of this Clause, a reference to privately owned land shall be construed as including land owned by the Joint Venturers.

5. Clause 16 deals with arrangements for mining operations on Crown (State Forest) land. Sub-clause (8) relates to the rehabilitation of mined State Forest land:

(8) As may reasonably be required by the Conservator, the Joint Venturers shall from time to time and at their expense take adequate measures —

(i) for the progressive restoration and re-afforestation of the forest destroyed;

(ii) for the prevention of soil erosion;

(iii) for the prevention of the formation of deep water pools and other dangers to persons who may use the forest areas.

PROVIDED THAT the Joint Venturers shall not be obliged to restore to its original contour land on which forest has been destroyed.

6. Relevantly, the State Agreement provided for different arrangements for the rehabilitation of mined areas on private land (which includes land owned by the proponent/Joint Venturers) and on Crown land, but the rehabilitation commitments have always been subject to consultation and agreement with the relevant State management agency[16], and to any implementation conditions imposed by the Minister for Environment.

7. Initially the proponent implemented the rehabilitation program that it committed to in the 1979 environmental review and management programme (ERMP), in consultation with the State management agency, and with subsequent review and amendment.

8. In EPA Report 1209 (November 2005), the EPA observed at page 14 that:

> Once mining activities have ceased it is imperative that the affected areas are rehabilitated such that the post-mining landform is stable, sustainable, and integrated into the surrounding environment. It is expected that State Forest areas will be rehabilitated to a range of local native vegetation types consistent with that normally associated with the equivalent landform. It is

[16] First the Forests Department, then the Department of Conservation and Land Management, the Department of Environment and Conservation, the Departments of Parks and Wildlife, and now the Department of Biodiversity, Conservation and Attractions.

also expected that private land areas will be rehabilitated to a mix of farm land and a range of native vegetation types appropriate to the landform that will at least maintain the area under native vegetation and improve ecological linkage. In order to achieve this goal, the EPA has recommended a condition (Condition 10 in Appendix 4) requiring the proponent to prepare a rehabilitation plan which will ensure that the planning and implementation of rehabilitation is undertaken in a manner consistent with industry best practice, and that rehabilitated areas will ultimately develop sustainable systems compatible with surrounding areas. Importantly, the plan should establish the rehabilitation criteria to be achieved prior to mining commencement. In particular, in developing the rehabilitation plan, the proponent should have regard for the matters identified in Appendix 4 of the ERMP document (URS Australia Pty Ltd, 2004) relating to the assessment of ecosystem sustainability.

9. Minister Statement 719 (April 2006) contained a set of implementation conditions relating to rehabilitation[17], and particularly for the proponent to prepare a Draft Rehabilitation Plan, seek agreement for that Plan, and then implement and comply with the agreed Rehabilitation Plan.

VIII. Offsets are not appropriate for this proposal

SUBMISSION 18

Offsets for the impacts are not appropriate because no offset is capable of achieving a benefit for the environment commensurate with the environmental value lost through the conversion of Jarrah-Marri-Wandoo forest to an alternate vegetation state with substantially less environmental value to ecosystem function on a bioregional basis and for support of threatened species.

SUBMISSION 19

Offsets are also not appropriate for this proposal because there is no additionality to the land parcels proposed for 'Habitat Protection' as an offset benefit for Direct Offset 1 and Direct Offset 2.

1. **The proponent owns the land parcels and there is no there is no real or appreciable risk of those lands being cleared of existing native vegetation or of the environmental degradation of those lands.**
2. **As such, the maintenance of those lands in their current condition – even with a change in tenure such as a conservation covenant or their being added to the conservation estate – does not generate any appreciable or material gain that would not otherwise have occurred.**

[17] See conditions 12(1) to 12(10).

3. **The restoration offsets proposed cannot, within the predicted next decade of high extinction risk of three listed threatened black cockatoos (see the listing of Baudin's Cockatoo, Carnaby's Cockatoo, and Forest Red-tailed Black Cockatoo under the State *Biodiversity Conservation Act 2016* and the Commonwealth *Environment Protection and Conservation Act 1999*) be capable of achieving any substantial improvement in forage and nest capability to match that lost by the clearing proposal.**

IX. Environmentally unacceptable – broad-scale land clearing

SUBMISSION 20

1. **The EP Act's legislative scheme for clearing native vegetation includes a prohibition on clearing and a set of principles for when native vegetation should not be cleared.**
2. **In enacting such a scheme, Parliament created a strong normative framework for the conservation of native vegetation in this State.**
3. **This normative framework informs the basic object of the Act and the EPA – 'to protect the State's environment' – the EP Act principles, and the standards of environmental acceptability the EPA must apply in assessing proposals and evaluating impacts on key environmental factors.**
4. **Given this normative framework – and prevailing community standards regarding native vegetation – a proposal for the broad-scale clearing of native forest cannot be environmentally acceptable.**
5. **The EPA must recommend that the proposal should not be implemented. The Minister (or Governor in Council) may decide to approve the proposal, even if the EPA has recommended against implementation.**

Reasoning for Submission 20

1. Although Part IV and Part V are distinct components of the EP Act, their operation overlaps to create an integrated legislative scheme to regulate the clearing of native vegetation.
2. Part V contains a key feature of this statutory scheme in the section 51C prohibition of the clearing of native vegetation except in certain defined circumstances. As observed by the WA Court of Appeal in *Erujin Pty Ltd v Jacob* (2018) 53 WAR 452:

> Section 51C creates an offence where a person, relevantly, causes or allows clearing, unless the clearing is done in accordance with a clearing permit or is of a kind set out in [Schedule] 6. The provisions of [Schedule] 6 specify clearing for which a clearing permit is not required. Accordingly, the legislative scheme involves, in effect, a general prohibition against the

clearing of native vegetation, subject to certain exemptions. The provisions with respect to clearing permits are one of the exemptions.

A Schedule 6 exemption also applies to clearing of native vegetation assessed under Part IV of the Act, pursuant to section 40 and as part of a proposal referred to the EPA under section 38. The clearing must be in accordance with the implementation agreement or decision.

3. The EPA may decide not to assess a referred proposal if the proposal's significant impacts relate to native vegetation clearing and the EPA considers that the clearing can be regulated under Part V processes to meet its environmental objectives.
4. The value Parliament places on native vegetation is also reflected in the offences of serious environmental harm and material environmental harm. Section 3A defines 'environmental harm' to include direct or indirect harm to the environment involving removal or destruction of, or damage to native vegetation or the habitat of native vegetation or indigenous aquatic or terrestrial animals.
5. The clearing principles set out in Schedule 5 of the Act are a mandatory relevant consideration for the CEO of DWER when considering an application for a clearing permit made under Part V, and the CEO may make a decision that is seriously at variance with the clearing principles if, and only if, in the CEO's opinion there is a good reason for doing so.
6. The effect of the legislative scheme for the clearing of native vegetation in Part V and Schedules 5 and 6 – and the integration with Part IV – is to establish a normative framework. The prohibition in section 51C is a strong norm – in the sense of providing a clear message to the community that the unauthorised clearing of native vegetation is unlawful. Similarly, the clearing principles in Schedule 5 provide a clear set of norms – in the sense of broad community standards – for when native vegetation should not be cleared.
7. Put another way, this normative framework affords high social value to the conservation of native vegetation, even at the consequence of limiting or preventing many human uses of land in Western Australia (e.g. the conversion of native forest or woodland to another land use such as cropping).
8. Broad-scale clearing of native vegetation is fundamentally inconsistent with this normative framework. This basic inconsistency between the Act's emphasis on preventing the clearing of native vegetation except in limited circumstances and a proposal that seeks statutory approval to clear large areas of native vegetation provides an important frame of reference for the EPA's assessment of the significance of the impacts of such a proposal on key environmental factors and the overall 'environmental acceptability' of the proposal.
9. Put simply, such a frame of reference implies that broad-scale clearing of native forest would be 'environmentally unacceptable'.

10. This is also consistent with societal norms relating to deforestation, and the recognition in international law that deforestation is a key threatening process for biodiversity in Australia and internationally. For example, Sustainable Development Goal (SDG) Target 15.2 is to:

    > By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.

11. The EPA may express the environmental unacceptability of the proposal as the residual impacts of a proposal being inconsistent with one or more of the key environmental factors for the proposal (ie failing to meet).
12. The question then arises as to whether:
    a. the proposal can be regulated through reasonable conditions to materially reduce inconsistency with the EPA objective(s);
    b. offsets are appropriate and whether offsets can reduce significant residual impacts so as to render the proposal environmentally acceptable
13. Having regard to the object and principles of the EP Act, the object of the EPA, and the normative framework the Act establishes for the clearing of native vegetation, a proposal to undertake broad-scale clearing of 4400 ha[18] of native forest can only be assessed as fundamentally inconsistent with the EPA factor objective for flora and vegetation, being to protect flora and vegetation so that biological diversity and ecological integrity are maintained.
14. As indicated in other sections of this public submissions, the residual impacts of this proposal on native vegetation are not able to be managed through reasonable conditions to materially reduce inconsistency with the EPA objective for flora and vegetation, and would remain significant. The residual impacts are similarly inconsistent with the EPA's objectives for Terrestrial Fauna and Terrestrial Environmental Quality.
15. Offsets are also not appropriate for this proposal, for reasons discussed elsewhere in this submission.

