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REPORT ON LIKELY IMPACTS ON THE THREATENED VERTEBRATE FAUNA OF THE PILLIGA FORESTS AND WOODLANDS FROM THE PROPOSED NARRABRI GAS PROJECT

David Milledge

9 August 2020

INTRODUCTION

1. I am a wildlife ecologist with more than 50 years' experience in undertaking wildlife surveys and research throughout eastern Australia.

2. I am a threatened fauna specialist and an accredited expert under the NSW Biodiversity Assessment Method (BAM) for several bird and one mammal species. I sit on the SoS Technical Group for the Government's Saving our Species (SoS) program and I am also an accredited biodiversity assessor under the BAM.

3. I have had a relatively long involvement in assessing the biodiversity and biodiversity conservation values of the Pilliga's forests and woodlands, having conducted a large owl survey across the Pilliga in 2001 (Milledge 2004, Soderquist 2009). In 2011, my colleagues and I carried out a rapid assessment of the State Forest section of the Narrabri Gas Project Area, targeting threatened flora and fauna species and evaluating the potential impacts on its biodiversity from coal seam gas mining (NICE and CUCCLG 2012).

4. I have undertaken two previous reviews of the likely impacts on threatened vertebrates from Santos' proposed Narrabri Gas Project (Milledge 2017, attached as **Appendix 1**: Milledge 2018, attached as **Appendix 2**) and made an earlier oral submission to the Planning Assessment Commission's hearing in relation to Santos' Dewhurst and Bibblewindi Gas Exploration Pilot Expansion Proposals at Narrabri in June 2014.

5. In compiling this report, I acknowledge that I have read Part 31, Division 2 of the *Uniform Civil Procedure Rules 2005* (NSW) and the Expert Witness Code of Conduct governing the use of expert evidence in NSW Courts and agree to abide by them.

BIODIVERSITY CONSERVATION SIGNIFICANCE OF THE PILLIGA FORESTS AND WOODLANDS

6. The 0.5 million hectares of the Pilliga Scrub comprise the largest, relatively unfragmented stand of temperate, semi-arid forest and woodland in eastern Australia (NICE and CUCCLG 2012, Lunney *et al.* 2017). It constitutes a major refuge for the biodiversity of these ecosystems, particularly their threatened vertebrate species, as an island in a sea of agricultural development.

7. As such, the Pilliga represents the stronghold for a suite of threatened vertebrates listed under the NSW *Biodiversity Conservation Act* 2016 *(BC Act*) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) (NICE and CUCCLG 2012).

8. Because of the Pilliga's landscape-scale ecological integrity, populations of these threatened species, if provided with effective habitat management, potentially have the capacity to remain viable in the medium to longer-term, particularly with regard to the escalating impacts of climate change.

9. Species with large home ranges, complex social ecologies and dependence on attributes of old-growth forest and woodland including large tree hollows, are more likely to be able to withstand the pressures of climate change in a large, continuous area of habitat, as represented by the Pilliga, than in small isolated remnants on its periphery. In the latter, climate change impacts can be expected to lead to threshold levels of critical habitat elements being rapidly exceeded, resulting in irreversible losses of populations of threatened species that may have survived in these remnants, as postulated by the theory of island biogeography (MacArthur and Wilson 1967, Terborgh 1974, Diamond 1975).

10. Key threatened species in the Pilliga include the Pale-headed Snake *Hoplocephalus bitorquatus*, Barking Owl *Ninox connivens*, Eastern Pygmy-possum *Cercartetus nanus*, Black-striped Wallaby *Macropus dorsalis*, South-eastern Long-eared Bat *Nyctophilus corbeni* and Pilliga Mouse *Pseudomys pilligaensis*.

11. Apart from one outlying occurrence, the Pilliga Mouse is endemic to the Pilliga and populations of other species there are among the most important in NSW. For example, the area encompasses the core of the South-eastern Long-eared

Bat's distribution in the State and supports one of only two viable populations of the Barking Owl and Black-striped Wallaby. In the case of the Eastern Pygmy-possum, future research may show its population in the Pilliga to constitute a distinct subspecies.

12. Many of the Pilliga's threatened vertebrate species comprise groups identified as most at risk from the major key threatening processes (KTPs, *BC Act 2016*) operating throughout the forests and woodlands of eastern Australia. KTPs already operating in the Pilliga comprise:
    - Human-caused climate change,
    - Clearing of native vegetation,
    - Loss of hollow-bearing trees,
    - Ecological consequences of high frequency fires,
    - Removal of dead wood and dead trees,
    - Predation by the European red fox,
    - Predation by feral cats,
    - Predation, habitat degradation, competition and disease transmission by feral pigs,
    - Competition and degradation by feral goats, and
    - Competition and grazing by the feral European rabbit.

13. Most of these are likely to be exacerbated by the Narrabri Gas Project within the Project Area, predominantly as a result of the high level of disturbance associated with the development of 850 gas wells and associated infrastructure (Milledge 2017). Probably the most significant will comprise:
    - greatly increased fragmentation of vegetation, resulting in detrimental edge effects and increased invasion of native vegetation communities by introduced predators and other pest animals,
    - the creation of wide, permanent barriers to vertebrate movements, and
    - cumulative impacts resulting from an increase in adverse effects already impacting the Pilliga, particularly from forestry operations.

14. Vertebrate groups especially at risk are declining woodland birds (Ford *et al.* 2001, Birds Australia 2005), migratory birds (Nix 1976, Griffioen and Clarke 2002) and hollow-dependent vertebrates (Parnaby *et al.* 2010a, b).

