Conservation Of North Ocean Shores Inc.
PO Box 828 Billinudgel NSW 2483

Attention: Director – Industry Assessments, Planning Services
Department of Planning and Environment

RE: Application No: SSD 8169 and MP 09_0028 MOD 3 (Concept Plan)

CONOS objects to the proponent's development proposal (SSD 8169) for a permanent approval to operate a Cultural Events Site at North Byron Parklands, Yelgun, and also objects to the modification of Concept Plan MP 09_0028 MOD 3. See details in the following pages.

CONOS Inc. asked the NSW Environmental Defenders Office to arrange for an independent assessment of the ecological monitoring in the EIS and related documents. The EDO arranged for Dr. Martin Denny, PhD FRZS MECANSW, to undertake the assessment, which was then provided to CONOS by the EDO. We include it here, as part of the CONOS submission, because it is highly pertinent to the Department's own assessment of the EIS.

We also include a copy of *A Review of the Effects of Human Intrusion and Disturbance on Wildlife; Reference to a Proposed Permanent Cultural Events Site at Yelgun, NSW* (Benwell and Scotts, 2010. We are including this in our submission because its contents are also relevant to this proposal.

CONOS has collected 1600 signatures on its change.org petition, which are automatically sent to the NSW Planning Minister, the Hon. Anthony Roberts, asking for the major music festivals to be moved away from the biological hotspot at Yelgun (Byron Shire).

This submission covers issues related to:
- ecological monitoring (numerous inadequacies)
- human intrusion on flora and fauna
- Koala and SEPP 44
- noise
- non-compliance with trial consent conditions
- incompatibility between the proposed action and existing conditions
- sewage and waste
- flooding, SEPP 44 wetlands, vehicular evacuation
- permanent security fencing
- legal matters

Robert Oehlman
President for Conservation of North Ocean Shores Inc.

1. Background

Conservation of North Ocean Shores was established in 1992. The group's main objective has been to protect the natural and cultural values of the lowland coastal ecological communities in the north of Byron Shire. CONOS was instrumental in the establishment of the Marshalls Creek & Billinudgel Nature Reserves.

Following the main points is a chronology, compiled over the past few decades titled 'NSW Government's Protection of the North Ocean Shores/Yelgun site'.

There are over 50 Threatened Species recorded for the Billinudgel Nature Reserve and surrounding lands. Additionally, there are several Ecological Endangered Communities, a state significant wildlife corridor, and a precinct rich in Aboriginal Cultural Heritage.

We wish to remind the DPE that the zoning of the North Byron Parklands (NBP) site was deliberately highly constrained for ecological reasons as a result of the Simpson and Cleland Inquires in 1990 and 1997 respectively. As a result of these inquiries the lands were zoned for habitat purposes and special cross hatching on the rurally zoned lands was applied as a particular development control that was inserted into BLEP88. The basis for such protection by way of the relevant environmental planning instrument has not changed, namely that the land forms part of the most easterly wildlife corridor on the Australian mainland, linking the World Heritage Gondwana Rainforests to the subtropical coastal habitats of the far North Coast of NSW.

The SSD application for a permanent festival site, with additional roads and permanent infrastructure catering for 35,000-50,000 patrons, now places all this at risk. The development proposal is contrary to the intent of Marshalls Ridge Wildlife Corridor and Billinudgel Nature Reserve.

2. Ecological Monitoring: Baseline Data

The baseline conditions referred to in the Biodiversity Assessment Report (BAR), do not meet the requirements for baseline conditions that were part of the PAC approval as stated in Statement of Commitment B6, with reference to page 4 of the Vegetation Management and Biodiversity Plan (2010 EA, Tech Paper E*, Appendix M, p 1047). This involved NBP doing monthly monitoring on-site for a year before any events took place in order to provide robust estimates of species abundance for target fauna groups, especially those of greatest concern. But this monthly monitoring was never done as described.

As noted in *A Review of 2010 Predictions of Ecological Impacts from the conduct of cultural events at North Byron Parklands (*Fitzgerald, 2015, page 9): "Implementation of the Flora and Fauna Monitoring Program began with the systematic time-constrained bird surveys on a monthly basis from November 2012 to September 2013". Because that period of time included the cutting into the wildlife corridor to construct a tunnel (Nov 2012), other preparatory activities leading up to Splendour 2013, and that event itself, those data do not meet the expected standards. This was a breach of the consent conditions and also compromised the ecological monitoring by not providing robust baseline data to which later observations could be compared.

The 2016 Flora and Fauna Rehabilitation Plan goes to considerable effort to define "baseline condition"—something that should have been defined at the time of project approval, in conjunction with the promised monthly monitoring. This document also states:

* B6 refers to Technical Paper F, but that paper relates to water management. The context of B6 suggests that the reference should be to Technical Paper E, Ecological Management.

"Considering all fauna records from the NBP site available at or around the Project Approval period, differences in results from Fauna surveys in 2007 and 2009 sampled different areas under different seasonal conditions, and involved substantially different levels of effort." So, although some early monitoring was done, it apparently did not yield robust data that were appropriate for baseline purposes.

Because clear and adequate baseline data have not been collected, meaningful conclusions can't be drawn about the impacts of the operation of the project from the counts that have been reported in surveys after April 2012, when approval to operate was granted. Although a distinction can be made between construction impacts (especially pre-festival construction) and festival impacts, NBP has consistently discussed both sources of impacts and made a special point of noting that pre-festival construction could very well have impacts that would need to be monitored and of committing to ongoing surveys that would be used to assess trends from the time of the pre-construction surveys through event operation.

3. Ecological Monitoring: Key Performance Indicators

> Condition C20(c) of the original 2012 Project Approval required: *"identification of the key performance indicators to be monitored at each location that would determine whether the operation of the project is having a detrimental effect on the fauna"*.
>
> Condition C20(e) of the MOD3 2016 Project Approval required: "identification of the key performance indicators to be monitored at each location that would determine whether the operation of the project is having a detrimental effect on the fauna".
>
> Condition C20(d) of the MOD4 2017 Project Approval required: *"identification of the key performance indicators to be monitored at each location that would determine whether the operation of the project is having a detrimental effect on the flora and fauna"*.

The Vegetation Management and Biodiversity Management Plan of 2010, considered a key document, promised that this plan would have "the later inclusion of robust estimates of species abundance for target fauna groups", following monthly monitoring referred to in #1 above. Such monitoring would have been useful for setting KPIs, but it did not occur.

In January 2013, NBP's ecologist stated: "Without prior data on the variation of counts of species, individuals and groups at all monitoring locations it is not possible to generate useful key performance indicators, although pre-event monitoring will provide measures of the variance of survey data for particular species and for faunal assemblages" *(North Byron Parklands Flora and Fauna Monitoring Program* by Mark Fitzgerald, page 17*)*.

However, the OEH considered KPIs to be essential to the monitoring program from the beginning and stated its concerns in early 2013. That agency also helped NBP create KPIs in 2015 (long after they should have been established), but the flora/fauna management plans issued after that were not adjusted to include those KPIs, and no KPIs with regard to ecological monitoring have been mentioned in any NBP performance report. The current BAR also makes no mention of the KPIs that were required to be used throughout the trial. It mentions only KPIs that *will be* established, if permanent approval is given, to allow for the growth of festival size in future.

NBP has not met the critical conditions relating to KPIs. In the absence of KPIs, meaningful conclusions can't be drawn about the impacts of the operation of the project during the trial. Any conclusions that have been drawn must be considered to be unsupported.