X. Welfare of wild animals

SUBMISSION 21

The destruction of Jarrah-Marri-Wandoo forest will 'harm' individual wild animals.

[18] Noting the total approved clearing as a result of the Revised Proposal is 9,662 ha and 8,400 in the Extended Mining Area – or c. 18,000 ha, and the cumulative forest loss from mining in the Boddington surrounds and the northern Jarrah-Marri-Wandoo forest as a whole.

Reasoning for Submission 21

1. Destruction of Jarrah-Marri-Wandoo forest will cause 'harm', as that term is defined in section 5 of the *Animal Welfare Act 2002*, to individual wild animals because animals will be killed or injured, or distressed when the vegetation is cleared, or will be otherwise harmed or prevented from engaging in normal behavioural patterns.
2. Section 5 of the *Animal Welfare Act 2002* defines 'harm' to include injury, pain, and distress evidenced by severe, abnormal physiological or behavioural reactions. That section also defines the term 'animal' to mean 'a live invertebrate'.
3. The harm that individual wild animals may experience because of the clearing of Jarrah-Marri-Wandoo forest include death, pain or distress arising from traumatic injury, misadventure, dehydration, exertional myopathy, nutritional disease, or temperature-related injuries. Table 1 in Finn and Stephens (2017)[19] defines and describes these and other relevant pathological conditions.

SUBMISSION 22

The harm that individual wild animals will experience because of the destruction of Jarrah-Marri-Wandoo forest is a relevant consideration and an environmental factor for the EPA to consider in its assessment of the proposal.

Reasoning for Submission 22

1. Section 3(1) of the EP Act defines 'environment' to mean 'living things, their physical, biological and social surroundings, and interactions between all of these'.
2. The natural and ordinary meaning of 'living things' is broad enough to include individual wild animals, as well as higher levels of biological organisation (eg populations, species, communities). Indeed, it would be inconsistent with the natural and ordinary meaning of 'living things' for the EPA to exclude individual wild animals from the ambit of the environmental factors considers in the course of its assessment of a proposal.
3. Further, there is nothing expressly stated in the definition of 'environment' or in the context of Part IV of the *Environmental Protection Act 1986* that compels the EPA to ascribe value to individual wild animals only in instrumental terms, such as their biodiversity value (eg as reservoirs of genetic diversity) or their ecological function (eg as predators, grazers, or bioturbators). Rather, as a 'living

[19] Finn, H. C. and Stephens, N. S. (2017). 'The invisible harm: land clearing is an issue of animal welfare'. 44(5) *Wildlife Research*: 377-391. https://doi.org/10.1071/WR17018. A copy of this paper is included as an attachment to this submission.

thing' it is relevant to consider how a proposal might, at least, affect the bodily integrity of an individual animal.

4. Along with short-term direct and indirect effects associated with the mechanical removal of vegetation, the destruction of Jarrah-Marri-Wandoo forest will change the physical surroundings of individual wild animals (ie living things) and their interactions with those physical surroundings in a way that will cause death, injury, and other pathologies.
5. Section 37B(1) of the *Environmental Protection Act 1986* defines 'significant proposal' to mean a 'a proposal likely, if implemented, to have a significant effect on the environment'. Although the proposal is clearly significant for other reasons, it is also an objective fact that implementation of the proposal will have a significant effect on living things, their physical surroundings, and the interactions between living things and their physical surroundings because of the severity of the harm that will be caused (eg death, traumatic injury, other pathological conditions) and the numbers of animals that will be harmed.
6. Section 44(2)(a) provides that the assessment report of the EPA must set out 'what the Authority considers to be the key environmental factors identified in the course of the assessment. Protecting the welfare of individual wild animals must be considered as an aspect of the EPA's objectives for meeting the terrestrial fauna environmental factor.
7. As such, the impact of a proposal on individual wild animals is relevant to the assessment of:
    a. the proponent's application of the mitigation hierarchy (e.g. to avoid and minimise actions that harm individual wild animals);
    b. whether reasonable conditions to manage the impacts of the proposal on individual wild animals cannot be imposed to materially reduce inconsistency with the EPA objectives for the terrestrial fauna factor; and
    c. the significance of the proposal's environmental impact and environmental acceptability as a whole (e.g. in terms of the number of animals that will be killed and injured, the nature and severity of harms to animals).
8. Consideration of individual wild animal welfare as an aspect of the terrestrial fauna environmental factor aligns with the construction of the term 'biological diversity' in clearing principle (a) in Schedule 5 to include diversity of both flora and fauna by Justice Tottle in *Erujin Pty Ltd v Jacob* [2017] WASC 35 (and supported by the Court of Appeal in *Erujin Pty Ltd v Jacob* (2018) 53 WAR 452). The Court of Appeal found that this construction of term 'biological diversity' is consistent with the definition of 'environment' in section 3(1) of the EP Act (which means, amongst other things, 'living things'), and promotes the express objects in section 4A of the Act, in particular, the protection of the environment and the conservation of biological diversity (which section 4A states 'should be a fundamental consideration').

SUBMISSION 23

The number of individual wild animals harmed by implementation of the proposal will be substantial.

Reasoning for Submission 23

1. The number of individual wild animals that will experience 'harm' because of the clearing of Jarrah-Marri-Wandoo forest during implementation of the proposal will be substantial, and likely will range from hundreds to thousands of individuals per year across the duration of mining activity.

Appendix 1

Reproduced from:

Bergstrom, D. M. et al. (2021). 'Combating ecosystem collapse from the tropics to the Antarctic'. 27(9) *Global Change Biology*: 1692-1703, doi:10.1111/gcb.15539. [see Table S1: Combating ecosystem collapse from the tropics to the Antarctic – Data, pages 70-73]

Ecosystem	**13. Mediterranean-type Forests and Woodlands**, south-western Western Australia (31–35°S)
Biome	Mediterranean region: forests and woodlands
Action	**Avoid, Restore, Renovate**
Baseline state	Mediterranean-type forests and woodlands cover >10,000 km^2. Extensive forests and woodlands experience wet winters and dry summers, and rainfall ranges from 700 mm to 1,100 mm per year. Vegetation comprises a mix of *Eucalyptus*-dominated forests comprising mainly northern jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*), but also tuart (*E. gomphocephala*), and banksia-dominated (*Banksia attenuata* and *B. menziesii*) woodlands of the Swan Coastal Plain. The forests and woodlands are part of the Southwest Australian Floristic Region (SWAFR) biodiversity hotspot[1] with >8,370 native vascular plant taxa. This area has a very high diversity of endemic species, particularly Proteaceae[2]. Ecosystems occur on plateau uplands of Archaean granite outcrops, on some of the oldest soils on Earth, and on sandy, very low fertility soils of the Swan Coastal Plain.
Current state and nature of collapse or shift	The vegetation is now highly fragmented due to clearing for agriculture, mining, and urban development. Since the 1970s, rainfall has greatly reduced as winter-dominant rainfall areas have contracted to the south-west[3,4]. Since the 1970s, rising air temperatures and decreased rainfall[4] have led to increases in very high and extreme forest fire weather, increased areas burned, increased fire frequency[5], and lengthened fire season[6]. For example, the Perth Airport weather station has shown a significant positive trend in the annual cumulative Forest Fire Danger Index over 37 years (1973/74–2009/10)[6]. Regional projections include a continued, consistent reduction in winter rainfall and overall warming over the coming decades[7]. In February 2011, prolonged drought stress from an acute drought in 2010 was followed by a record heatwave (9 days >35° C) driven by a strong La Niña event [8]. In a range of forest and woodland types covering ~165 km^2, the impact of the drought combined with the heatwave resulted in rapid die-off in forest canopies and tree mortality[9]. Within six months, distinct patches with up to 74% crown death led to 26% stem death in key species in the northern jarrah forest (jarrah, marri, and *B. grandis*). Some banksias died within five days[10]. In a *Banksia* woodland on the Swan Coastal Plain, 13–58% of Menzies' banksia *(B. menziesii*) died[11,12]. In addition, 500 ha of tuart woodlands ~90% of trees >20 cm diameter at breast height were affected. Die-off and mortality was associated with sites with lower water holding capacity and rocky outcrops, and xeric areas in the landscape[13]. In January 2010, after a day of extremely high temperatures, 145 endemic and endangered Carnaby's black cockatoos (*Calyptorhynchus latirostris*) succumbed to heat stress and died[14]. In March 2010, a severe hailstorm killed or severely injured other birds as well as vegetation[14,15]. Long-term decrease in rainfall and increase in temperature appear to have intensified pressures from pathogens, such as the fungus *Phytophthora cinnamomi*, canker (*Quambalaria coyrecup*)[16–18], and leaf blight (*Q. pitereka*)[19]. Outbreaks of an endemic wood-boring Eucalyptus longhorn