15. The Pilliga's refuge function in supporting viable populations of threatened vertebrates represents a unique and irreplaceable value that qualifies the Pilliga as of national significance for biodiversity conservation (NICE and CUCCLG 2012). The area forms part of a National Biodiversity Hotspot (Australia's 15 National Biodiversity Hotspots, Department of Agriculture, Water and the Environment website, accessed July 2020) and a globally significant Key Biodiversity Area (BirdLife International website, accessed July 2020).

16. Unfortunately, these attributes are all at risk from the Narrabri Gas Project for the reasons expounded above.

EXISTING ENVIRONMENTAL STRESSES OPERATING ON THE PILLIGA FORESTS AND WOODLANDS

17. Although the Pilliga forests and woodlands currently possess a high level of faunal habitat integrity and support significant populations of threatened vertebrates, they have been subjected to past and on-going environmental stresses that have already had detrimental effects on biodiversity (Lunney *et al.* 2017, Milledge 2004, 2017, Niche Environment and Heritage 2004, Parnaby *et al.* 2010a, b). This has included the apparent extinction of a number of bird and mammal species including the Malleefowl *Leipoa ocellata*, Squatter Pigeon *Geophaps scripta*, Western Quoll *Dasyurus geoffroii*, Western Barred Bandicoot *Perameles bougainville*, Bilby *Macrotis lagotis* and Brush-tailed Rock-wallaby *Petrogale penicillata* (NICE and CUCCLG 2012) and appears to be a continuing process, as illustrated by the decline of the Koala *Phascolarctos cinereus* (Lunney *et al.* 2017).

18. Recent past perturbations such as drought, extreme temperatures and wildfires have resulted in a severe decline in the Pilliga Koala population that 20 years ago was considered to be the most important west of the Dividing Range in NSW (Lunney *et al.* 2017). This population has now been described as “completely unviable” or functionally extinct (NSW Legislative Council 2020) and forewarns of other potential losses of threatened vertebrate populations, particularly with the increase in frequency and intensity of these perturbations predicted for the Pilliga under climate change scenarios (Lunney *et al.* 2017, OEH 2014).

19. Impacts from the Narrabri Gas Project, particularly indirect impacts including habitat fragmentation and likely increases in fire frequency, and pressures from introduced predators and herbivores, will only worsen the levels of stress and place local populations of threatened vertebrates at greater risk.

DEPARTMENT OF PLANNING, INDUSTRY AND ENVIRONMENT ASSESSMENT REPORT

20. Although the Department of Planning, Industry and Environment (DPIE) Assessment Report refers to the landscape-scale biodiversity conservation values of the Pilliga (DPIE 2020), it does not appear to recognise the national significance of these values.

21. The report argues that the NSW Government's 2005 strategic land use planning outcomes for the Pilliga struck a balance between competing land uses, but fails to recognise that the reserves created for biodiversity and/or cultural heritage conservation did not adequately protect the most important areas for conservation. The status of some reserves also allows activities other than conservation management that are detrimental to biodiversity conservation. Significantly, the zoning has enabled resource extraction to occur in areas of high biodiversity value such as the Pilliga Outwash Subregion of the Interim Biogeographic Regionalism of Australia (Australia's Bioregions (IBRA), Department of Agriculture, Water and the Environment website, accessed July 2020).

22. A significant component of the Narrabri Gas Project Area falls within the Pilliga Outwash Subregion, which has been demonstrated as having especially high value for biodiversity conservation (Milledge 2004, NICE and CUCCLG 2012).

23. The DPIE Report (DPIE 2020) accepts that Santos' proposed on-site measures to minimise biodiversity impacts will be effective and that "residual" biodiversity impacts from the proposal can be mitigated by land-based offsets applied in accordance with NSW Government policy (*NSW Biodiversity Offsets Policy for Major Projects 2014*).

24. However, both these approaches are seriously flawed in relation to conserving populations of key and other significant threatened vertebrate species in the Narrabri Gas Project Area and are unlikely to avoid or compensate for adverse effects, as indicated in Paragraphs 25 to 43 below.

Avoidance and minimisation of impacts within the Gas Project Area

25. The proposed avoidance and minimisation of on-site impacts is compromised by Santos' inadequate field survey work that, as previously documented (Milledge 2017, 2018), failed to obtain sufficient records of key threatened species to inform an adequate assessment of potential impacts on these species and provide the basis for the design of satisfactory mitigation measures.

26. For example, as previously documented (Milledge 2018), Santos' surveys only recorded a maximum of five individuals each of the nationally threatened (*EPBC Act 1999*) South-eastern Long-eared Bat and Pilliga Mouse over a four-year survey period, whereas the NICE and CUCCLG (2012) surveys recorded 21 and 25 individuals of these species respectively over a 10-day survey period.

27. Other key threatened vertebrates poorly surveyed in the Project Area by Santos included the Pale-headed Snake and Barking Owl, with only four records for each

species. Even more inadequately recorded were the Eastern Pygmy-possum and Squirrel Glider *Petaurus norfolcensis*, which were only recorded twice and once respectively.

28. Had the Santos surveys identified the locations of important populations of key threatened species and critical habitat elements prior to the DPIE assessment of the Narrabri Gas Project, this would have enabled conditions to have been imposed on the siting of gas field infrastructure that provided a degree of certainty with respect to mitigating impacts on these values. For example, the locations of areas with concentrations of the Eastern Pygmy-possum, Black-striped Wallaby and Pilliga Mouse could have been avoided and hollow-bearing trees used as nest, den and roost sites by the Glossy Black-cockatoo *Calyptorhynchus lathami*, Turquoise Parrot *Neophema pulchella*, Barking Owl, Squirrel Glider, Yellow-bellied Sheath-tailed Bat *Saccolaimus flaviventris*, South-eastern Long-eared Bat could have been protected.