4. Ecological Monitoring: Other Aspects of Design and Implementation

The BAR (Appendix N) focuses on impacts related to events, not impacts related to the operation of the project, as is required by the PAC approval. A full picture of ecological impacts must consider the full operation of the project, which has included the severing of the Wildlife Corridor, significant earthworks, road building, other infrastructure work before the first event, and ongoing infrastructure work after the first event. In fact, NBPearly on identified the potential negative impacts of road building, car park creation, and other such infrastructure but then did not assess the impacts of those changes on the ecology of the area. The Event Impact Monitoring that NBP has focused on is quite different in that it involves observations immediately before, during, and after individual events. Other impacts of the development have been left out of the picture.

The EIM has a number of weaknesses that undermine the validity of the conclusions drawn, as noted by ecologist Dr. Andrew Benwell (in private communications). These include:

- Poorly chosen impact sites. (Two were in low-impact locations, and bird monitoring was not done in the places where birds were most likely to be found, including the Wildlife Corridor, which was supposed to be included in the monitoring.)

- Data from control and impact sites were combined. (Data from the two types of sites should have been compared, not combined and treated as a whole.)

- Many more control sites than impact sites. (The control-site data dominated the impact-site data in the data analyses.)

- Inconsistent monitoring locations. (Monitoring sites were changed after the first year)

- Sampling bias. (Common species were combined with rarer species, so the common species, being much more numerous, dominated the data, masking any impacts on the rarer species—when the rarer species were of particular interest.)

- Small sample size with high variability. (The number of sampling sites was small, and the variability of observed fauna was high. That combination introduces a high risk that false conclusions will be drawn—in this case, the risk that actual impacts were not detected.)

- The statistical analyses did not discuss the assumptions underlying the statistical tests used. (If assumptions are violated, the results are questionable.

- Unknown impacts on 16 threatened species. (Of the 20 threatened bird species known to be in the immediate area, only 4 were observed in the EIM. Impacts of the festivals on the others are unknown, so a conclusion of no adverse impacts cannot be drawn about those 16 species.)

- Ignored adverse impacts. (The reported data actually do show evidence of adverse impacts on bird life, but that evidence is not acknowledged or discussed in interpretations and conclusions.)

- Systematic insect observations not done. (The conclusions of no adverse impacts are extended to insects although it does not appear that any attempt was made to monitor impacts on insects. In 2013, the OEH noted that the NBP ecologist said attempts

would be made to record incidental insect kills, but this apparently was not done. Each event introduced numerous, bright, artificial lights that were in place at night throughout the events, which gave good opportunities to observe the impacts on insects. In 2013, the OEH agreed that the annual percentage of time that bright lights would be employed on site was small, but research has shown that the impact of such lights on insects can be substantial, especially when the lights are first introduced, so attention to that kind of impact would have been useful. In any case, since systematic observations were not made, the no-adverse-impacts conclusion is not justified.

In addition, the monitoring program has addressed only how the festivals might be affecting the presence of fauna on or near the site but ignores any other impacts, such as how disruptions from the festivals might be affecting other aspects of fauna existence (e.g., breeding). However, good evidence exists in the scientific literature that this kind of human intrusion does have a number of worrisome effects (Benwell and Scotts, 2010).

Furthermore, no connection has been made between the project's noise monitoring and the ecological monitoring although in April 2013 OEH specifically recommended that the connection should be "explicitly addressed".

In March 2014, a discussion about the ecological monitoring was held at an RWG meeting, and OEH expressed concern, stating that they wanted to see "a clear line of sight between monitoring, assessment and results". In this context, the NBP ecologist remarked on the limited time and resources available for monitoring, and the mayor of Byron Shire expressed concern that the inadequacies would reflect negatively on the ecological awareness that Byron Shire is known for. An OEH representative then stated that the "key was to focus on doing the best with what programmes and data was available"—seeming to indicate official acceptance of the inadequacies. The OEH did express concern that Performance Report #1 "implied OEH 'tickoff' which wasn't relevant or given" and Mat Morris said he would look at the relevant wording, but no change was made in the final report, so the report indicates that the OEH fully accepted the ecological monitoring that had been done to date even though it did not meet critical consent conditions.

The PAC directed that monitoring procedures and protocols were to be consistent with relevant government publications and/or Australian standards, as noted in C20(d) of the 2012 approval, C20(f) of the MOD3 approval, and C20(e) of the MOD4 approval. This meant that the monitoring should have been governed by basic, well-accepted scientific principles, including sound principles of research design, but the RWG discussion in March 2014 revealed that the expected principles weren't being followed and that the monitoring was not providing the kind of robust data that were required.

As the trial continued, NBP proposed and was given modifications to several key consent conditions related to the ecological monitoring. The modifications were not consistent with the intent of the original approval and seriously undermined the required ecological impact assessment. For example, modifications in 2016 required only assessment of impacts of the "continued operation of the project" rather than assessment of the operation of the project from the beginning, as had originally been specified. As was pointed out to the Department in 2016, changing the conditions of the monitoring is comparable to changing the conditions of a scientific experiment after the experiment has begun. The monitoring was already undermined when key conditions were ignored (baseline data, KPIs). The later modifications undermined it still further, rendering the data unusable for drawing meaningful conclusions.

The very modest expectations of the Department, the willingness of the Department to support scientifically inappropriate changes to the consent conditions, the inferior design and execution of the monitoring program, and the limited time and funds have all worked against

robust monitoring. This is all quite unacceptable. Locating this intrusive development so close to a major Wildlife Corridor and Nature Reserve was a major issue from the outset and led directly to the stringent consent conditions related to assessing ecological impacts.

NBP has not done what they were required to do to assess impacts and yet are now concluding that they have detected no adverse impacts or have seen only minor, temporary impacts. This is deplorable science. Their conclusions cannot be justified.

People who are unfamiliar with research design and statistical analysis are likely to dismiss the above points as of little real concern, but proper research procedures are as essential in this context as they are in other areas of scientific research. The impacts of new medicines on animals and humans or the impacts of new agricultural treatments are only two examples of areas in which strict adherence to good research design, data collection, statistical analyses, and interpretation of results are essential to sound decision making. Given the acknowledged environmental significance of the project area, the weaknesses in the ecological monitoring are very serious and must not be ignored.

5. Ecological Monitoring: Post-trial Monitoring and Operations

Despite the many weaknesses in the trial-period ecological monitoring, the BAR accepts NBP's conclusions and states that from now on, "the gradual increase in site utilisation will allow any potential impacts to be monitored and appropriate modifications to events to be implemented" (page xi). However, since appropriate and robust monitoring did not happen during the trial, and since certain cautionary measures were not followed as advised by OEH, we have no confidence that good monitoring and appropriate modifications will happen in future.

The BAR also states that "potential impacts of the new program of events are associated with more traffic (both vehicles and people), increased noise and light as well as increased trampling and bush fire risk" and goes on to say that all of these impacts can be considered low risk and merely temporary (page xii-xiii). We consider this an overly optimistic assessment, given that the conclusion is based on the results of the seriously inadequate monitoring that has been undertaken so far and given what is known about human intrusion of this kind on ecologically sensitive areas (Benwell and Scotts, 2010). The truth is that no one can know for sure what kinds of impacts the proposed intensifications will have, but the properly-done research cited by Benwell and Scotts indicates that negative impacts are much more likely than positive impacts.

The BAR further states that "events held within the development site had minor irreversible impacts to fauna species" (page 87) but does not discuss what those irreversible impacts were and what they might mean for the future, especially when considering the dramatic increases in the scale of events and in the numbers of days of activity on site.