		beetles (*Phoracantha semipunctata*)[20,21] and the gum- leaf skeletoniser *Uraba lugens* also occurred in drought-stressed trees following drought/heatwave conditions[22].
Pressures	**Global climate change presses**	Increased air temperatures and chronic decrease in rainfall since the 1970s[4].
	Global climate change pulses	Heatwaves[9], increasing fire frequency[23]; increased storm frequency and intensity; fires.
	Human presses	Land clearing for agriculture, urban development, and forestry activities. Management fires.
	Human pulses	Unknown.
Ecological impacts and trajectory		Following die-off and tree mortality, some forest and woodlands systems are characterised by an altered structure via the decrease in tree height and prolific resprouting[24]. Changes affect remaining mid-storey trees, regeneration rates, understorey plant species[25], fuel dynamics and potential fire behaviour[23], fauna communities[9], microbial communities[26], and carbon dynamics[27]. Climate shifts are changing host-pest interactions in the region[9,20]. A legacy of chronic drought has exacerbated tree mortality and crown dieback during a heatwave-compounded drought[28]. Altered fire seasonality could affect the persistence of plant populations and community composition[29]. Modelling has predicted that Mediterranean-type ecosystems in the northern part of south-western Australia will contract, while areas to the south are expected to remain stable or expand[30].
Time to detection of impact		Days to months
Collapse profile		SMOOTH — regional, e.g., decreased precipitation[31] STEPPED — regional, e.g., clearing destroys habitat and communities[32] ABRUPT — local, e.g., drought/heatwave[10,12, 31]
Social and economic consequences		Loss of forest resources and ecosystem services (carbon storage), tourism and increasing fire risk.
Current mitigation and challenges		*Current mitigation:* reserves, management for plant pathogens, e.g., *Phytophthora* spp. The Banksia woodland of the Swan Coastal Plain, and tuart forests and woodlands of the Swan Coastal Plain are both listed nationally as Threatened Ecological Communities. Experimentation with climate-ready provenancing is another mitigation strategy being explored[19], and a proposed focus for mining rehabilitation on understorey[33]. *Challenges:* long-term climate change, the loss of water availability and consequential loss of ecosystems, the size of the region, the speed of change and the loss of keystone species. Dead plants can increase fuel load with potential positive feedbacks that may change fire behaviour, followed by non-native plant species expansions, including invasive grasses and African bulbs on the Swan Coastal Plain[23, 34]. Determine response of thinning on forest health[35].
Potential actions		AVOID: expand protected areas for key woodlands. Protect vegetation patches adjacent to water-gaining sites as forest and woodland relicts of a former climate. Continue extension and management of conservation reserves as a point of reference informing targets for restoration of degraded lands (carbon storage). Global climate action. RESTORE: active restoration in banksia woodlands on the Swan Coastal Plain[36,37], and tuart woodlands of the Swan Coastal Plain[38,39] including plantings of native taxa. Focus on understorey rehabilitation to sustain vegetation cover and promote diversity of native species characteristic of the region, and to sustain and connect faunal populations[40,41]. Control/ manage overabundant herbivore populations[41]. Remove non-native species. RENOVATE: investigate genotypes resistant to warmer and drier conditions,

	and pathogens[19,41]. Assisted gene flow and migration of widespread foundation/ keystone species.
Global context	Mediterranean forests and woodlands are a global conservation priority because of their high plant diversity. Droughts and heatwaves are having greater impacts and fire frequency and intensity will continue to increase under climate change in Mediterranean biomes[29,41].

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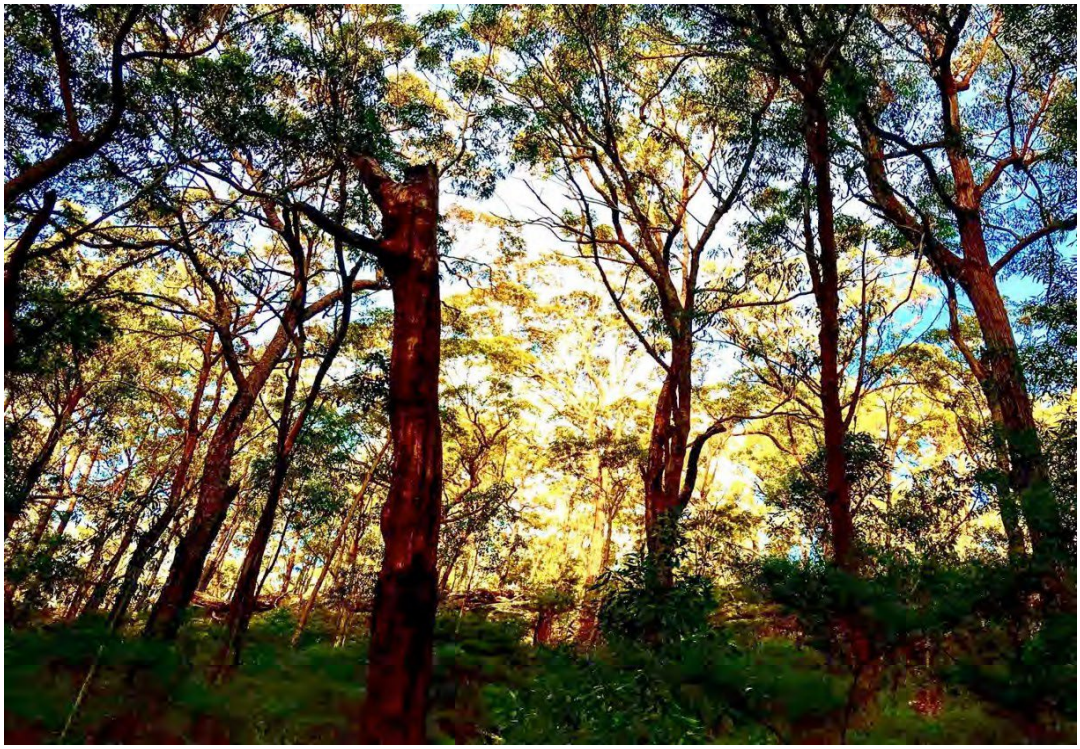
Image top: Intact forest dominated by jarrah (*Eucalyptus marginata*) (Image: Carl Freedman). Bottom: Stand of jarrah and marri (*Corymbia calophylla*) that experienced drought and heatwave-induced die-off in 2011. Stands still have altered structure eight years after the collapse (photo taken January 2019). (Image: Katinka Ruthrof) [These images are also part of Bergstrom et al. (2021)]



Appendix 2

Article:

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Review

The invisible harm: land clearing is an issue of animal welfare

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Abstract. Land clearing is a significant environmental issue in Australia and an area of active legislative reform. Despite evidence of the harm that land clearing causes to individual animals, such harm is either ignored or considered only indirectly in environmental decision-making. We argue that the harm that land clearing causes to animals ought to be identified and evaluated in decision-making relating to land clearing and consider the following three propositions in support: (1) land clearing causes deaths that are physically painful and psychologically distressing because of their traumatic and debilitating nature; (2) land clearing causes physical injuries, other pathological conditions, pain and psychological distress over a prolonged period as animals attempt to survive in the cleared environment or in the environments they are displaced to; and (3) on the basis of current clearing rates, more than 50 million mammals, birds and reptiles are likely to be killed annually because of land clearing in Queensland and New South Wales. The scientific consensus about the harm caused by land clearing means that decisions to allow land clearing are decisions to allow most of the animals present to be killed and, as such, frameworks for decision-making ought to include proper evaluation of the harm to be imposed.

Additional keywords: environmental decision-making, injury, morbidity, mortality, stress, wildlife.

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Introduction

Animal welfare is an increasingly significant component of environmental decision-making involving wildlife, whether the underlying decision relates to the conservation, exploitation or control of a species (Bradshaw and Bateson 2000; Twigg and Parker 2010; McMahon *et al*. 2012; Hampton *et al*. 2014; Descovich *et al*. 2015; Beausoleil *et al*. 2016). Factors that have influenced that shift in Australia include the evolution of animal welfare statutes in the Australian states and territories, government and non-government initiatives to communicate welfare issues (e.g. RSPCA Australia 2002; Cogger *et al*. 2003; Johnson *et al*. 2007; Commonwealth of Australia 2011; McLeod and Sharp 2014) and improvements in our understanding of how wild animals respond to non-lethal interactions with anthropogenic stressors (e.g. Bejder *et al*. 2009; Johnstone *et al*. 2012*a*; Brearley *et al*. 2013; van der Hoop *et al*. 2017; Tablado and Jenni 2017).

One consequence of this shift has been the development of objective and transparent procedures for the identification and assessment of the harms that human activities cause to individual animals, so that those harms can be appropriately weighed against the perceived benefits of the activity (Sharp and Saunders 2011; Calver 2012; Beausoleil *et al*. 2016). However, the integration of such harm–benefit frameworks into environmental decision-making has been uneven and it might fairly be said that we are currently better at identifying and evaluating certain harms than others. Further, there are some human activities for which no effective procedure exists for the identification and evaluation of the harm caused to individual animals. The harm that land clearing causes to native wildlife is one example.

The basic premise of this article is that the deaths, physical injuries, other pathological conditions, pain and psychological distress experienced by individual wild animals during and after land clearing constitute a form of harm that is of sufficient intrinsic value to warrant broad consideration in environmental decision-making, including in assessments of applications for permits (or other authorisation) to clear native vegetation, assessments of planning or development proposals that will require land clearing, and strategic planning initiatives in which land clearing is contemplated (e.g. Department of the Premier and Cabinet 2015). Currently, the harm that land clearing causes to the welfare of individual animals is either ignored in such decision-making or is considered only in instrumental terms, such as when decision-makers focus solely on assessing the population-level effects of the loss of individuals from a proposed clearing action.