29. Identification of threatened vertebrate habitat values is now dependent on micro-siting surveys proposed to be carried out under the Field Development Protocol (DPIE 2020), but this approach is unlikely to be effective as assessments will be limited in time and in relation to season. For example, the detection of rare or cryptic species is unlikely to be successful in the short time-frame expected to be afforded to micro-siting surveys, migratory or widely-ranging species may not be present when surveys are undertaken and hollow-bearing trees may not be occupied by breeding individuals at the time of these surveys.

30. In addition, even if significant threatened vertebrate values are identified, such as occupied hollow-bearing trees or high-density concentrations of individuals, avoidance would only be applied to the greatest extent “possible” (DPIE 2020) and mitigation measures may only be implemented “where practicable” (Executive Summary, EIS for the Narrabri Gas Project). Further, mitigation of impacts on key threatened species and their habitats can be dispensed with if these are not considered “feasible or reasonable” (DPIE 2020), engendering little confidence in the process and suggesting that protection of these values cannot be guaranteed even if they are identified.

Offsetting of unavoidable or residual impacts

31. The commitment to offset unavoidable or “residual” impacts on threatened vertebrate species relies on a fundamentally flawed process, despite following Government policy (*Offsets Policy for Major Projects*, *EPA Act 1999*). It depends partly on the assumption that the occurrence of particular threatened species (defined as “ecosystem credit species”) can be predicted on the basis of the

presence of a specified plant community type (PCT, NSW BioNet Vegetation Classification system).

32. However, the occurrence of such species cannot be reliably predicted based on vegetation floristics alone, as threatened vertebrates are typically specialised species dependent on particular structural and functional habitat attributes as well as floristics. They are also frequently rare or patchily distributed and cannot be expected to occupy all or even the majority of patches of a designated PCT. Further, the process does not allow for an assessment of the quality of the habitat being degraded or destroyed or of the viability of the population being impacted. Consequently, an area of high-quality habitat can be offset by an area of lower quality, and a viable population by one that is unviable.

33. Offsetting under Government policy also does not mandate a “like-for-like” approach in selecting an offset, including a requirement for an offset to be located in the same landscape system. Significantly, it does not require evidence that an offset contains the species being impacted. If a suitable offset cannot be obtained, the policy allows the impact to be “offset” by the payment of money into the Biodiversity Conservation Fund (DPIE 2020), a mechanism that also does not require “like-for-like” compensation with the expenditure of these funds.

34. Significantly, despite the use of offsetting to compensate for the impacts of a number of recent major resource developments in western NSW, there appears to have been no auditing of the method to gauge its effectiveness, particularly in maintaining the viability of the relevant affected threatened species.

35. In the case of the Narrabri Gas Project Area, the potential for unavoidable impacts on threatened vertebrates being purportedly offset by a number of small, isolated patches of habitat spatially distant from the main Pilliga block and lacking populations of the impacted species appears a likely outcome. Although Santos claims that more than the total area of land necessary to meet offsetting requirements exists in the region (DPIE 2020), no details have been provided as to how this would allow for the retirement of credits for relevant “species credit species” or cater for habitat loss of the numerous ecosystem credit species. Such land is also likely to have already suffered the effects of fragmentation and, in accordance with the principles of island biogeography (MacArthur and Wilson 1967, Terborgh 1974, Diamond 1975), may have already lost many of the specialised threatened species that are supposedly being compensated for by offsetting.

36. Even if potential offsets containing species such as the Barking Owl, Black-striped Wallaby, South-eastern Long-eared Bat and Pilliga Mouse are currently available in the region, these are likely to be significantly smaller in area than the

main Pilliga block and can be expected to lose these specialised species in future as climate change perturbations begin operating at an increased frequency.

37. Consequently, together with the uncertainties associated with effectively compensating for impacts on ecosystem credit species (as described above), the majority of threatened vertebrates with important populations in the Narrabri Gas Project Area are unlikely to have their habitat losses compensated for by offsetting.

38. The entire group of declining woodland bird species, most of which have core populations in the Pilliga, are designated ecosystem credit species (Table 13, DPIE 2020) and include the Turquoise Parrot, Barking Owl, Brown Treecreeper *Climacteris picumnus*, Speckled Warbler *Chthonicola sagittata*, Painted Honeyeater *Grantiella picta*, Grey-crowned Babbler *Pomatostomus temporalis*, Varied Sittella *Daphnoesitta chrysoptera*, Dusky Woodswallow *Artamus cyanopterus*, Hooded Robin *Melanodryas cucullata* and Diamond Firetail *Stagonopleura guttata*.

39. All these species are likely to be significantly affected by the Narrabri Gas Project (Milledge 2017, 2018, NICE and CUCCLG 2012) and in combination with the cumulative effects of climate change, are likely to experience serious and irreversible impacts leading to localised extinctions.

40. The group of hollow-dependent threatened species designated as ecosystem credit species are also likely to be poorly compensated for loss of habitat by offsetting. The Turquoise Parrot and Barking Owl also fall within this group, together with the Glossy Black-cockatoo, Little Lorikeet *Glossopsitta pusilla*, Masked Owl *Tyto novaehollandiae*, Yellow-bellied Sheath-tailed Bat, Little Pied Bat *Chalinolobus picatus* and South-eastern Long-eared Bat.

41. Offsetting also appears highly unlikely to have the capacity to mitigate impacts on nominated ‘species credit’ species. For example, the core of the Pilliga Black-striped Wallaby population is contained within the Narrabri Gas Project area and as a result it is improbable that land containing viable populations of this species will be available as offsets.