The BAR also notes that future impacts "will generally have greater duration and frequency when compared to the impacts monitored as part of the trial period" (page 88) but assumes that this should not be cause for concern without giving any reason for the optimism.

The reference on pp 87-88 to "adaptive management" indicates that if increased impacts do happen to be detected, NBP will figure out what to do about them after the fact—when the whole point of management in this context should be to prevent negative impacts from occurring in the first place, a point that was made by OEH in early 2013.

6. Ecological Monitoring: Oversight and Compliance

No Department compliance action has been taken in the face of repeated breaches of the ecological monitoring conditions, despite the declared significance to the state of the Wildlife Corridor and Nature Reserve. The Department has also ignored the evidence that

fauna changes have indeed occurred. As of March 2016, according to NBP's records, more than half the threatened macrofauna species recorded on the site before the approval were not observed in any subsequent monitoring. This information, and other relevant information about the monitoring, was brought to the attention of the Department at a meeting in Sydney in March 2016, but no follow-up appears to have been done. In attendance at that meeting were two members of the community and an EDO representative.

Along with accepting the inadequate monitoring and recommending inappropriate changes to it, the Department has supported increased noise limits, increased numbers of minor events on site, and increased numbers of patrons on site. All of that, along with the Department's inadequate oversight of the monitoring, further calls into question NBP's confident statements that no adverse impacts have occurred.

An additional concern is that the Environmental Representative (required by Consent Condition C6 of the Project Approval) has also been the General Manager of NBP. The GM is responsible for operations, whereas the ER has competing responsibilities. Among other things, the ER is supposed to be an independent overseer of the monitoring programs that are used to detect adverse impacts of the operations and is supposed to take firm action in the face of such impacts. Having the GM also be in charge of "independent" oversight is not appropriate. It's comparable to having a company's finance officer in charge of an external audit. As noted above, the ecological monitoring program has been seriously inadequate, but the ER/GM has allowed the weaknesses to persist, despite having been informed about the issues in RWG meetings.

7. Ecological Monitoring: Independent Evaluation Needed

No independent evaluation of the ecological monitoring program has been done by the Department although in March 2016 (at the meeting cited in #6 above), at the urging of those present, the Department stated that it would call for such an evaluation.

The review of NBP's work by EcoLogical (Appendix N) cannot be considered an independent evaluation. As EcoLogical states, its work involved only reviewing the reports provided to it by NBP. The firm was not charged with evaluating the effectiveness of the overall design and implementation of the monitoring program and was not given documents that raised ongoing concerns about the program, such as comments from OEH and RWG members (in meeting minutes and other correspondence), meetings and correspondence with the Department, and submissions to the Department and the PAC from experts that raised major concerns about the monitoring. EcoLogical was also not asked to raise any such concerns of its own. In addition, EcoLogical's work did not include analyses of primary data, as they note in their Appendix F, page 1.

In completing the BAR, EcoLogical's focus was on Event Impact Monitoring rather than the impact of the operation of the project as a whole, from before any events began on the site. That limited focus appears to have resulted from the state's reducing the rigour of the monitoring by twice agreeing to revise the original consent conditions, as requested by NBP. As noted above, those revisions undermined the strength of the monitoring program and made possible the more lenient process of relying heavily on EIM instead of monitoring the operation of the project from the very beginning. In addition, NBP has not provided raw ecological monitoring data through the years and has presented the reported information in inconsistent and confusing ways in multiple documents.

The BAR states on page ii that the "scope of services was defined in consultation with North Byron Parklands, by time and budgetary constraints imposed by the client, and the availability of reports and other data on the subject area". So, the client for the BAR is NBP, not the Department, whereas the Department is the authority that should be taking a thorough, critical look at the overall monitoring program, in light of the letter as well as the intent of the consent conditions.

EcoLogical claims no responsibility for any use of their report by any third party, such as the Department. This is a typical disclaimer, but it's still noteworthy. An independent, unbiased evaluation of the ecological monitoring is essential, one that gives attention to the many issues raised about the research design, data collection, analyses and interpretation of data, and implications arising from the data. The review done by EcoLogical cannot serve that purpose.

The existing Concept Plan calls for further events to be allowed only if the performance of the trial is found to be satisfactory, but the conclusions that the project has been satisfactory with regard to ecological impacts, drawn by NBP and echoed by EcoLogical, are simply not warranted by the data.

The independent assessment of the EIS that was undertaken at the request of the NSW EDO raises a number of concerns about the ecological monitoring that has been done to date. (See that assessment by Dr. Martin Denny in the addenda here.)

8. Issues Relating to Human Intrusion

The original approval was based on NBP's assurance that the site would see very limited activity and that long periods between events would mean minimal, temporary impacts on fauna. In fact, limiting human intrusion on the site was stated as the primary mitigation measure for protecting the sensitive ecology. Yet NBP, with the full support of the Department, has significantly increased the frequency and intensity of human intrusion on the site during the trial period and now seeks to dramatically increase the intrusion still further so that more than 50% of the year would involve festival activity (event days plus bump-in and bump-out days). Ongoing maintenance, sewage disposal, and other activities would add to that percentage of use, and 100% of the year would involve activities related to the operation of the hotel, bar, and associated facilities—at a proposed scale that is now twice as large as originally proposed. (Further comments about this aspect of the proposal in #12 below,)

We further note that the OEH stated in April 2013 that "the location of noise, light and general festival activities (other than camping) would be the key means by which to prevent/mitigate potential impacts". They went on to point out that the developers "have always sought 'flexibility' in respect of event layouts, but the approach taken to siting festival and stage locations (as OEH learned at the last RWG meeting) is likely to increase the possibility of impacts upon vertebrate fauna to be monitored." At that time, the OEH also noted that a thorough literature review should have been undertaken with regard to the impacts of festivals, citing especially the extensive review done by Benwell and Scotts (2010). Not using such a review to inform the project operation and the monitoring program was considered by OEH to be "a weakness that should be amended".

As Benwell and Scotts (2010) noted, human intrusion in or close to sensitive ecological areas has significant impacts. The sudden intensity of human activity, on the scale that the festivals bring, is particularly disturbing to wildlife, leading to stress and other negative impacts. The points they raised about this site are still valid although the BAR makes no reference to that important research review. It should not be assumed that the intense activity has had no impacts on fauna and will have no impacts in future, especially since the only thing measured has been the relative presence of some specific species, and that measurement has been deeply flawed.

The massive human intrusion on fauna and flora caused by the festivals remains a significant concern. The inadequate monitoring undertaken by NBP has not provided evidence that the festivals are not causing significant impacts. The Precautionary Principle is as relevant now as it was in 2012 when Part 3A was allowed to override local environmental zoning and environmental concerns and establish the festival site in that location.

9. Koala and SEPP 44

Ecologist David Scotts was engaged by CONOS in 2012 to address impacts on koalas in the Yelgun-Billinudgel area, with attention to the NBP festival site. His comments are summarised below:

Koala (*Phascolarctos cinereus*) is a Vulnerable species under the EPBC Act (in NSW, Qld and the ACT). The Yelgun – Billinudgel Koala population is part of a far north-east NSW and south-east Qld coastal Koala population that has declined dramatically.