To support this premise, we seek to demonstrate three basic propositions, namely that (1) land clearing causes deaths that are physically painful and psychologically distressing because of their traumatic and debilitating nature, (2) land clearing causes physical injuries, other pathological conditions, pain and psychological distress over a prolonged period as animals

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attempt to survive in the harsh and unsuitable environment of the cleared area or in the environments they are displaced to and (3) land clearing is likely to kill more than 50 million mammals, birds and reptiles in Queensland and New South Wales each year on the basis of current clearing rates.

In advocating for greater consideration of the harm that land clearing causes to individual animals in environmental decision-making, we do not wish to minimise or disregard the tension that may arise between the objectives of conserving populations and species and those focussed on preventing harm to individual animals (Fulton and Ford 2001; White 2009; Paquet and Darimont 2010; Twigg and Parker 2010; Cooney *et al*. 2012; Jones *et al*. 2012; Lunney 2012*a*, 2012*b*; Harrington *et al*. 2013). Rather, we seek here to set out a normative basis for why the harm that land clearing causes to individual animals ought to be considered as a relevant and significant harm in its own right.

The article uses terminology commonly applied in wildlife pathology and in wildlife forensic investigations (see Vogelnest and Woods 2008; Ladds 2009; Cooper 2013*a*, 2013*b*; Vogelnest and Allan 2015, as well as materials supported by the Australian Registry of Wildlife Health at http://arwh.org/common-diseases, accessed 6 June 2017). Definitions and relevant references for some terms are given in Table 1. Although the focus here is on harm to mammals, reptiles and birds, the issues are broadly applicable to other vertebrates (e.g. frogs, Hazell 2003) and to invertebrate species (Valentine 2004), although we note relevant differences across taxa in terms of (e.g.) the perception of pain and the experience of psychological distress (Koolhaas *et al*. 1999; Paul-Murphy *et al*. 2004; Wingfield 2005).

Land clearing in an Australia context

The conversion of native vegetation to other land uses, or 'land clearing', remains a fundamental pressure on the Australian environment (Jackson *et al*. 2016). Evans (2016) described 'land clearing' as the 'local term for deforestation' in her analysis of the clearing and modification of native forest in Australia for agricultural, urban and industrial development. The amount of native vegetation that is cleared annually in Australia for those purposes is significant on global terms (Bradshaw 2012; Ritchie *et al*. 2013; Evans 2016). Systematic monitoring of clearing rates for native vegetation is undertaken in some jurisdictions. In Queensland, for example, the total state-wide woody vegetation clearing rate was reported to be 296 000 ha year^{-1} in 2014–15 (i.e. an area of ~54 km × 54 km), of which 91% was undertaken to convert land to pasture (Department of Science, Information Technology and Innovation 2016). The remainder related to forestry (5%) and to clearing for cropping, mining, infrastructure or settlement. In New South Wales, a reduction in woody vegetation of 40 500 ha was reported for 2011–12 and 105 900 ha for 2012–13, with fire and forestry accounting for most of those reductions (Office of Environment and Heritage 2016). The rates of woody vegetation loss in New South Wales due to clearing for cropping, pasture, infrastructure, and thinning were reported to be ~13 000 ha year^{-1} for 2011–12 and 2012–13 (Environmental Protection Authority 2016; Office of Environment and Heritage 2016). The New South Wales figures are controversial, with suggestion that they may substantially under-estimate clearing rates in that state (Hannam 2016*a*, 2016*b*).

More broadly, the national State of the Environment report for 2016 reported the following total deforestation rates for the Australian states and territories for the period 2010–14, on the basis of deforestation data reproduced from Evans (2016): New South Wales (297 482 ha), Northern Territory (7232 ha), Queensland (477 555 ha), South Australia (49 534 ha), Tasmania (17 163 ha), Victoria (54 941 ha) and Western Australia (119 231 ha) (Metcalfe and Bui 2016). Illegal native vegetation clearing also remains an issue in Australia (Bricknell 2010), with 'unexplained clearing' accounting for a significant proportion of total woody vegetation clearing detected by satellite monitoring in New South Wales (Office of Environment and Heritage 2014).

Regulatory frameworks for land clearing in Australia

Evans (2016) described New South Wales, Queensland, South Australia, Victoria and Western Australia as the 'historically high-deforestation states' in Australia. The regulatory frameworks for land clearing in those states typically consist of a complex amalgam of statutes, statutory instruments (e.g. regulations), policies, and guidance and technical materials (see COAG Standing Council on Environment and Water 2012; Evans 2016). Three observations may be made about the consideration that wild animal welfare receives within the regulatory frameworks for land clearing in those states.

First, the frameworks do not expressly recognise harm to the welfare of individual wild animals as a relevant category of harm caused by land clearing. Those frameworks all identify particular harms that land clearing is said to cause, either as part of a list of statutory objects for the principal acts (e.g. Section 3 of the New South Wales *Native Vegetation Act 2003* and Section 3 of the Queensland *Vegetation Management Act 1999*) or as part of a list of principles provided to guide decision-making about native vegetation clearance (e.g. Schedule 5 of the Western Australian *Environmental Protection Act 1986*, Schedule 1 of the South Australian *Native Vegetation Act 1991*, and Clauses 52.16-6 and 52.17-5 of the Victoria Planning Provisions). The harms identified in those statutory objects and lists of principles include loss of biodiversity, loss or fragmentation of habitat for native species, land degradation, salinity, deterioration of surface or underground water quality, and greenhouse gas emissions. Notably absent from the compendium of harms contained in those objects and principles is the harm that the clearing of native vegetation causes to the welfare of the animals using that vegetation. Similarly, considerations of animal welfare are not mentioned in *Australia's Native Vegetation Framework*, which was intended to provide a national policy framework to guide the ecologically sustainable management of Australia's native vegetation (COAG Standing Council on Environment and Water 2012).

Second, those regulatory frameworks do not require decision-makers to identify and evaluate the harm that a proposed clearing action may cause to the welfare of individual animals. None of the four principal acts indicated in the paragraph above nor the Victoria Planning Provisions contain any provision or clause that expressly requires decision-makers to take animal welfare considerations (i.e. the causing of physical injuries, other

Table 1. Definitions and descriptions of pathological conditions that animals may experience in environments in which vegetation has been removed or in environments they are displaced to

Pathological condition	Description
Deceleration injury	Blunt impact trauma incurred when the body in motion is forcibly stopped; however, because of inertia, the body cavity contents continue in the line of motion. The brain in particularly vulnerable.
Dehydration	Excessive loss of water from the body, occurring in several ways (e.g. inadequate intake of food, diarrhoea, vomiting). It can result in inadequate tissue perfusion and electrolyte imbalances and, ultimately, death (i.e. hypovolaemic shock).[A]
Disease	Wobeser (2006) defines disease as 'any impairment that interferes with or modifies the performance of normal functions, including responses to environmental factors such as nutrition, toxicants and climate; infectious agents; inherent or congenital defects; or a combination of these factors'. Therefore, disease is a heterogeneous term, capturing any dysfunction or perturbation in normal physiologic homeostasis and there is a spectrum, ranging from mild and clinically insignificant, through to severe and life threatening.
Disease transmission (increased likelihood of)	The loss of vegetation and possible dispersal to a new habitat may alter intra- and inter-specific contact rates and vector (e.g. ticks, mosquitos) and host densities, thus increasing the likelihood of vector-borne or direct transmission of infectious disease.[B,C,D]
Exertional (capture) myopathy (rhabdomyolysis)	A degenerative disease characterised by muscle damage, usually following extreme exertion, struggle or stress (or a combination of factors) and potentially exacerbated by high ambient temperature, nutritional deficiencies and electrolyte depletion (dehydration).[A,E–G] It may occur when animals are pursued, are entangled or entrapped, or are panicked and fleeing. Although seen in a range of species including birds, it is most commonly diagnosed in macropods.[E]
Immune function (adversely affected)	Immune function refers to an animal's capacity to mount an immune response to a pathogenic (i.e. capable of causing disease) challenge. Conditions relating to land clearing such as chronic stress, inadequate energy intake, exposure to temperature extremes, and secondary infections of wounds sustained during clearing can adversely affect immune function (stress-induced immunosuppression), thereby making animals more susceptible to infectious disease and opportunistic pathogens (e.g. pneumonia, parasites).[H,I]
Maladaptation	Maladaptation is a circumstance of chronic stress in which an animal fails to adapt to its environment because of (e.g.) unfamiliarity with it, lack of necessary resources or of conspecifics to associate with, or adverse interactions with other animals.[E,J] Immune function and other normal function may be compromised.
Misadventure	Death that is caused by the animal interacting with its physical environment in some way. During clearing or during attempted dispersal, death could occur through (e.g.) vehicle strike, drowning or entanglement in fencing.[E,K]
Morbidity	The state of being diseased. It may also refer to the incidence or prevalence of a disease.
Mortality	The state of being dead. It may also refer to the incidence or prevalence of death.
Nutritional disease	Nutritional disease most often refers to a general nutritional deficiency (e.g. inadequate intake of proteins or calories, vitamin deficiency) and less commonly to disease resulting from nutritional excess or some other nutritional disorder.[5] Inadequate or negative energy balance will result in resource partitioning, and potentially dampening of key systems or processes such as immune function, reproduction and growth.[D]
Pain	An unpleasant sensory and psychological experience associated with actual or potential tissue damage.[L,M] Animals may experience pain if they sustain physical injuries or are experiencing tissue damage because of some other pathological condition. Pain comprises heterogeneous categories (e.g. deep pain, visceral pain, cutaneous pain), which vary significantly in their quality, duration, and function and, further, gradation exists, ranging from low level and relatively tolerable (at least in the short term) through to unbearable.
Pathologic conditions (pathologies)	A state indicative of or caused by disease, rather than that which occurs physiologically as a result of homeostasis. Therefore, a pathogen is any agent (infectious or not) that is capable of causing disease (e.g. infectious agents such as viruses, bacteria and parasites and non-infectious agents such as toxins, adverse environmental conditions, and nutritional deficiencies or excesses).
Predation	Death as a result of attack by a native or non-native predator, or by a domestic animal.
Reproduction (adverse effects on)	The reproduction of animals may be affected by a reduction in fertility or reproductive output, or in survivorship of offspring, because of (e.g.) the death of offspring at foot or *in utero* or a failure to reproduce because of diminished body condition and diversion of resources (energy), the absence of a conspecific to mate with, or the lack of a suitable hollow or other nest site.[D,I]
Reservoir	An animate (e.g. any animal or plant) or inanimate (e.g. soil, water) nidus or host of an infectious pathogen in which it normally lives. The pathogen primarily depends on the reservoir for its survival, and must also be able to multiply within it, typically without causing significant clinical disease within animate reservoirs. Significant clinical disease may eventuate in a susceptible host following transmission.