42. Of particular concern in this regard is the treatment afforded by offsetting to the Pilliga Mouse, a Pilliga endemic which is inexplicably designated as an ecosystem credit species (Table 13, DPIE 2020). Under the DPIE SoS Program this species is defined as a “site-managed” species, which indicates it should be considered as a species credit species for the purpose of offsetting. However, as no populations of the Pilliga Mouse are known from lands in the region being considered as offsets, impacts on this species appear incapable of being offset.

43. Further, Santos has not provided any information on how credits for other important species credit species with restricted distributions in the region could be retired, such as for the Pale-headed Snake or Eastern Pygmy-possum.

CONCLUSION

44. The lack of any certainty that the landscape-scale refuge function and important key threatened vertebrate populations of the Narrabri Gas Project Area will be maintained under the DPIE's recommended consent conditions for the Project militates strongly against its approval. Loss of these values is likely to have a significant adverse impact on the Pilliga's unique and irreplaceable biodiversity.

45. Impacts on populations of key threatened vertebrate species as well as on a number of other threatened vertebrates with core populations in the Pilliga are likely to be severe and irreversible. This because they are unlikely to be alleviated by proposed mitigation measures or compensated for by the use of offsets.

46. The DPIE Assessment Report (DPIE 2020), in recommending consent to the Project, has failed to adequately address these concerns by neglecting to acknowledge:
    - the inadequacy of Santos' survey effort and impact assessment, resulting in a failure to identify core areas of habitat for key threatened vertebrates within the Project Area;
    - the significance of the Pilliga forests and woodlands in a national context;
    - the likely contribution of the Narrabri Gas Project to cumulative impacts on the Pilliga's biodiversity, particularly those resulting from climate change;
    - the inability of offsetting to mitigate the most significant likely impacts on threatened species from the Narrabri Gas Project, particularly fragmentation of their habitats and increased pressures on these species and their habitats from introduced predators and herbivores;
    - the lack of performance-based examples of the effectiveness of offsetting; and
    - one of the fundamental flaws of offsetting, consisting of the inability to ensure the mitigation of impacts on ecosystem credit species with any certainty.

It is my contention that consent for the Narrabri Gas Project proposal should be refused on these grounds.

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APPENDIX 1

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Report on the adequacy of the Environmental Impact Statement for the Narrabri Gas Project in assessing and mitigating impacts on the vertebrate fauna of the Project Area

David Milledge

14 May 2017

1. I have been asked by EDO NSW to prepare a report based on a review of the Environmental Impact Statement (EIS) for the Narrabri Gas Project in relation to likely impacts on the vertebrate fauna of the Project Area and on the adequacy of the EIS in assessing and mitigating these impacts.

2. In this regard I have been provided with a copy of Division 2, Part 31 of the *Uniform Civil Procedure Rules 2005* and the *Expert Witness Code of Conduct* (Code of Conduct) in Schedule 7 of those rules. I have read the Code of Conduct and have adhered to those rules in preparing this report.

3. Also in preparing this report, I have read the following documents that comprise part of the EIS for the Narrabri Gas Project:
   a) Executive Summary
   b) Chapter 15 - Terrestrial ecology
   c) Chapter 29 - Cumulative impact
   d) Chapter 30 - Environmental management and monitoring
   e) Appendix C - Field Development Protocol
   f) Appendix J1 - Ecological impact assessment 1 of 2
   g) Appendix J1 - Ecological impact assessment 2 of 2
   h) Appendix J2 - Biodiversity assessment report
   i) Appendix V - Rehabilitation strategy

4. I have had considerable field experience in the Pilliga forests and woodlands and associated habitats, including the EIS Project Area, having conducted a survey for large forest owls at 500 sites throughout the Pilliga in 2001. This survey demonstrated that the area supported the most significant population of the Barking Owl *Ninox connivens* in NSW, a species listed as Vulnerable on the Schedules of the NSW*Threatened Species Conservation* (*TSC*) *Act 1995*.

5. I also took part in a comprehensive targeted survey of Threatened fauna species in the majority of the Project Area in 2011, when 20 Threatened species (*TSC Act 1995*) were recorded. These included the South-eastern Long-eared Bat *Nyctophilus corbeni* and Pilliga Mouse *Pseudomys pilligaensis*, both also listed as Vulnerable under the Commonwealth's *Environment Protection and Biodiversity Conservation* (*EPBC*) *Act 1999*.

6. The results of the large forest owl survey have been published in Milledge (2002), Milledge (2004) and Milledge (2009).

7. Results of the targeted Threatened fauna survey in the Project Area have been published in NICE and CUCCLG (2012), and in Paull *et al.* (2014) in relation to the Pilliga Mouse.

Overall appropriateness and adequacy of the assessment of impacts on vertebrate fauna

8. A review of the EIS assessment of impacts on vertebrate fauna (Appendix J1, 1 and 2; summarised in Chapter 15) shows that the EIS has not appropriately and adequately assessed potential impacts on vertebrate species and on key Threatened species in particular, despite a substantial amount of field survey effort. This is due to a number of factors, consisting of:

   a) a failure to acknowledge the overall significance of the Pilliga forests and woodlands for biodiversity conservation and of the importance of the Project Area in this context;

   b) a failure to acknowledge the high level of environmental stress already operating on the Pilliga forests and woodlands, and to take into account the potential additional impacts of climate change;

   c) a failure to obtain a sufficient number of records of most key Threatened species, precluding the identification of important local populations of these species in the Project Area, that are necessary to implement effective protective measures;

   d) a failure to acknowledge the likely high level of impact on vertebrate fauna from the proposal, particularly from indirect and cumulative impacts, together with the dismissal of the potential for a likely significant effect on key Threatened species.