According to Biolink 2012, koalas in this NSW/QLD area have declined substantially in numbers and range in the face of habitat loss, degradation and fragmentation on the fertile coastal lowlands. This decline has been particularly drastic in the Tweed and northern Byron local government areas to the extent that the Commonwealth government approved a substantial grant to protect and restore Koala habitat and corridor links in that area under the Biodiversity Fund. The Yelgun – Billinudgel area is included within the area of concern for that program and is also included, along with the coastal Tweed area, as a focus area for conservation of a potentially Endangered Koala Population (Biolink 2011, Phillips *et al.* 2011).

The proposed development at Yelgun will further fragment the Marshalls Ridges Wildlife Corridor and elevate the potential for Koala roadkills and stressful disturbance caused by the intense human pressures.

Primary Koala habitat, in the form of the coastal floodplain Forest Red Gum (*Eucalyptus teretecornis*) community, is mapped within the proposed development site at Yelgun (Biolink 2011, 2012). The long-term retention and expansion of these high-quality floodplain habitats is fundamental to the persistence and recovery of the local coastal koala population, but this is also at odds with the development proposal at Yelgun which will envelop these key habitats within festival areas, parking areas, and conference-centre areas. The adjoining Billinudgel Nature Reserve also supports important Koala habitat and has been identified in the past as a core area for the species based upon the prevalence of records there (Landmark 1999). Although some surveys at NBP have failed to locate substantial evidence of koalas (e.g. Biolink 2011) historical records show Koala movements along the Marshalls Ridges Corridor throughout all months of the year, indicating its potential and inherent importance as habitat and as part of the corridor linking to Billinudgel Nature Reserve. Also, koalas were sighted in 2016 in the northwest part of the NBP property, and sightings of koalas along Jones Road are regular, the latest being in 2017.

The documented decline of koalas in this part of far north-east NSW highlights the importance of known refuges, primary habitat, and viable habitat corridors, such as the Yelgun – Billinudgel area, in overall recovery efforts. Biolink (2012) promoted the recognition of a Koala Management Area (KMA) at this location to encourage and promote Koala population recovery and conservation at Billinudgel Nature Reserve and surrounds.

The Marshalls Ridges Corridor is clearly an important focus in that context and should be afforded an accordingly high level of importance, protection, and targeted restoration. (We note that the Wildlife Corridor bisects the NBP property.)

Biolink (2012) did not see disease *per se* as a direct or overriding threat to long-term Koala population viability in the area providing that sufficiently large areas of habitat remain so as to effectively buffer key source populations from undue disturbance. In this context recent work on a coastal Koala population at Tyagarah, about 12 kilometres south of Yelgun, is relevant. Hopkins and Phillips (2010) monitored this Koala population during and after a music festival (Bluesfest 2010) and reported particularly high disease and mortality levels, with genetic profiling

revealing a high level of inbreeding, manifesting in a suppressed immunological response (Hopkins and Phillips 2010).

Clearly, Koala populations in coastal far north-east NSW are in trouble and reports such as this reinforce the need to minimize to the greatest extent possible processes that may threaten remaining populations. Loss of corridor functionality and elevated stress levels mediated by intense human presence are key threats in that context and are directly relevant to the NBP proposal.

It seems clear that music festivals lead to elevated stress levels in local Koala populations. It seems a logical extension, and a justifiable application of the precautionary principle, that music festivals can be added to the list of threats to Koala populations, particularly in situations where the local population is already exhibiting signs of stress (e.g. reductions in numbers, signs of inbreeding). We note that the festivals at NBP are bigger and louder than Bluesfest and will become still bigger and louder is this approval is granted.

The continued fragmentation of Marshalls Ridge Wildlife Corridor and the imposition of episodic intensive human pressures in the midst of an identified Koala Management Area are at direct odds with the purpose of a Management Area. These threats are real, cannot be mitigated, and are likely to impact the local Koala population directly and indirectly. The proposed permanency and intensification of the festival site will degrade habitat and will not promote the recovery of the population in a previously identified stronghold. As demonstrated by Biolink (2012) the basis for Koala recovery in the Yelgun – Billinudgel area remains but requires appropriate conservation management.

Approximately 85 sightings and calls of Koala have been recorded along the Marshalls Ridge wildlife corridor (Jones Road) over the past four decades and are recorded on the NSW Wildlife Atlas Database. Numerous Koala sightings and calls have also been recorded along the Wildlife Corridor over the past 5 years and since the commencement of events at the site, with the most recent sighting having been in 2017.

The SEPP 44 – Koala Monitoring Report (Biolink 2016) in Appendix N of the EIS, does not contain the most comprehensive records of koala sightings in the Yelgun-Billinudgel area.

The Jones Road ridgeline straddles the NBP site. Any koalas sighted along the Jones Road ridge are either crossing from the NBP site into the Billinudgel Nature Reserve or alternatively from the Reserve into the NBP site. Under these circumstances, it is important to ensure that all relevant koala records from the NSW Wildlife Atlas Database are examined.

10. Noise

The current noise criteria should not be used for any future festivals that might be allowed on the site. The noise has been unpredictable in its levels of disturbance to residents and is of particular concern as a disruption to the wildlife in the immediate area.

The Industrial Noise Policy of 2000 is the governing document, according to the SEARs, and should guide the setting of noise limits if approval is given for any further festivals on site. The INP states that the Intrusiveness Criteria must be used for setting limits in the rural/residential area of the project site—an area that has particularly low existing background noise levels.

Appendix L states that festival noise cannot be and should not have to be inaudible but at the same time gives examples in which inaudible sound is the expectation:

- The NSW Liquor and Gaming Authority states that "noise from licensed premises shall not be audible within any habitable room in any residential premises between the hours of 12:00 midnight and 07:00AM" (p 21).
- In Queensland, open-air events on any day have noise limits of 10dB(A) above background from 10PM to midnight. In addition, the noise must be inaudible from midnight to 7AM (page 28).
- In the ACT, all concerts must finish by 11PM (page 28).
- In the UK, the noise code for outdoor concerts and festivals requires noise to be "inaudible inside dwelling" from 11PM to 9AM every day (page 22).

Given that inaudibility is recognised as a reasonable criterion, we believe it should be applied to this development as well. Inaudibility after 12 midnight should be the rule.

11. Non compliance with Consent Conditions.

Besides not complying with required conditions relating to ecological monitoring, NBP has breached numerous other conditions through the years, in several cases breaching the same condition repeatedly. Other situations may not have been literal breaches but have shown very poor management, e.g., serious and repeated internal traffic jams, as experienced over the several days of Splendour 2016. However, the Department has acknowledged very few breaches and has issued even fewer penalty infringement notices or official cautions.

At the March 2016 meeting cited in #6 above, the Department was given an extensive list of breaches to date, with specific references to official documents (e.g., RWG meeting minutes, NBP's reports, correspondence with the Department). The Department was asked to respond to the list, but a response was never received. As of February 2018, the breaches in that supplied list have not been added to the Department's records of breaches. These breaches could easily have been verified at the time by referring to the cited documents, so it is not at all clear why that was not done rather soon after that meeting.

Since then, other breaches have been noted by community members. To date, the community has logged over 100 breaches since the trial began, including breaches of noise limits and noise monitoring requirements, patron numbers, campers outside of camping areas, use of illegal fireworks on site, litter management, and more, along with a great number of serious breaches of the ecological monitoring conditions, as noted above. Many aspects of NBP's management of the trial have also been called into question by other authorities, e.g., the NSW Police report relating to Splendour 2016.

The ongoing NBP breaches have been bad enough. Of even greater concern is the Department's ongoing unwillingness or incapacity to diligently monitor the performance of the trial, keep track of breaches, and acknowledge verifiable breaches noted by others. The oversight process has been unacceptable.