(*continued next page*)

Table 1. (*continued*)

Pathological condition	Description
Shock	A physiological response to diverse causes (such as trauma resulting in haemorrhage and hypovolaemia or other challenge), involving inadequate blood flow to tissues, cardiovascular collapse, and cellular hypoperfusion and hypoxia that can be life threatening.[A,N]
Stress and stressors	The optimal state of equilibrium (homeostasis) is constantly challenged by intrinsic and extrinsic forces, which are known as stressors (which may be multiple and may interact). Duration and frequency of stress is central to its significance. In general, a short-term response is an adaptive 'emergency' allostatic response that promotes survival until the stressor(s) subside(s) as well as a return to homeostasis, and is functional (i.e. physiological). However, prolonged and or frequent stress causes allostatic overload and can be maladaptive (i.e. pathological), potentially resulting in a variety of dysfunctions (i.e. disease), including adverse effects on immune and reproductive function.[D,O]
Stress-related pathology	Animals may experience maladaptation and chronic stress because of sustained exposure or anticipation of biotic (e.g. predators, hostile conspecifics) or abiotic (e.g. suboptimal environmental conditions) stressors, which may have adverse effects on physiologic functions and, thereby, on body condition, growth, immune function and reproduction.[B,D,E,P]
Temperature-related injuries	Injuries owing to hyperthermia or hypothermia as a result of excessive or extreme heat or cold arising because of lack of shelter or cover and changes in microclimates.[E,F] Burns may occur if debris is burned.
Traumatic injury	Injury caused by a sudden, violent force resulting in the compression, stretching, avulsion, torsion, fracturing or penetration of tissue, as well as haemorrhage.[N]
Vector	Any living creature that transmits disease from one host to another. Typically, the term applies to arthropods (e.g. mosquitoes, ticks, biting flies).

Sources: [A]Zachary and McGavin (2012); [B]Hing *et al*. (2016); [C]Brearley *et al*. (2013); [D]Wobeser (2006); [E]Ladds (2009); [F]Vogelnest and Woods (2008); [G]Wiggins *et al*. (2010); [H]Pacioni *et al*. (2015); [I]Acevedo-Whitehouse and Duffus (2009); [J]Cooper (2013*a*); [K]Hanger and Nottidge (2009); [L]International Association for the Study of Pain (2016); [M]Bateson (1991); [N]Cooper and Cooper (2013); [O]McEwen and Wingfield (2003); [P]Narayan and Williams (2016).

pathological conditions, pain, and psychological distress to individual animals) into account when making a decision in relation to proposed clearing actions.

Three, some indirect consideration of the harm that land clearing causes to individual animals may occur if decision-makers are required to evaluate the potential impact of a proposed clearing action on a threatened species or to assess the value of vegetation proposed for clearing as habitat for a threatened species or for native species generally. For example, threatened species assessment guidelines issued and enforced under Section 94A of the New South Wales *Threatened Species Conservation Act 1995* provide for the evaluation of direct and indirect impacts of proposed developments, including land clearing, on individuals and their habitat (Department of Environment and Climate Change 2007). Nonetheless, the focus of those impact assessment guidelines, similar to guidelines in other Australian jurisdictions (e.g. Commonwealth of Australia 2013; Department of Environment and Heritage Protection undated; Environmental Protection Authority 2016), is on population-level impacts. Further, as was observed by Thompson and Thompson (2015, p. 223), 'rarely, if ever, are impacts on the non-threatened fauna seriously considered in the [environmental impact] assessment process and mitigation strategies included in the approval conditions'.

For reasons of length, it is not proposed here to set out any particular mechanisms by which the harm caused to individual animals could be integrated into decision-making for land-clearing. Nonetheless, it is relevant to point out that there are a range of potential statutory mechanisms, including the express extension of statutory prohibitions on the taking of fauna to the circumstances of land clearing (McDonald *et al*. 2003), the statutory expression of considerations or principles relating to animal welfare that decision-makers are required to consider in assessing applications to clear native vegetation and statutory requirements for applicants or proponents to provide estimates of native fauna mortality likely to occur if a proposed clearing action proceeds (Thompson and Thompson 2015). Statutory changes could be complemented by the development of policy-based mechanisms, including assessment methodologies to appropriately identify and evaluate harms from land clearing actions. A key point is that the objective of making considerations of individual animal welfare legally relevant to decision-making about land clearing does not necessarily prescribe any particular mechanism by which that aim might be implemented.

Why the issue is relevant for wildlife researchers and managers and other environmental professionals

An evaluation of the harm that land clearing causes to wildlife may seem unnecessary because there would appear to be little scientific controversy as to the basic proposition that clearing native vegetation kills animals living at that site (Ehmann and Cogger 1985; Glanznig 1995; Williams *et al*. 2001; Cogger *et al*. 2003; McDonald *et al*. 2003; Department of the Environment 2006; Johnson *et al*. 2007). Nonetheless, there are several reasons why it is timely to review the harm that land clearing causes in a journal read by wildlife researchers and managers and environmental consultants, as well as by other environmental administrators and professionals.

First, regulation of the clearing of native vegetation remains an active area of legislative reform in Australia (Evans 2016).

For example, in November 2016, following the release of a review of New South Wales biodiversity legislation in December 2014 (Byron *et al*. 2014) and of a package of proposed biodiversity and land-management reforms by the New South Wales Government in May 2016, the New South Wales Parliament passed the *Biodiversity Conservation Act 2016* and the *Local Land Services Amendment Act 2016*. Notably, those legislative reforms provided for the repeal of the *Native Vegetation Act 2003* and the *Native Vegetation Regulation 2013* (as well as the *Threatened Species Conservation Act 1995*) and the introduction of a new statutory framework for native vegetation clearance in rural areas that will remove many existing controls on clearing activities. In Queensland, a bill to reform the *Vegetation Management Act 1999* failed to pass the Queensland Parliament following debate in August 2016. Those legislative reforms had been proposed as a response to increases in land clearing rates in Queensland, following the repeal or weakening of key statutory restrictions on land clearing in 2013 by the previous Queensland Government (Department of Science, Information Technology and Innovation 2016; Metcalfe and Bui 2016).

It is important to recognise that what the scientific community states, individually and collectively, about the harm that land clearing causes to wild animals can influence political debate about appropriate regulatory frameworks for land clearing. For example, on 17 August 2016, during the Second Reading speech in the Queensland Parliament for the *Vegetation Management* (*Reinstatement*) *and Other Legislation Amendment Bill 2016*, Jacklyn Trad (then Deputy Premier for the Queensland Government) observed the following:

> The fact is Queensland has a shameful history on the issue of broadscale tree clearing. In 1997, we were clearing over 400 000 hectares annually and, according to the Society for Conservation Biology Oceania's scientific declaration, it is estimated that 100 million native animals were dying each year between the years of 1997 and 1999 (Queensland Parliament 2016, p. 2934).

The text of that declaration, signed by over 250 scientists and environmental professionals, is available at http://scboceania.org/policystatements/landclearing, accessed 6 June 2017.

Second, it is axiomatic in conservation biology that local population declines and, ultimately, extinctions at regional- and species-level scales are primarily driven by the mortality, morbidity and reduced reproductive success of individuals (e.g. Saunders *et al*. 1991; Ford *et al*. 2001; Lindenmayer and Fischer 2006; Ford 2011). There is, therefore, a basic commonality of interest between concerns about harm to individual animals and efforts focussed on conserving populations and species (Cogger *et al*. 2003; Johnson *et al*. 2007). On that basis, efforts to integrate consideration of the death, physical injury and other pathological conditions caused by land clearing into environmental decision-making should also support better conservation outcomes.