Significance of the Pilliga forests for biodiversity conservation and of the importance of the Project Area in this context

9. The Pilliga forests and woodlands represent the largest, relatively intact, unfragmented block of dry sclerophyll forest and woodland in eastern Australia. As such they provide a crucial refuge for biodiversity in a landscape largely cleared for agriculture (NICE and CUCCLG 2012, Lunney *et al. submitted 2017*).

10. They comprise part of one of 15 National Biodiversity Hotspots recognised by the Commonwealth (Australian Government Department of Environment and Energy website, accessed 14 May 2017) and a globally significant Important Bird Area (now termed Key Biodiversity Area, Birdlife Australia website, accessed 14 May 2017).

11. The Pilliga forests and woodlands also constitute a stronghold for numerous declining woodland bird species (e.g. Birds Australia 2005) as well as many other Threatened vertebrates (NICE and CUCCLG 2012, Milledge 2013) and constitute part of the eastern Australian bird migration system, providing seasonal foraging and movement habitat (NICE and CUCCLG. 2012, Milledge 2013).

12. These attributes have been virtually ignored in the EIS and do not appear to have been considered as background or context (Chapter 15, Appendices J1 (1 and 2), J2) in assessing the biodiversity significance of the area, the potential for significant impacts and the mitigation of such impacts.

13. The Project Area falls mainly within a landscape unit known as the Pilliga Outwash Province (Provinces of the Brigalow Belt South Bioregion, NSW EPA Forests Agreement, Western Regional Assessment, website accessed 14 May 2017). This Province has generally higher soil nutrient status, increased plant productivity and a higher vertebrate carrying capacity than the adjoining Pilliga Province (Milledge 2004), which encompasses the greater proportion of the Pilliga forests and woodlands.

14. Much of the National Park and Nature Reserve estate in the Pilliga lies in the eastern and southern sections within the Pilliga Province with its poorer soils and higher incidence of wildfire (Milledge 2004). These reserves provide relatively poor quality habitat for vertebrate fauna compared with conservation areas in the Outwash Province, which although containing more productive soils, comprise Community Conservation Areas that provide lower levels of protection. This is because they are subject to a range of activities excluded from National Parks and Nature Reserves that diminish their biodiversity conservation values.

15. Consequently it is inaccurate to imply that the approximately 50% of the Pilliga allocated to conservation (EIS Executive Summary, What is proposed?; Chapter 15, s.15.2.1) is of equal value in this regard.

16. The lack of consideration and acknowledgement of these attributes and values refutes the claim that the Project Area has been evaluated in the wider Pilliga context (EIS Chapter 15, s.15.1) and that the "ecology of the project area is well understood" (EIS Executive Summary, Terrestrial and aquatic ecology).

17. Although the "high ecological and landscape value" of the Pilliga forests and woodlands is noted (EIS Chapter 15, s15.2.1) and that the area comprises a "unique biological, geological and geographic unit" (EIS Appendix J1(1), s4.11.3), this is not carried through to any analyses or mitigation measures. Neglecting consideration of the specific ecological values of the Project Area in a regional and national context have contributed to the inappropriateness and inadequacy of the impact assessment and to the lack of identification of particular areas requiring the application of precise protection and mitigation measures.

High level of environmental stress already operating on the Pilliga forests and woodlands, and the potential additional impacts of climate change

18. The Pilliga forests and woodlands have been subject to severe environmental stress over the past few decades, including prolonged drought, extreme temperatures, wildfire and losses of significant fauna habitat elements (Lunney *et al. submitted 2017*, Niche Environment and Heritage 2004, Parnaby *et al.* 2010, Milledge 2004).

19. This situation should have been taken into account in assessing the impact of the proposal, particularly in relation to cumulative impacts. However, as with the Pilliga's overall biodiversity conservation significance and the Project Area's values in the wider Pilliga context, it has generally been overlooked.

20. The failure to detect any live Koalas *Phascolarctos cinereus* in the Project Area over the four year survey period (EIS Chapter 15, Appendix J1 (1)) in areas where the species had previously been recorded (NICE and CUCCLG 2012, Niche Environment and Heritage 2014) should have raised concern and served to inform the impact assessment process.

21. The status of the formerly extensive and healthy Koala population in the Pilliga forests and woodlands, now considered to be on an extinction trajectory (Lunney *et al. submitted 2017*), is a an indication of the level of environmental stress currently impacting the Pilliga's ecosystems.

22. The potential for even greater detrimental impacts on these systems posed by anthropogenic climate change has similarly received little consideration in the EIS's assessment of the proposal's impacts, again particularly with respect to cumulative impacts. Predictions for climate changes in the Pilliga area include frequent extended extreme temperatures, altered rainfall with longer periods of drought and increased fire frequency and intensity (Lunney *et al. submitted 2017*, Niche Environment and Heritage 2014).

23. These effects, although discussed in the supporting documents in the EIS (Appendix J1 (2)), have not been adequately considered, particularly in identifying refuges and designing specific measures to mitigate impacts likely to be exacerbated as the climate changes.

Lack of a sufficient number of records of most key Threatened species to enable identification of important local populations of these species in order to implement protective measures

24. An examination of the locations and numbers of individuals of most key Threatened species (species with significant populations in the Pilliga forests and woodlands) detected in the Project Area over the four year survey period (EIS Appendix J1 (1), Figs 20, 21; Appendix J1 (2), Appendix C) indicates that the field surveys failed to obtain a sufficient number of records of these species to adequately inform the assessment and mitigation of impacts likely from the proposal.