The record of compliance to date provides strong evidence that the performance of the trial has not been satisfactory and that permanent approval should not be granted.

12. Incompatibility with the Sensitive Ecology of the Area

The use of this site for mega festivals is not compatible with the ecologically sensitive land in the immediate proximity or with the quiet, rural residential areas that surround the site.

The North Coast Regional Plan 2036 has as its Goal 1/Direction 1 to enhance biodiversity, habitats, and water catchments in the coastal area, with particular focus on land east of the Pacific Highway. The NBP site is bisected by the Wildlife Corridor and is adjacent to the Nature Reserve. It's also on a major floodplain, and the runoff from the site flows into two water catchments that are critical to residential and farm properties in the area and a

SEPP 14 wetlands. Allowing festivals to increase in frequency and intensity on the site is not compatible with the NCRP 2036.

The NCRP 2036 also has as a Byron Shire priority "to support a strong and diversified economy" based on the "unique character, landscapes and important farmland" of the shire. We have been working for decades to support that unique character, from helping to protect the NBP site from the degradation wrought by an earlier owner to now trying to protect it from a different kind of degradation. Although NBP has planted trees on their property, they've done no more than hundreds of rural landowners in the area have been doing for years, but the tree planting does not make up for the ongoing pollution of the land from tens of thousands of festival goers, thousands of vehicles, and debris and waste that will never be fully cleaned up.

In addition, the use of this land for festivals is also incompatible with the Far North Coast Regional Conservation Plan that indicates LEPs need to protect land from inappropriate development by setting environmental priorities. That plan recognises the critical habitat corridor from Mount Jerusalem to Billinudgel Nature Reserve as a "conservation priority area" with Aboriginal significance. Approving this proposal would effectively ignore the decades of protections that the state has given to the land in and around NBP and would accomplish just the opposite of the goals of the FNCRCP.

Furthermore, the proposed intensification of activity on the site is incompatible with NBP's own statements of the need to keep activity to a minimum. In their 2010 application (MP 09_0028), Statement of Commitment A7 promises to '*enhance the biodiversity values of the site and locality"* specifically stating the commitment to "maximize 'down time' between larger events such that non-event days substantially dominate the annual cycle, providing time for 'normal' ecosystem processes, post-disturbance recovery and for local rehabilitation of habits to occur." This Statement of Commitment became part of the consent conditions when the PAC approved a five-year trial. However, NBP now proposed a dramatic increase in patron numbers and a significant increase in event days. When you add up the amount of event days annually plus 'bump in' and 'bump out' required for each event, and ongoing maintenance activities, it can easily be predicted that many species will be displaced and become isolated or will be severely impacted in other ways.

The addition of the proposed conference centre would introduce still more destruction of flora and still more human intrusion into the area around the dam on the site, which numerous threatened species regularly use. The doubling of the capacity of this centre (beyond the originally proposed structure) is cause for still more concern, as is the proposed year-round use of the hotel and bar, which will carry with it ongoing disturbing human and vehicle movements, along with the entertainment noise associated with such a venue. This aspect of the proposal is especially incompatible with the ecological sensitivity of the area. We note that Section 3.3.2 of the EIS states that "the jetty and conference centre breakout space would be built over the dam, and would be accessed from near the main conference centre building. The breakout space would have an area of approximately 30m2 (excluding jetty) and would be of timber construction. The jetty would be built on piles driven into the base of the farm dam.' Construction of this kind, including road building and parking areas would impact and alienate species, such as the threatened Comb-crested jacana (recorded at the dam) and others, that frequent and rely on the dam for their food source.

The additional massive amounts of proposed infrastructure on the site, detailed in NBP's Preliminary Environmental Assessment, are also incompatible with the need to protect the sensitive ecology of the area. These include earth and gravel works for car parks; extensive roadworks and pick-up/drop-off zones with the associated hardening, drainage, and concrete works; a major transport hub upgrade; massive earthworks and drainage at the amphitheatre; concrete stages with basements; slope excavation and sealing of roads; 8km of electrical works; road widening; and more. All of this is unnecessary, given that the developers have been operating successfully without it for many years, at NBP and

elsewhere. The proposed works will permanently and drastically reduce the important ecological values of the area that the government has protected, with considerable effort and money, for decades.

The fact that these infrastructure works are the driving force behind the project being declared a State Significant Development is the height of irony. The state of NSW has repeatedly recognised the area as highly significant for its ecological values and its values to the traditional owners of the land and yet now presents the massive intrusions on this important asset as "state significant". (See the Chronology that immediately follows these main points for a history of the state's actions.)

13. Sewage and Waste

As reported in Appendix R of the EIS, the plans for treating sewage on site are not fully developed, and the envisioned program will be implemented "as budgeting allows". These are both concerns, but the biggest concern is the number of "moderate" and "major" constraints of the proposed Effluent Management Areas. Those ratings reveal uncertainty about how well these EMAs will function and thus how effective the entire sewage treatment process will be, despite the suggested management strategies.

The most notable issues are high rainfall in the area and the flood-prone characteristics of the property. Neither can be controlled. Observations and photos taken by locals through the years confirm that the northern part of the site, where the EMAs are located, floods regularly and quickly, to depths of 1-2 metres or more, and that in this climate, rain is likely for much of the year. The extent of flooding is often unpredictable, too, which poses additional challenges for the proposed sewage treatment plans. The Molino Stewart Flood Risk Management Plan (2017) in Appendix K notes "some hazard areas throughout the north east corner of the event area" for a 1 in 5 change per year flood (page 15) and also notes that "the depth of floodwater ranges from a maximum of approximately 4m across the north-east camping areas to 0.5m in the south-west parts of the event area" (p 21).

Other "moderate to major" constraints include the landforms, slopes, erosion potential, drainage, soil depth, depth to seasonal watertable, soil permeability, chemical composition of the soil, soil stability, soil dispersiveness of the EMAs, cation exchange capacity, exchangeable sodium percentage, and phosphorus sorption capacity, as noted in Appendix R—all critical elements when considering the sewage-disposal plans being proposed. The plans also call for some waste to be transported off site, but it should be noted that Byron Shire has warned NBP that the shire has very limited capacity for accepting effluent from the festival site and that NBP should not assume that Byron's STPs or Tweed's STPs will be available (as noted in Byron Shire's response to the SEARs, 11 January 2017.

We are also concerned about how the regular burying and spraying of large amounts of effluent on the site will affect the soils and water of the area, including the catchment into which the water from the EMAs flows. Chlorine, mentioned as the disinfectant that is to be used, kills most bacteria but is not as effective on viruses. It's to be expected that some of both will remain in the waste material, along with some protozoa. In fact, the aim is only to reduce the amounts of these substances.

Many pharmaceuticals and nanoparticles persist in municipal wastewater plants and are discharged into soil and waterways at the end of the treatment process, so we would expect these substances also to persist at the end of the NBP treatment process. As even cursory research shows, many components of the sludge resulting from sewage treatment remain undetected and are not even tested for, including substances in personal care products that festival-goers use on site. Synthetic fibers from fabrics can also be considered a concern.

It is not at all clear how the ecology of the area will be affected by such massive amounts of effluent being deposited on the property. Also of concern are the bits of plastic

and other inorganic materials that are part of the waste that is discarded on site rather than deposited in trash bins. This pollution cannot be fully kept from entering the soil and waterways on the site, even though some of it is planned to be captured as part of the effluent treatment, so the amount will accumulate with each festival. One example is the 50 kg of glitter that was sold by a vendor at Splendour 2017 for body decoration and ended up not only in the soil and drains on the site but also wherever else the glitter-decorated festival-goers went during and after the event.