Third, on-going debate over the efficacy of offsets for land clearing (Gibbons and Lindenmayer 2007; Maron *et al*. 2015, 2016; Sonter *et al*. 2016; May *et al*. 2017) and of programs to capture and translocate animals from sites to be cleared (Germano *et al*. 2015; Thompson and Thompson 2015, 2016; Menkhorst *et al*. 2016) suggests a need for careful consideration of the precise harm that the removal of vegetation may cause to individual animals present at that site, so that such information can then assist in environmental decision-making. In particular, such information is necessary to support appropriate applications of the mitigation hierarchy, robust evaluations of potential offset measures for residual impacts and adequate assessments of the overall significance and acceptability of impacts from land clearing.

Finally, the clearing of native vegetation for agricultural, urban and industrial development is clearly analogous to the practice of clearcutting in forestry, and thus investigations of wildlife responses to clearcutting may also yield insights for decision-making in relation to proposed land clearing (Semlitsch *et al*. 2009; Blumstein 2010). For example, studies of the behaviour and fate of individual animals after clearcutting have investigated whether observed declines in abundance reflect mortality associated with clearcutting, displacement into adjacent forest, or other processes (Tyndale-Biscoe and Smith 1969; Miller *et al*. 1997; Di Stefano *et al*. 2007; Semlitsch *et al*. 2008; Escobar *et al*. 2015).

Evaluating the harm that land clearing causes

The article deliberately uses the word 'harm' to describe the deaths, physical injuries, other pathological conditions, pain and psychological distress that animals may suffer when vegetation is cleared for two reasons.

First, the term 'harm' carries with it connotations of physical injury and deliberate intent. While noting that individuals of some species may disperse to other habitats (if such habitat is available) when vegetation is cleared, the clear scientific consensus is that most, and in some cases all, of the individuals present at a site will die as a consequence of that vegetation being removed, either immediately or in a period of days to months afterwards (Cogger *et al*. 2003; McDonald *et al*. 2003; Johnson *et al*. 2007).

That consequence is an important basic consideration for environmental decision-making because it means that any decision to clear native vegetation (or to allow it to be cleared) is also a decision to kill most or all of the individual animals inhabiting that vegetation (or to allow them to be killed). Although a person who clears land may not desire for animals to suffer, suffering is the inevitable consequence of the decision to do so. The relevant question for decision-making is not *if* death, injury and other pathology will occur when land is cleared, but *how much* of that harm will occur, how severe it will be, and whether it ought to be avoided. If such harm is, nonetheless, deemed necessary, then the question is how the harm to be imposed could be minimised.

Broadly speaking, as a question of animal welfare, the removal of native vegetation may harm individual animals by causing some immediate or longer-term adverse change to their physical or mental state, either directly (e.g. by causing traumatic injury through the application of mechanical force during the clearing process) or indirectly, when animals interact with harmful physical and biological agents (e.g. inimical microclimates, predators, aggressive conspecifics, lack of food) present in the cleared environment itself or in other environments the animals are displaced to. Whereas efforts are sometimes made to distinguish between 'direct' and 'indirect' harms in

environmental impact assessment (e.g. the New South Wales threatened species assessment guidelines differentiate between 'direct impacts' and 'indirect impacts', see Department of Environment and Climate Change 2007, pp. 3, 4), the physical clearing of native vegetation creates environments (or causes animals to encounter environments) where the risk of exposure to harmful agents is high. Thus, land clearing can relevantly be said to place animals 'in harm's way' both during the clearing process and afterwards.

The Australian Animal Welfare Strategy, published in 2011, noted Australia's acceptance of the agreed international definition of animal welfare from the World Organisation for Animal Health (OIE) (Commonwealth of Australia 2011). That OIE definition appears at Article 7.1.1 in the current version of the OIE Terrestrial Animal Health Code (OIE 2016) and states, in part, the following:

> *Animal welfare* means how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear, and distress.

The changes that land clearing causes to the physical or mental state of an animal can be considered in terms of the underlying pathology. Thus, land clearing could be said to 'harm' an animal if the clearing of vegetation causes (or leads to the development of) disease in that animal. Disease is here understood in the broad sense of being a departure from or an impairment of the normal structure or function of any part, organ or system of an animal, which can be caused by (1) *infectious* agents (e.g. viruses, bacteria) or (2) *non-infectious* agents (e.g. physical injuries, nutritional deficiencies) or by a combination of both (Wobeser 1981, 2006; Ladds 2009; Jakob-Hoff *et al*. 2014). Disease can vary in its degree of severity and may have multiple causes.

The second reason for using the word 'harm' is to establish a linkage between the harm caused by land clearing and the concept of harm to individual animals that underlies animal welfare legislation in Australia. Notably, several Australian animal welfare statutes include definitions for 'harm'. For example, Section 3 of the South Australian *Animal Welfare Act 1985* defines 'harm' to mean any form of damage, pain, suffering or distress (including unconsciousness), whether arising from injury, disease or any other condition, and Section 5 of the Western Australian *Animal Welfare Act 2002* defines 'harm' to include injury, pain and distress evidenced by severe, abnormal physiological or behavioural reactions.

The purpose in noting those statutory definitions of 'harm' is not to suggest that land clearing is an animal cruelty offence under existing statutory frameworks for animal welfare in Australia, although arguably there may be grounds for a prosecution in some jurisdictions in circumstances where an unlawful clearing action is undertaken, on a basis that the suffering that an animal experienced was unnecessary because there was no legitimate object (i.e. purpose) for the activity, and where there exists some evidence to demonstrate the suffering that the animal experienced (Radford 2000; McEwan 2016). Rather, we highlight the overlap in concepts of harm to demonstrate that land clearing causes harm that is of a character that would be prohibited if such harm were inflicted on an individual wild animal in other circumstances.

The concept of the harm that land clearing causes to animals should also be broad enough to include the adverse mental states (i.e. what we broadly refer to as psychological distress in the present paper) that animals will experience as a consequence of experiencing pain, physical injury, other debilitating pathological conditions, and the range of abiotic and biotic stressors they will encounter in environments fundamentally inimical to their survival. A conception of harm that includes mental states is consistent with the concepts of distress and wellbeing applied in the *Australian Code for the Care and Use of Animals for Scientific Purposes* (8th edition; National Health and Medical Research Council 2013) and with conceptions of animal welfare used in frameworks for assessing the humaneness of wildlife management actions (Mellor *et al*. 2009; Sharp and Saunders 2011; Beausoleil *et al*. 2016).

We now turn to three specific propositions we make to support the claim that the harm that land clearing causes to individual wild animals ought to be identified and evaluated in environmental decision-making as a relevant and significant harm in its own right.

Proposition 1: land clearing causes deaths that are physically painful and psychologically distressing because of their traumatic and debilitating nature

Land clearing involves the removal of some or all of the aboveground biomass of native vegetation present at a site, as well as the destruction of burrows, middens and termitaria in or on the substrate. The methods by which vegetation may be removed are diverse; for example, plants may be cut, toppled, burnt, ploughed, grazed, ring-barked, poisoned or otherwise damaged (Australian Greenhouse Office 2000; Seabrook *et al*. 2006). In most cases, vegetation is removed using machinery designed for earth-moving or forestry operations or, for broad-scale clearing, by dragging a chain between two tractors (Turnbull *et al*. 1992; Fulton and Majer 2006; Harris *et al*. 2010; Gleeson and Gleeson 2012; Thompson and Thompson 2015). Fallen vegetation is often pushed into piles of residue that are later removed, burnt, buried, wood-chipped, or allowed to decompose in place (Newell 1999; Department of Industry Innovation, Climate Change, Science, Research and Tertiary Education 2013; Pyne 2015; Thompson and Thompson 2015).

The use of machinery to clear vegetation may cause traumatic injury or entrapment (i.e. physical confinement or burial within hollows, burrows or other cavities, underneath fallen stems or branches or other debris, or within soil or other matter) (Shine and Fitzgerald 1996; Rhind 1998, 2004; Cogger *et al*. 2003; Johnson *et al*. 2007; Andrews *et al*. 2008; Hanger and Nottidge 2009; Gleeson and Gleeson 2012; Thompson and Thompson 2015).

Possible outcomes include death arising from traumatic injury or non-drowning asphyxiation as a result of suffocation, as well as pain and shock. Forms of traumatic injuries that animals may experience as a result of land clearing include compression injury, penetrating injury, laceration, degloving injury, amputation, fracture, joint luxation (displacement of a bone from a joint) or subluxation (partial dislocation), and blunt force injury to the skeleton, soft tissues, and central nervous system and internal

haemorrhage. Those injuries may be sustained through contact with vegetation (e.g. as it is felled or shifted after felling), soil, machinery, motor vehicles, or containment barriers.

Thompson and Thompson (2015) undertook a catch and relocation program for reptiles, amphibians and mammals during vegetation clearing at a coastal site in the Pilbara region of Western Australia and found that survivorship during clearing operations differed by the type of machinery used in clearing operations (e.g. dozer, excavator, loader) and by taxa. They observed that survivorship in the clearing process appeared to reflect the 'preferred retreat site' and movement speed of animals, and the manner in which vegetation was removed and substrates disturbed.