25. Examples of the low numbers of locations and individuals of such Threatened species that were obtained in the Project Area comprise:

a) no records of the Pale-headed Snake *Hoplocephalus bitorquatus* from the State Forests (the main area of forest and woodland in the Project Area) and only four locations outside these Forests;

b) no records of the Barking Owl from the State Forests and only four locations outside State Forests;

c) only one location for the Eastern Pygmy-possum *Cercartetus nanus* within the Project Area and one outside;

d) only one location for the Squirrel Glider in the Project Area;

e) only four locations in the Project Area for the South-eastern Long-eared Bat with only four to five individuals captured;

f) only three locations in the Project Area for the Pilliga Mouse with only five individuals captured.

26. These results, from surveys conducted over four years contrast markedly with those obtained by NICE and CUCCLG (2012) in and closely adjacent to the Project Area over only approximately 10 days, when for example, 21 individuals of the South-eastern Long-eared Bat and 25 individuals of the Pilliga Mouse were captured at 8 and 7 separate locations respectively.

27. Perhaps the low number of records of these Threatened species from EIS field surveys reflected the environmental stresses experienced in the Pilliga prior to and during the survey period (paras 18-23 above), or perhaps they also reflected additional impacts operating as a result of previous and on-going gas mining exploration activities. However, the NICE and CUCCLG

(2012) surveys were undertaken within the same period with sharply contrasting results (para 26 above).

28. Whatever the reasons for these low numbers, such a paucity of information has resulted in an inability to accurately demonstrate the occurrence of important populations of key Threatened species in the Project area, preventing an adequate assessment of potential impacts and severely restricting the ability to formulate effective mitigation measures.

29. The identification of specific habitats and habitat elements being used by the key Threatened species is required prior to planning the locations for siting gas wells and well pads to facilitate avoidance and buffering of these attributes.

30. For example, the locations of hollow-bearing trees used by the hollow-dependent Pale-headed Snake, Barking Owl, Eastern Pygmy-possum, Squirrel Glider, Yellow-bellied Sheath-tailed Bat and South-eastern Long-eared Bat in the Project Area should have been determined to enable protection measures to have been precisely applied.

31. In addition, the paucity of survey records of key Threatened species is also likely to have compromised the modelling of their habitats (EIS Appendices J1 (2), J2), as indicated by the use of only five Pilliga Mouse captures at three sites to inform derivation of the Pilliga Mouse habitat model (EIS Appendix J1 (2), F5).

Likely high level of impact from the proposal and particularly from indirect and cumulative impacts, and dismissal of potential for a likely significant effect

32. It is difficult to accept, as the EIS has found, that there would not be a major significant adverse effect on the vertebrate fauna, including a number of Threatened species (EIS Executive Summary, Terrestrial and aquatic ecology), from the installation and operation of up 850 gas wells on up to 250 well pads over a 20 year period as proposed by the Narrabri Gas Project.

33. The installation and operation of these pads and wells will result in the following detrimental impacts over approximately 15% of the higher quality vertebrate habitat in the Pilliga forests and woodlands:

:

a) increased fragmentation of a landscape already under severe environmental stress;

b) the creation of wide, effectively permanent barriers to vertebrate movement resulting from construction of linear corridors and bushfire asset protection zones; these will have an associated effect of increased exposure of vulnerable species to predation from introduced vertebrates including the Red Fox *Vulpes vulpes*, Feral Cat *Felis catus* and Feral Pig *Sus scrofa*;

c) increased sedimentation of already silted up, ephemeral waterways and the reduced availability of surface water essential to the maintenance of many vertebrate populations;

d) increased disturbance from an exponential increase in vehicle movements, dust, noise and lighting associated with gas mining operations;

e) continuing detrimental impacts on high value riparian habitat crucial for vertebrate refuges and movements;

f) increased adverse impacts on vertebrate habitats from pest vertebrate species such as the Feral Pig and Feral Goat *Capra hircus*;

g) cumulative impacts resulting from the exacerbation of perturbations already operating in the Project Area due to now intensive forestry operations (Niche Environment and Heritage 2014) and climate change, particularly the loss of hollow-bearing trees (Parnaby *et al.* 2010), vegetation loss and increased fire frequency (Lunney *et al. submitted 2017*).

34. The statement that the proposal would not have a significant impact on Threatened vertebrate species (EIS Executive Summary, Terrestrial and aquatic ecology) is based primarily on the claim that it would only impact on a very small area of habitat, and on largely untested mitigation measures intended to alleviate the direct and indirect impacts listed above (para 33).

35. Mitigation measures relied on to reduce these impacts include the employment of an "Ecological Scouting Framework" (EIS Executive Summary, Chapter 15, Appendix J1(2)), but this appears untested and should have been developed and validated prior to the field surveys to demonstrate its usefulness. Further, its effectiveness is likely to be highly compromised as the "avoidance, management and mitigation measures" proposed to protect the values it might identify will only be implemented "where practicable" (EIS Executive Summary, Terrestrial and aquatic ecology).

36. Another mitigation measure is the proposed progressive rehabilitation of well pads (EIS Executive Summary, How will the project be developed?, Fig. ES 2) but the benefits of this measure have not been demonstrated, despite the rehabilitation of exploration well pads having been underway for at least two years (EIS Executive Summary, Fig. ES 2).

37. It could also have been expected that permanent monitoring plots would have been established to gauge the effectiveness of proposed mitigation measures. These should have initially been installed to collect baseline data and allow for adaptive management, and to engender confidence in the mitigation measures proposed, but such plots do not appear to have been established..