In the absence of a first-rate sewage-treatment plant on site, it is difficult to see how NBP will be able to properly manage the sewage and other wastewater generated repeatedly by on-site populations that are as large or larger than the whole of Byron Shire. Any ineffectiveness or carelessness at any step in the process has the potential to seriously affect the soil and water systems of the property and the surrounding area and thus the sensitive ecology of the area.

14. Flooding, SEPP 14 wetlands, and Vehicular Evacuation

The NBP site straddles 2 Catchments, the Yelgun Catchment to the south of the Jones Road ridgeline and the Crabbes Creek Catchment to the north.

The southern car park is located in the Yelgun Catchment and adjoins SEPP 14 wetlands (No. 57) and the Billinudgel Nature Reserve. All waters in the Yelgun Catchment flow east, so any flood-affected vehicles and associated pollutants will float east, contaminating the Yelgun Creek, the SEPP 14 wetlands, and Billinudgel Nature Reserve.

The event and camping areas are located to the north on a floodplain with underlying deposits of peat.

In Section 3.4.3 of the Flood Risk Management Plan 2017, Molino Stewart predicts that in a 1 in 5 chance per year, flood depths would be between 0.1m – 0.9m and states that "cars in more than 0.3m of water could begin to float." In a 1 in 50 chance per year "any cars left in these areas would float, and in a 1 in 100 chance per year "most of the flooded parts of the site would be unsafe for vehicles or pedestrians" (Appendix K).

CONOS notes that during a 35,000-patron event, approximately 2,249 cars will be parked in the southern car park. In a 50,000-patron event, however, the southern car park would accommodate up to 7,040 cars.

Appendix K states 'In a PMF [Probably Maximum Flood] the majority of the flooded areas have very high flood hazard…' and 'the rate at which floodwaters rise also contributes to the overall flood hazard' (Sections 3.4.2 & 3.4.4).

NBP's earlier Floodplain Development Manual (Technical Paper G, EA, MP 09_0028, 2010) defines "High Hazard" as '…where floodwaters present a danger to life and limb, could cause structural damage to buildings, and where the resultant social disruption and financial losses could be high.'

In Appendix K, Section 3.5.1 (Vehicular Evacuation), the following points raise concerns:

- In a 35,000-patron event, it is predicted that the evacuation of the southern car park will take approximately 3.5 hours, whilst the northern car park will take an additional 5 hours, bringing the estimated time of evacuation of all vehicles to 8.5 hours. However, Molino Stewart also highlights several different scenarios that could contribute to longer evacuation times.

- 'The NSW SES, in its evacuation modeling (Opper 2004), allows a further 2-3 hours for traffic delays caused by vehicles breakdowns, accidents, trees across road or water across roads for this duration of evacuation traffic'.

- 'In addition to these travel times and potential delays, there would be time taken for management to decide to call an evacuation, time to organize staff for an evacuation, time to disseminate the evacuation order to patrons, time for patrons to pack and time for patrons to reach their vehicles.'

- 'Therefore, the evacuation times previously calculated should be increased by about 4 hours to obtain the total time of when the evacuation decision is made to when the last vehicles leave the site.'

Appendix K, Section 3.7.2 (b) Calibration, states that 'It should be noted that there is about a 30 minute delay between the data being collected and it appearing on the BoM Enviromon interface'. That introduces still more time to the total evacuation time needed.

Based on these figures, it would take approximately 13 hours to evacuate all vehicles off the site. However, that does not include the numerous other risks factors identified by Molino Stewart that could also cause complications and very possible further delays, making the evacuation process even longer. As noted in Section 3.6:

- 3.6.1 **Intoxication of Patrons**, states 'If a flood were to occur during an event, problems would exist with the number of people capable of safely driving their vehicle due to alcohol and potentially, recreational drug consumption.'
- 3.6.2 **Night Time Flooding,** 'If a flood happened during the night, additional risks will be present including trying to communicate with people who may be asleep and a lack of lighting for response actions to be taken.'
- 3.6.5 **Risk of Electrocution**, 'With a range of temporary onsite power generators located across parts of the site there is a risk that if such infrastructure becomes inundated there arises the potential for electrocution.'
- 3.6.6 **Medical Emergencies** 'This may be complicated if external and internal roads are closed due to flooding and ambulances need to transport a patient off-site.

Section 3.5.1 of Appendix K states, 'it is clear that evacuation would need to commence well before a flood causing rainfall event began if it is expected to get all vehicles and patrons off the site ahead of floodwaters becoming hazardous'. And Section 3.3.2 of Appendix K states "the response time of the southern catchment is significantly shorter than that of the Crabbes Creek catchment to the north".

Additional useful information comes from hydrologist Toby Fiander regarding a flash flood event for the southern car park. He pointed out that the Yelgun Catchment would have a 20-minute warning time before that part of the site would be seriously flooded. [NBP DA 10.2007.462.1, T. Fiander, Flood Assessment 2007]. Fiander also states that cars will not be able to be evacuated in a flood event and recommends that 'patrons be advised that the car park is located on flood-prone land.' (T. Fiander 2007) See below for a photo of the Yelgun Catchment taken from Yelgun Road during a flood event in that catchment.

Appendix K has not addressed the impact the 4.15 km of permanent palisade fencing could have on thousands of patrons in a flood event. This permanent fencing (with Spear Tops) has the potential to have a devastating impact on the mobility of thousands of patrons by severely restricting their movement in a flood, fire, and/or terrorist event.

15. Permanent Security – Palisade Fencing

The proposal calls for permanent fencing of the event site, making references to this in different sections of the proposal. The prospect of this fencing being installed is cause for very great concern.

- Section 3.7 in Appendix D provides one paragraph referring to the erection of 4.15km of permanent security fencing (palisade fencing) 2.20m high, along the southern, western, and northern boundaries of the event area on the portion of the site north of Jones Road.

- Fig. 5 in Appendix N (BAR) illustrates the location and extent of the proposed fencing, allowing one to envision the serious impact the fencing could have on fauna species (including threatened) that utilize the Marshalls Ridge Wildlife corridor and Billinudgel Nature Reserve.

- Section 5.3 in Appendix K (Molino Stewart) states 'security fencing will be erected around the events area to prevent unlawful entry.' It is difficult to envisage how this fencing would prevent unlawful entry when the developers do not intend to fence the eastern boundary, the most likely location for trespass, as experience during the trial events has clearly shown.

- Sheet No. 21 in Appendix C, Civil Design Plans, gives a diagram of a fauna gate that forms part of the proposed permanent palisade fencing. The gates are 2.4m wide x 2.10m high; steel posts use crushed Spear Top at 1400mm. These Spear Tops are perilous for wildlife species, particularly birds species that forage in these areas and other species, such as koala and wallabies, that may try to jump or climb over the fenced area.

- Section 2.1.2 of Appendix K (Molino Stewart) states, "Events will include a standard layout where the performance area will be entirely fenced (1.8m high x 2.4m wide temporary fencing panels that slot into concrete footings and are secured at the top by way of a bracket)."

- Section 5.1 of Appendix N (BAR) states, "out of event times, the proposed permanent security fencing will be opened to allow movement of koalas. That is, every 5th or 6th panel will be on hinges (acting as a gate) and will be permanently open except during events. Each fencing panel is approximately 2.5m long. The fence will also be set 100mm off the ground to allow movement of smaller fauna. (Who will be responsible for opening and closing the gates and ensuring their maintenance?)