Animals that live in tree hollows, either in living trees or in woody debris, may be injured, crushed, suffocated or entrapped when vegetation is felled and pushed into piles and when substrates are disturbed (Rhind 1998, 2004; Hanger and Nottidge 2009; Thompson and Thompson 2015). Clearing often involves the shifting of soil by machinery, which may capture, bury and crush animals present on the surface, in the soil or in termitaria (Thompson and Thompson 2015). Animals that shelter in debris piles may suffer burns or be incinerated when the piles are set alight, or killed when the vegetation is transported, sawn or ground to woodchips.

The size of arboreal animals and the capacity for flight may affect whether they are killed or seriously injured when trees are felled. A study of the effects of logging on brush-tailed phascogales (*Phascogale tapoatafa*) in the jarrah forest in south-western Australia assessed the fate of phascogales and two possum species (western ringtail possums (*Psuedocheirus occidentalis*) and brushtail possums (*Trichosurus vulpecula*)) when trees were felled during logging operations (Rhind 1998, 2004). Rhind (2004) reported that three radio-collared phascogales that were present in trees when they were felled survived without apparent injury, but that, of 65 possums found in the hollows of felled trees over an area of ~63 ha in a 12-week period, 17% had died when the tree was felled. Tyndale-Biscoe and Smith (1969) reported that the number of sugar gliders (*Schoinobates volans*) killed at tree fall was small and that most were able to escape the effect of impact by gliding free of the tree. Newell (1999) reported that Lumholtz's tree-kangaroos (*Dendrolagus lumholtzi*) remained in the tree or vine thicket they were using until a bulldozer approached the tree or a chainsaw had nearly toppled it, then leapt from the tree and quickly hopped away.

A draft Code of Practice developed for the welfare of animals affected by land clearing in Queensland includes descriptions of the deaths and injuries that animals may experience when land is cleared (Hanger and Nottidge 2009). The authors were then from the Australian Wildlife Hospital (now the Australia Zoo Wildlife Hospital) and could speak of the injuries suffered by animals because of land clearing through their own first-hand experience of them (see also Gonzalez-Astudillo *et al*. 2017). Hanger and Nottidge (2009) described the traumatic injuries and issues of entrapment that may arise when native vegetation is cleared in the following terms:

> Animals injured directly in the process of vegetation clearing generally suffer from major crushing, deceleration or fall related injuries. Arboreal species may suffer from trauma associated with falling from a tree and/or crushing and avulsive injuries associated with boughs falling on or beside them. Such injuries include severe internal bleeding and organ disruption, multiple bone breaks, [and] eye and head injuries. Animals resting in hollows, similarly, may receive crushing injuries if the hollow bough disintegrates, or suffer internal organ injuries and tearing as a result of rapid deceleration (deceleration injury).
>
> Ground dwelling animals, such as bandicoots, echidnas, snakes and lizards, most commonly suffer from crushing and avulsive injuries (such as traumatic limb amputation), or may be buried alive during earthworks.
>
> Highly mobile species such as birds and macropods may avoid direct injury by machinery, but may suffer injuries by running into fences, motor vehicle strike or other misadventure.
>
> Injuries suffered by animals during land-clearing vary from mild to severe and fatal, but these animals are only rarely presented to wildlife hospitals or shelters. This is primarily because they are less likely to be discovered by members of the community and are more usually buried or confined in piles of debris during the process of clearing, which are then subsequently burnt or chipped (p. 6).

We will deal further with the pain and psychological distress associated with debilitating conditions below, but it should be obvious that the types of traumatic injuries inflicted by land clearing cause tissue damage that will result in severe physical pain (see Bateson 1991; Weary *et al*. 2006). Animals will also experience the adverse mental states associated with the subjective experience of pain and with their cognitive assessment of their circumstances (including the experience of being smothered or physically entrapped) (Machin 2007; Mellor *et al*. 2009; Rogers 2010; Mosley 2011; Ferdowsian and Merskin 2012; Beausoleil *et al*. 2016; Miller and Patronek 2016; Griffin *et al*. 2017).

Proposition 2: land clearing causes physical injuries, other pathological conditions, pain and psychological distress over a prolonged period as animals attempt to survive in the cleared environment or in other environments they are displaced to

Animals that survive the clearing process and that remain at the cleared site are left to inhabit a harsh and radically altered environment that is generally inimical to their survival (Tyndale-Biscoe and Smith 1969; Newell 1999; Bladon *et al*. 2002; Cogger *et al*. 2003; Fulton and Majer 2006; Johnson *et al*. 2007; Thompson and Thompson 2015). Likewise, animals that leave the cleared site may encounter environments that are, for example, unfamiliar (Powell and Mitchell 2012), unsuitable (Sato *et al*. 2014) or hostile (Doherty *et al*. 2015).

Many native species show strong attachments to small areas of habitat and have low mobility and, thus, if vegetation is removed from a site, most individuals will not disperse to adjacent habitat (if such habitat is available), but will remain at or near the cleared site (Newell 1999; Cogger *et al*. 2003; Johnson *et al*. 2007; Kavanagh *et al*. 2007; Brown *et al*. 2008). Containment barriers around the area where clearing occurs may prevent those animals

that do manage to avoid land clearing activity from actually being able to leave the cleared area (Environment and Communications References Committee 2017, paragraph 2.22).

Even if individuals are able to leave the cleared site, they are likely to die or suffer physical injury or other pathological conditions because of the predators and other environmental challenges (e.g. vehicle strikes) they will encounter, both in the environments they disperse through and in the habitat they are ultimately displaced to (Fischer and Lindenmayer 2000; Bennett 2003; Cogger *et al*. 2003; Johnson *et al*. 2007; Guy and Banks 2012; Armstrong *et al*. 2015; Menkhorst *et al*. 2016; Gonzalez-Astudillo *et al*. 2017). Further, a new habitat, if suitable, may already be occupied by conspecifics, which may lead to hostile interactions, competition for resources, and infectious disease transmission because of increased population density (Cogger *et al*. 2003; Wobeser 2006; Ladds 2009; Sainsbury and Vaughan-Higgins 2012; Pacioni *et al*. 2015). A new habitat may also result in contact with new species, who may act as either vectors for infectious disease or as reservoirs for hitherto novel infectious diseases (Wobeser 2006). Even if dispersal is initially successful, the ultimate harm of dispersing to another habitat might not manifest until sometime later (McAlpine *et al*. 2017).

The clearing of vegetation from a site removes or substantially alters the habitat features present, including the abiotic environmental conditions (e.g. temperature, humidity), the availability of resources (e.g. shelter (cover), food resources, water) and the biotic and social environment (e.g. the presence or absence and abundance of prey, predators and conspecifics, interspecific interactions with novel species including potential infectious disease vectors or reservoirs) (McIntyre and Hobbs 1999; Ford *et al*. 2001; McAlpine *et al*. 2002; Cogger *et al*. 2003; Kanowski *et al*. 2003; Wardell-Johnson *et al*. 2004; Pearson *et al*. 2005; Wobeser 2006; Johnson *et al*. 2007; Craig *et al*. 2012).

The harms that may occur as a consequence of those changes include, but are not limited to, pain from tissue damage sustained through physical injury or other pathological condition, predation, temperature-related injuries, stress-related pathology (e.g. adverse effects on reproduction, adversely affected immune function, suppression of growth), secondary infection and shock (sepsis) arising from injuries sustained during clearing or afterwards, maladaptation, misadventure, exertional myopathy, nutritional disease, dehydration and increased likelihood of infectious disease transmission (see Table 1).

It is not feasible to discuss all of those harms here. However, the harms associated with stress-related pathologies deserve some comment because they are complex and are an area of active research for Australian species (Brearley *et al*. 2013; Narayan 2015; Hing *et al*. 2016; Bradshaw 2017; McAlpine *et al*. 2017). Notably, physiological stress responses to human-modified landscapes have been documented for several Australian marsupials (Brearley *et al*. 2012; Johnstone *et al*. 2012*b*; Davies *et al*. 2013; Hing *et al*. 2014; Narayan and Williams 2016).

An environment in which vegetation has recently been removed will present animals with multiple persistent and potentially interactive environmental stressors, both biotic (e.g. interactions with predators, food availability) and abiotic (e.g. suboptimal temperatures) (Wingfield 2005; Saunders *et al*. 2011; Sih *et al*. 2011; Schulte 2014; Hing *et al*. 2016; Narayan and Williams 2016; Schoepf *et al*. 2017). Where exposure to stressors is acute, an animal may mount a suite of behavioural and physiological responses in adaptation to the stressors (i.e. an allostatic response) and experience no lasting detriment to their health (McEwen 2005; Wobeser 2006; Schulte 2014). However, the intensity and duration of the stressors present in cleared environments are such that animals are likely to experience maladaptation and chronic stress (Moberg 2000; Gunderson *et al*. 2016; Narayan and Williams 2016). Further, they may sustain physical injuries that can act as an additional stressor (Ganswindt *et al*. 2010). In situations of maladaptation and chronic stress, the burden of maintaining adaptive responses to stressors may cause diversion of energy away from physiologic processes or have other deleterious health effects, and predispose the animal to disease (McEwen and Wingfield 2003; McEwen 2005; Wobeser 2006; Hing *et al*. 2016). Notably, the immune function of an animal may be adversely affected after chronic physiological stress (Acevedo-Whitehouse and Duffus 2009; Brearley *et al*. 2013; Hing *et al*. 2016; Narayan and Williams 2016). Because of the energetic cost of mounting and maintaining an immune response, resource allocation away from physiologic processes such as growth and reproduction may also result in minimised reproductive effort and adverse reproductive outcomes (Acevedo-Whitehouse and Duffus 2009).