38. Similarly, vertebrate pest control programs could also have been established to inform this proposed mitigation measure, as pest animal impacts have been ongoing during the past years of exploration activities in the Project Area

(NICE and CUCCLG 2012), but again this does not appear to have been trialled.

39. **In summary, the EIS does not provide an appropriate and adequate assessment of the likely impacts of the proposed Narrabri Gas Project on vertebrate fauna, and particularly on Threatened species (*TSC Act 1995*, *EPBC Act 1999*), or of adequate mitigation of these impacts.**

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APPENDIX 2

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Santos' Narrabri Gas Project - Response to Submissions (RTS)

Does the additional information provided in the RTS satisfactorily address the concerns raised in my submission of 14 May 2017?

Unfortunately, most of the concerns raised in my 14 May 2017 submission on the EIS have not been satisfactorily addressed in Santos' RTS.

Some of these concerns have been ignored, others are quoted as included in submissions but are not further discussed, and others are answered by simply reiterating sections of the EIS without elaboration.

I have dealt with my major issues of concern with respect to impacts on vertebrate fauna, and in particular on threatened species, under the headings adopted in the RTS.

RTS 6.15.1 Flora and fauna baseline data - Survey effort and low capture rates

Effort for particular species and low capture rates compared with NICE and CUCCLG results

In my submission I contrasted the results of Santos' surveys for threatened fauna species (*BC Act 2016*) over a four-year period with those from the NICE and CUCCLG 10-day survey. This clearly demonstrated that Santos' surveys were inadequate for impact assessment purposes and suggested an inappropriate and deficient sampling stratification and survey effort. It is exemplified by a comparison of the number of individuals captured at survey sites of two of the key threatened

species present in the area (table below), the South-eastern Long-eared Bat and Pilliga Mouse, both of which are also listed under the Commonwealth *EPBC Act 1999*.

	Santos		**NICE&CUCCLG**	
survey period	**4 years** (Nov. 2010-Sep. 2014)		**10 days** (Oct. 2011)	
threatened species	number of individuals	number of sites	number of individuals	number of sites
South-eastern Long-eared Bat	**4-5**	**4**	**21**	**6**
Pilliga Mouse	**5**	**3**	**25**	**7**

The RTS claims that "exceptional seasonal conditions following widespread rainfall and flooding in 2010/2011" were responsible for the "high capture rates" obtained by the NICE and CUCCLG surveys, but as these conditions were operating during the first half of Santos' surveys this poses the question as to why Santos did not obtain similar results.

Apart from this failure to explain Santos' poor results, the RTS has endeavoured to interpret the NICE and CUCCLG results as representative of a population "boom" phase in a "boom-bust" cycle. However, this characterisation is inaccurate as all the key threatened species in the Project Area apart from the Pilliga Mouse are not "boom-bust" adapted. For example, the Pale-headed Snake, Barking Owl, Koala, Eastern Pygmy-possum, Squirrel Glider and South-eastern Long-eared Bat are *K*-selected rather than *r*-selected species and do not exhibit rapid population increases during favourable conditions.

The RTS also claims that the NICE and CUCCLG results were used "to inform the field survey …. for the EIS", but if this was the case then the failure of Santos to investigate sites where key threatened species were detected by NICE and CUCCLG cannot be explained.

However, it is doubtful that Santos did consider the NICE and CUCCLG results because in November 2013 I made a submission to the Bibblewindi Gas Exploration Pilot Expansion proposal (located within the Project Area) that stated that Santos had ignored these results, based on their environmental assessment for the proposal. This was conveyed in an address to the NSW Planning Assessment Commission at Narrabri on 19 June 2014 and was not refuted by Santos.

RTS 6.15.1 Flora and fauna baseline data – Hollow-bearing trees

Determination of locations of hollow-bearing trees used by threatened hollow-dependent vertebrates to facilitate the implementation of protection measures

The RTS claims “a detailed analysis of the total number of hollow-bearing trees in three size classes (<200 mm; 200-300 mm; and >300 mm) to be impacted by the project was undertaken” from vegetation survey plot data. Apart from this method being inadequate to obtain reliable data due to the small size of vegetation plots (20 m x 20 m), the size classes adopted did not enable identification of large diameter hollow-bearing trees (=/> 800 mm). Large hollow-bearing trees have been shown to be a crucial resource in the Pilliga forests and woodlands, being required by a number of hollow-dependent threatened species for den, nest and roost sites. Such species include the Glossy Black-cockatoo, Barking Owl, Yellow-bellied Sheath-tailed Bat and South-eastern Long-eared Bat.

Had an analysis of the occurrence of large hollow-bearing trees been undertaken this should have allowed targeted surveys, informed by the records Santos claimed to have used, to have determined the occurrence for example of Barking Owl nest or South-eastern Long-eared Bat maternity roost sites. Such information, which should have been feasible to obtain in a four-year survey period, would have been eminently more valuable in protecting these species than a walk-through assessment under the ecological scouting framework that would probably be conducted in a single day. Detection of threatened species occupation of large hollow-bearing trees would be unlikely using the latter method and in any case their avoidance only appears to be guaranteed if this does not compromise “engineering limits for construction and operation”. Even if large trees used by threatened species are avoided, they are likely to be abandoned in the vicinity of mining operations due to the associated noise and other disturbances.