CONOS strongly opposes the use of *any* permanent fencing for the NBP site because it is contrary to the aim of wildlife corridors that facilitate the movement of fauna species throughout the landscape. Not only would permanent fencing severely restrict the movement of fauna species across the landscape, but it would also place fauna species at further risk from predators. In addition, considering the proposed Crushed Spear Top (palisade) fencing,

death and/or injury from contact with the fencing can readily be predicted.

We wish to remind the DPE that the RTA, at a considerable cost, constructed a fauna overpass and an underpass approximately 100m north of Jones Road to facilitate fauna movement across the Pacific Highway (M1) and Tweed Valley Way into the Jones Road wildlife corridor and Billinudgel Nature Reserve. The permanent fencing proposed for the western boundary of NBP is in close proximity to the RTA fauna underpass and overpass and makes a mockery of the conservation mechanisms and state government investment into the on going viability of the Marshalls Ridge Wildlife Corridor.

Further arguments against this fencing can be found in the *Far North Coast Regional Conservation Plan, 2010* (FNCRCP)*,* which details basic principles of conservation that are relevant to this area*:*

> • Section 1.3 states that Principle 1 of conservation planning principles is to 'Protect high value environments by avoiding direct impacts on the biodiversity of these areas.'
>
> • Section 3.7.4 states, "Where vegetated corridors are mapped across the landscape and their biodiversity values verified, there should not be an intensification of land use".
>
> • Section 5.1.3 states, "Most existing vegetation and habitat within identified regional wildlife corridors, including riparian areas, should be protected and enhanced" and "land use should not be intensified in identified wildlife corridors".

The Billinudgel Range is one of 8 regional conservation priority areas identified in the FNCRCP. The Marshalls Ridge (Jones Road) wildlife corridor forms the eastern section of the Billinudgel Range and is described thus:

> "3. Billinudgel Range – corridor between Mount Jerusalem and Billinudgel NR: This area focuses on the prominent east-west coastal range that extends from Mount Jerusalem in the west to the Billinudgel Nature Reserve in the east. It is one of the few remaining coast to ranges habitat corridors in the far North Coast Region and is home to a number of threatened species, EECs and large areas of old-growth forest, which is a relatively rare occurrence in the Far North Coast region. The corridor will be critical in terms of adaptation to climate change and linkages with the great eastern ranges corridor. (FNCRCP, 2010, page 59, citing DECC 2008)
>
> The Billinudgel Range corridor provides significant Aboriginal cultural heritage linkages that are part of the natural landscape. These connections include movement routes, opportunities for recreation, and ceremonial, spiritual and natural heritage values (for example, food and medicine)" (FNCRCP, 2010, page 59).

Section 5.2.3 of the FNCRCP 2010 (*Regional conservation priority areas)* identifies the Billinudgel Range in Group 1, which is described in these words: "Typically, these areas form significant contiguous areas of high conservation value native vegetation. These areas are relatively large, well connected and contain a range of ecological communities in moderate to high condition. Conservation of these areas is critical in terms of offsetting the impacts of the FNCRS and achieving an overall improve or maintain outcome" (page 57).

Section 6.1.2 of the FNCRCP 2010 states: 'The range of environmental and NRM issues can be extensive. Planning authorities should refer to the Department of Planning's NRM model clauses and practice Notes. These model clauses ensure that the consent

authority will consider all potential adverse impacts of development proposals on these mapped environmental assets and that approved developments will avoid, minimise and mitigate these adverse impacts' (page 63).

The proposal to install 4.15 km of permanent palisade fencing throughout a wildlife corridor is totally unacceptable and abhorrent and can be compared to the use of barbed wire fences in a conservation area. NBP have utilized temporary fencing throughout the 5 year Trial and can continue to utilize temporary fencing in the future, if further festivals are allowed, in order to maintain the current wildlife corridor values on site.

CONOS objects to permanent fencing which will not only severely restrict the movement of fauna species but would also place these species at risk of injury and death from predators and from the fence itself.

16. Legal Issues

A. Conservation of North Ocean Shores Inc. v Byron Shire Council & Ors [2009] NSWLEC 69

Conservation of North Ocean Shores Inc. (CONOS) challenged the development consent granted by Byron Shire Council (Council) in 2008 to hold the Splendour in the Grass music festival as a one-off event. The Court found in 2009 that the development a 'place of assembly' was prohibited in a 7(k) Habitat zone. The Court ruled that the development consent was 'invalid and of no effect'. The Part 3A process was legally able to override that court ruling, but this proposal is being assessed under Part 4 of the planning regulations, and the local 7(k) zoning is again relevant.

B. Incompatibility with the existing Concept Plan

Although the existing Concept Plan gives general approval for post-trial festivals, permanent approval is not given and was not envisioned. Further approval must be obtained from Byron Council for any post-trial events and only under certain conditions. Also, the existing Concept Plan gives general approval for post-trial festivals up to 35,000 attendees per day, not the 50,000 that is proposed here. So the existing Concept Plan cannot be used to justify this proposed development.

Conclusions

CONOS objects to Parklands proposed SSD for reasons outlined in this submission. We also object to MOD 3 (Concept Plan) to increase attendance numbers to 50,000 and object to the deletion of the current Statement of Commitments outlined in Schedule 3. The state of NSW has repeatedly recognised the area in and around NBP as highly significant for its ecological values and its values to the traditional owners of the land and has made substantial investment in protecting the area's natural and cultural values, including the Marshalls Ridge (Jones Road) wildlife corridor. Yet now the state presents massive intrusions on this important asset as "state significant". As noted above, this is the height of irony.

In the unfortunate circumstance that the government decides to give approval for further festivals on this site, consent conditions need to introduce much more rigour than has been required during the trial period. Specifically:

1. Allow only year-to-year approval based on satisfactory performance as determined by Byron Shire Council, relevant government agencies (e.g., NSW Police, OEH, RFS, SES), and independent assessments as needed

2. Align closing times with the times used by Bluesfest and other festivals in Byron Shire. A closing time of 12 midnight for all festival activity, including cafés and bars, will lessen the impacts on fauna in and near the site, especially along the Wildlife Corridor and the Billinudgel Nature Reserve. (We note that Bluesfest ceases *all* music at 12 midnight.)

3. Restrict attendance numbers to no more than 30,000, inclusive of patrons, holders of free tickets, and all other personnel on site. Even fewer would be more advisable.

4. Impose strict noise limits, using the Intrusiveness Criteria of the NSW Industrial Noise Policy of 2000.

5. Ensure that moderate and major events are not held during peak holiday times. (Christmas/New Year, Easter, and school holidays) to avoid saturation to nearby towns, such as Brunswick Heads and Pottsville.

6. Require an ecological monitoring program that is properly designed by a Certified Practicing Ecological Consultant, as endorsed by the Ecological Consultants Association of NSW.

7. Reject or greatly diminish the proposed infrastructure works so as to protect the sensitive ecology of the area.

Addenda

In the following pages, we include these documents, which should be considered part of this submission:

1. Measures Taken by the NSW Government in Protecting the North Ocean Shores/Yelgun Site: A Chronology by CONOS

2. North Byron Parklands Cultural Events Site – Assessment of EIS and Associated Documents for State Significant Development Application (SSD 8169) by Dr. Martin Denny

3. A Review of the Effects of Human Intrusion and Disturbance on Wildlife; Reference to a Proposed Permanent Cultural Events Site at Yelgun, NSW by Andrew Benwell and David Scotts (2010)

Measures taken by NSW Government in Protecting the North Ocean Shores/Yelgun Site

Compiled by Conservation of North Ocean Shores (CONOS)

1985 SEPP 14 Wetlands No. 57 gazetted by NSW Dept. of Planning.

1987 NSW Labor Minister for Planning & Environment places Interim Conservation Order (ICO) over lands at North Ocean Shores/Yelgun following the bulldozing of culturally significant coastal lands.