Clearing-related mortality and morbidity in animals that survive the initial clearing process will typically reflect a multifactorial aetiology. For example, Gonzalez-Astudillo *et al*. (2017) analysed a substantial ($n = 20\,250$ entries) long-term (1997–2013) dataset of koala (*Phascolarctos cinereus*) records at wildlife hospitals in south-eastern Queensland to assess causes of morbidity and mortality. The authors identified 11 aetiologies, as well as several spatial–temporal clusters (or 'hotspots') for the occurrence of particular aetiologies or for combinations of aetiologies. Gonzalez-Astudillo *et al*. (2017, p. 7) suggested that these aetiologies were acting together as multifactorial determinants for koala decline in the region and observed that current extensive land clearing in Queensland 'could be leading to starvation in koalas, an issue that has surprisingly not generated much discussion'.

How long animals survive in cleared environments may reflect a range of factors, including the species and condition of the individuals affected, the prevailing environmental conditions (e.g. summer vs winter) and water availability, whether vegetation debris is left for a period after clearing, the proximity of other native vegetation, and the ability of predators to access the area (Newell 1999; Cogger *et al*. 2003; Sih *et al*. 2011; Schoepf *et al*. 2017). A study of the effects of habitat fragmentation on eastern pygmy-possums (*Cercartetus nanus*) found that a pre-clearing population of at least 15–20 individuals declined to five to eight animals within 12 months after 30% of the study site was cleared (Bladon *et al*. 2002). The clearing coincided with the pygmy-possum breeding season and the recruitment of young appeared greatly reduced. Tyndale-Biscoe and Smith (1969) found that, following clear-felling of a forest block, few sugar gliders dispersed into an adjacent depopulated area, indicating that most gliders died *in situ* without migrating out of their original home range. The authors reported that '(t)he process of clear-felling thus results in the death

of over 90% of the glider population inhabiting the area, only a few animals on the boundary being able to survive in adjacent forest. The majority lose weight, lose pouch young and presumably die within 1 week of tree fall' (Tyndale-Biscoe and Smith 1969, p. 656). Newell (1999) reported Lumholtz's tree-kangaroos surviving for months within clear-felled forest where debris was retained (before its eventual burning to create pasture), but that mortality rates of affected animals appeared to increase after clear-felling, with evidence of predation by domestic dogs or dingoes and also of infectious disease.

Animals that survive the clearing of vegetation, but remain at the cleared site are likely to experience pain caused by physical injuries or by debilitating pathological conditions (e.g. malnourishment progressing to starvation, with negative energy balance also predisposing them to increased risk of infectious disease, secondary to stress-induced immunosuppression) related to the clearing of vegetation, for periods ranging from days to months after clearing. These animals will also experience adverse mental states that persist (either continually or intermittently) for similar periods because of their subjective experience of such pain, perception of other physiological states associated with pathological conditions such as thirst, hunger, nausea, dizziness, debility and fatigue (Mellor *et al*. 2009), experience of fear or anxiety (or other adverse emotions) relating to the presence (or anticipation) of predators or hostile interactions with conspecifics or other species (Steimer 2002; Morgan and Tromborg 2007) and cognitive assessment of their circumstances and emotional state (Panksepp 2005; Mellor *et al*. 2009; Rogers 2010; Mellor 2016).

Proposition 3: land clearing causes substantial mortality

The overall conclusions reached by Cogger *et al*. (2003) and Johnson *et al*. (2007) were strikingly clear, namely that the removal of native vegetation leads to the rapid death of all or nearly all of the birds, reptiles and mammals present. Cogger *et al*. (2003, p. 14) stated the following:

> One general assumption made in these calculations [of mortality from clearing], based primarily on knowledge of the ecology of a wide range of species, as well as the absence of any evidence that remaining remnant vegetation supports higher densities of a wide range of species following adjacent land clearing, is that the vast majority of animals displaced by clearing will die – either immediately or after a short space of time. Deaths result primarily from physical injury, exposure to lethal conditions of temperature or lowered microclimatic humidity, predation, or lack of food.

Both Cogger *et al*. (2003) and Johnson *et al*. (2007) estimated the scale of mortality from land clearing on the basis of published population densities for birds, reptiles and mammals. These densities were then multiplied by available information on the area (in ha) of native vegetation cleared (in Queensland and New South Wales respectively) to obtain estimates of mortality from clearing. Cogger *et al*. (2003) estimated that clearing in Queensland between 1997 and 1999 killed ~100 million native birds, mammals and reptiles per year. Johnson *et al*. (2007) estimated that approved land clearing in New South Wales between 1998 and 2005 killed more than 104 million native mammals, birds and reptiles. Both reports emphasised that the estimates were highly conservative and that actual mortality rates were likely to be substantially higher. Taylor and Dickman (2014) conducted a comparison of land clearing and mammal deaths in New South Wales from clearing before and after 2005, and suggested that a decline in clearing rates (and, thus, also in associated mammal deaths) post-2005 could be attributed to the more stringent clearing controls established by the New South Wales *Native Vegetation Act 2003*, which came into force in 2005. As indicated earlier, that statute is to be repealed as part of the legislative reforms undertaken by the New South Wales Government in 2016.

The 2006 State of the Environment report for Australia included an indicator (BD-08 estimated loss of biodiversity resulting from land clearing) to represent the number of wild animals killed by land clearing (Department of the Environment 2006). The indicator was expressed as a measure of the pressure that land clearing places on biodiversity and was based on the following assumption:

> The immediate effect of clearance of native vegetation on plant and animal species can be significant. When land is cleared, everything that lives in it is killed. Estimates of the number killed are a direct indicator for this pressure.

The information presented in support of the indicator noted the mortality estimates in Cogger *et al*. (2003) and the absence of similar information on clearing-related mortalities on a continent-wide scale. The information provided for the indicator then stated the following, as a way of giving 'a very rough indicator, rather than a serious estimate':

> In the absence of any similar continent-wide study, if the Queensland averages were assumed to apply across Australia. . .a national death toll from land clearing can be extrapolated. AGO [Australian Greenhouse Office] remote sensing data suggests that around 424 727 hectares of wooded land was cleared across the continent in 2004. . .Using the WWF averages [a reference to information provided in Cogger *et al*. 2003], the animal death toll from this land clearing, in mammals, reptiles and birds alone, would have been around 95 million animals. Across the 17 million hectares cleared since 1972, approximately 4 billion birds, reptiles and mammals would have died.

Updated information for the Indicator BD-08 did not appear in the 2011 or the 2016 State of the Environment reports. However, a rough assessment of the current situation can be undertaken by applying the methodology and fauna density estimates in Cogger *et al*. (2003) and Johnson *et al*. (2007) to the current estimates of clearing rates for (1) each biogeographic region in Queensland (Department of Science, Information Technology and Innovation 2016) and for (2) the state of New South Wales as a whole (Office of Environment and Heritage 2016).

In Cogger *et al*. (2003), the overall annual clearing rate applied to estimate mortality in Queensland was 445 900 ha year^{-1}, whereas Johnson *et al*. (2007) estimated mortality in New South Wales from 1998–2005 on the basis of the amount of native vegetation approved for clearing by the state government across the whole 8-year period (639 930 ha). By comparison, the overall annual woody vegetation clearing rate for Queensland in 2014–15 was 296 000 ha year^{-1} (largely for

conversion of native vegetation to pasture; Department of Science, Information Technology and Innovation 2016), whereas the overall annual rate of woody vegetation loss for New South Wales in 2012–13 for cropping, pasture, thinning and infrastructure was 13 000 ha year^{-1}. Those clearing rates would indicate, as a combined mortality estimate for the two states together, that more than 50 million mammals, birds and reptiles are killed each year in Queensland and New South Wales because of land clearing.

Conclusions

Free-ranging native animals suffer, of course, independent of any human action, and that suffering is both severe and substantial (Kirkwood *et al*. 1994; Nussbaum 2006; Doherty *et al*. 2016). A world of more frequent and more intense wildfires also promises that animals will suffer, both during fires and in their aftermath (Chia *et al*. 2015), as does a world of more roads and more traffic (Lunney 2013; Rhodes *et al*. 2014).

However, the central fact remains that land clearing kills, injures or otherwise harms animals in a manner that is direct (i.e. the clearing of vegetation either causes damaging physical contact with animals or creates the cleared environment that animals subsequently experience), demonstrable (i.e. the harms can be demonstrated through forensic or scientific investigation) and capable of being avoided or minimised with appropriate application of the mitigation hierarchy.

Thus, efforts to ignore the harm that land clearing causes must present as an act of wilful blindness which is inconsistent with objective and transparent decision-making about the benefits and harms of land clearing. Further work is needed to develop appropriate statutory and policy-based mechanisms to identify and evaluate the harms caused by proposed land clearing activities and to allow for the effective consideration of those harms in decision-making relating to land clearing.

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