RTS 6.15.2 Flora and fauna impacts – Impact assessment

The finding that the proposal is unlikely to have a significant impact on threatened fauna

The RTS reiterates the EIS finding of no significant impact on threatened vertebrate fauna based on the erroneous or unvalidated claims of:

i) the assumption of an insignificant development footprint relative to the overall size of the Project Area;
ii) no fragmentation or isolation of populations;
iii) implementation of a “field development protocol” including an “ecological scouting framework”;
iv) progressive rehabilitation of up to half the impacted area; and
v) proposed minimisation and mitigation measures.

The first point fails to address my concerns over the distribution of the impact of the proposal, which will occur as a network of damaging effects spread across the entire Project Area. It is misleading to characterise this impact as affecting only a small proportion of the total Project Area because it disregards cumulative edge effects and other indirect effects including siltation of waterways and facilitation of the dispersal of introduced predators and other pest species.

Conversely, the RTS also states that “indirect effects are likely to be a more significant issue” because of the “diffuse nature of the project across the landscape”, contradicting the claim that removal of only a small proportion of threatened species habitat will not result in a significant effect.

The second point ignores my concerns over the barrier effect of infrastructure corridors, which will operate as wide, permanent obstacles to movement for small terrestrial fauna species, particularly the threatened Pale-headed Snake, Eastern Pygmy-possum and Pilliga Mouse. Populations of these species will inevitably be fragmented and isolated by such barriers and co-locating linear infrastructure along existing roads and tracks is likely to exacerbate these effects by widening and consolidating the barriers. The scale of habitat removal relative to the Project Area is an irrelevant consideration with respect to small terrestrial species with relatively poor powers of dispersal.

The RTS continues to propose implementation of the field development protocol as a means of avoiding a significant effect on threatened species, but this is unacceptable as the methodology does not appear to have been independently reviewed and there is no guarantee that findings from the ecological scouting framework will be used to avoid or mitigate impacts. My concerns in relation to the uncertainty associated with this process, and the statement that avoidance and mitigation measures are only likely to be implemented “where practicable” or “where practical”, have not been addressed in the RTS.

My submission raised the concern of significant impacts from vertebrate pest species and the RTS confirms “feral” animals represent a significant threat. This impact is proposed to be reduced below the level of significance by a “nil-tenure” control program, but the resources necessary for such a program to be effective have not been detailed and again, there is no guarantee of success. Reliance on methods and programs whose effectiveness cannot be satisfactorily assured to reach a finding of no significant effect renders the finding invalid.

RTS 6.15.2 Flora and fauna impacts – Significance of Pilliga and biodiversity values

The values of the Project Area in a local, regional and national context

My submission emphasised the special significance of the Project Area as an integral part of the Pilliga block of forests and woodlands that is nationally important as a large vegetation remnant conserving irreplaceable biodiversity values in a largely cleared landscape. While the EIS presented literature reviews that discussed these values, it failed to demonstrate how they would be affected by the proposal due to an inadequate survey and impact assessment.

The literature findings were also not used to identify areas that required specific protection, and avoidance and mitigation of impacts was proposed to be achieved by an unvalidated protocol applied as development proceeded. This approach fails to take into consideration the unique biodiversity conservation values of the Pilliga such as the provision of thermal refuges to combat the effects of global warming, and neglects to demonstrate how these will be protected. Instead, the assessment of impacts and their mitigation is confined to addressing statutory requirements and relying on an assertion that the development protocol and ecological scouting framework will identify important values, enabling impacts to be avoided and mitigated through refining extraction plant design as development progresses. However, Santos' lack of success in detecting the presence of threatened vertebrate species over four years of surveys in the Project Area provides little confidence that the proposed scouting framework will be effective in avoiding impacts on significant values.

RTS 6.15.2 Flora and fauna impacts – Rehabilitation strategy

Evidence that proposed rehabilitation will be effective

In my submission I questioned the effectiveness of the proposed rehabilitation strategy as no supporting data were provided from areas previously rehabilitated following mining exploration activities. The RTS claims that rehabilitation sites have attained 72% of the condition of reference sites, although condition is not defined and again, supporting data for this contention are not provided. However, it is likely that rehabilitated habitat would take many years to reach a level of condition suitable for use by many sensitive vertebrate species and therefore its contribution to reducing the overall impact of the proposal would be considerably limited.

RTS 6.15.2 Flora and fauna impacts – Ecological monitoring

The requirement for permanent monitoring plots

The RTS claims that "biodiversity monitoring has been undertaken since 2015 at a number of exploration sites" but no data are presented to demonstrate that this monitoring has been satisfactorily undertaken such as the experimental design, the species being monitored or any outcomes from the monitoring results.

My submission commented on the lack of permanent monitoring plots to gauge the effectiveness of mitigation measures and allow for adaptive management, but the RTS reply indicates that Santos have little understanding of the concept of monitoring. Simply resurveying the locations of surveys undertaken for the EIS is unlikely to generate data useful for assessment of impacts or the effectiveness of mitigation measures as these surveys:

i) provided little useful information on sensitive species and their habitats;
ii) do not appear to have been repeated in intervening years to establish patterns of distribution and abundance; and
iii) were not located or replicated for impact assessment purposes.

RTS 6.15.2 Flora and fauna impacts – Consideration of climate change in mitigation and management

Likely severe adverse impacts of climate change and the need to provide habitat refuges

The RTS states that the EIS "considered the effect of a (*sic*) highly variable climatic cycles on the Pilliga" but appears to conclude that the potentially severe effects of climate change and associated impacts, particularly cumulative impacts that are likely to be worsened by the proposal, do not warrant effective mitigation. These impacts could be alleviated by the identification and management of refuges of suitable habitat for the most sensitive species as suggested in my submission, although Santos apparently considers such a concept unworthy of discussion.

David Milledge