1989 Large areas of North Ocean Shores/Yelgun Referenced by NPWS.
N.B. Only areas of high conservation value meet this criteria.

1990 Commission of Inquiry (COI) into Rezoning of Lands at Ocean Shores, North. Commissioner Simpson recommends the majority of lands be zoned for environmental protection due to the areas natural and cultural values.

1990 Survey uncovers 22 Aboriginal Archaeological sites & defines Marshalls Ridge (Jones Road) as a Ridge of 'High Archaeological Sensitivity' (Navin, Canb.)

1994 The Natural and Cultural Values of the North Ocean Shores/Yelgun are listed on the Register of the National Estate, Canberra, as an 'Indicative Place'.

1995 NSW Coalition Government acquires 325 ha of SEPP 14 Wetlands and the Billinudgel Nature Reserve is created.

1995 NSW Labor Government places a 12 month Interim Protection Order over environmentally-sensitive lands at North Ocean Shores/Yelgun.

1995 NSW NPWS Satellite Imagery highlights the Marshalls Ridge wildlife corridor as the only substantial link of native vegetation connecting coastal remnants through to the hinterland and World Heritage rainforests of the Mount Warning caldera.

1996 NSW Labor Government purchases a further 350 ha of environmentally sensitive lands at North Ocean Shores/Yelgun for additions to the Billinudgel Nature Reserve.

1996 NSW Labor Minister for Environment extends IPO for a further 12 months over North Ocean Shores/Wooyung lands.

1997 NSW Labor Government purchases a further 40 ha of culturally significant land at Wooyung for additions to the Billinudgel Nature Reserve.

1997 RTA redrafts section of Pacific Highway Upgrade at Yelgun to avoid impact on SEPP 14 Wetlands and the Billinudgel Nature Reserve.

1997 NSW Minister of Planning places a 'Stop-Work Order' over lands in the Marshalls Ridge (Jones Road) wildlife corridor to halt clearing in habitat areas.

1997 NSW Minister of Planning calls a Commission of Inquiry into the Rezoning of Lands at North Ocean Shores to resolve issues surrounding conflicting land uses i.e. environmental &

agriculture. *N.B. Commissioner Cleland acknowledges the scientific information supporting the environmental and cultural significance of Marshalls Ridge (Jones Road) wildlife corridor, despite its partial degradation. The Commissioner strengthens and expands Byron Council's draft environmental zonings to prevent inappropriate development.*

1998 NSW Minister of Planning adopts Commissioner Cleland's recommended zonings for North Ocean Shores/Yelgun and Amendment 51 of the Byron LEP is gazetted.

1998 RTA recognises the findings of Cleland COI and invests $3.5 million for a 'Cut and Cover' overpass to maintain connectivity to the Marshalls Ridge (Jones Road) wildlife corridor to enable a safe passage for fauna. This initiative was the first of its kind in NSW, possibly Australia. RTA invests a further $1 million on fauna mitigation devices, i.e. underpasses.

2002 RTA acquires additional lands as 'Compensatory Habitat' in the Marshall's Ridge (Jones Road) locality to enhance the wildlife corridor servicing the Billinudgel Nature Reserve.

2002 A regionally significant Aboriginal archaeological site is discovered (Piper, 2002*), bringing the total of registered sites with NPWS to 32 for this precinct.

2002 NSW Labor Minister for Environment issues a 'Stop-Work Order' over the Marshalls Ridge (Jones Road) wildlife corridor to stop unauthorised clearing.

2002 NSW Labor Minister for Environment issues another 12 months Interim Protection Order over the Marshalls Ridge (Jones Road) wildlife corridor. *N.B. IPO's & ICO's are rarely enacted; however, NSW Labor Ministers have enacted this legislation on numerous occasions at North Ocean Shores/Yelgun.*

2002 NSW Labor Minister for Environment writes to Byron Council reminding it to enforce Amendment No 51 of its Local Environment Plan.

2002 NSW Fisheries takes landowner to court over the clearing and pollution of Yelgun Creek. Landowner is convicted and ordered to rehabilitate. *N.B. Government agencies, e.g. Byron Council, NPWS, Dept. of Agriculture & NSW Fisheries, have spent valuable resources in numerous court battles defending the high conservation values of the site.*

2004 Fire escapes into peat deposits along Marshalls Ridge and burns underground for months (RFS, 2004). Toxic smoke is reported kilometres away and cases of respiratory problems, headaches, and asthma are recorded by the NSW Health Department (NRPH & DOCS, 2004).

2004 A second fire escapes into Reserve lands. A Declaration of Emergency [Sec. 44] is issued by the NSW Fire Service and costa the State over $1 million. Fifty fire units, 5 helibombers, and 120 firefighters, including crews from the mid-north coast, battled the fire for 3 days until heavy rain extinguished the main blaze. An adjacent primary school and housing estate were evacuated.

2004 Byron Council incorporates all forested areas and intervening pasture along Marshall Ridge (Jones Road) in their wildlife corridor mapping (BSC, 2004). In addition, all forest blocks are mapped as High Conservation Value, Koala Habitat, and Threatened Fauna Habitat (BSC, 2004).

2005 Director General of the NPWS places a 'Stop-Work Order' on lands within the Marshalls Ridge (Jones Road) wildlife corridor at North Ocean Shores/Yelgun. Landowner ordered to rehabilitate.

2006 Billinudgel Property Pty. Ltd. purchases 2 adjoining properties (256 ha) at North Ocean Shores/Yelgun and names the site North Byron Shire Parklands.

2008 Byron Council grants approval to hold a one-off 'Trial' festival for a Splendour in the Grass festival (DA No. 10.2007.462.1) at Yelgun (1,000+ submissions received).

2009 An Appeal is lodged in the Land & Environment Court against Byron Council's approval for a 'Trial' Splendour in the Grass festival.

2009 *Conservation of North Ocean Shores Inc. v Byron Shire Council & Ors NSWLEC, 2009.*
Chief Justice of the L & E Court, Judge Preston, found that Byron Council's approval for a 'trial' Splendour in the Grass festival @ Yelgun was prohibited under the B,LEP and ruled it to be 'invalid and of no effect'. . (Decision #69 at www.lawlink.nsw.gov.au/lec (Judgments > NSW Caselaw > Decisions by Number.)

2009 The *Northern Rivers Regional Biodiversity Management Plan* (DECC May 2009) identifies Marshalls Ridge as part of an important Climate Change Corridor.

2009 Billinudgel Property Pty. Ltd. submits a proposal to the NSW Department of Planning to establish a permanent 'Cultural Events' site at North Byron Shire Parklands (Yelgun). The proposal is lodged as a Major Project, subject to the guidelines of Part 3A of the Planning Act. (Later in the year, the promoters announce that they will temporarily relocate their 2010 music festival to Woodford, Queensland.)

2010 The *Far North Coast Regional Conservation Plan* (DECC 2010) identifies the Billinudgel Range (Marshalls Ridge forms the eastern section) as a rare east-west escarpment that 'will be critical in terms of Climate Change and linkages with the Great Eastern Ranges corridor'.

2012 The Planning Assessment Commission (PAC) hold public meetings in Byron Bay & Ocean Shores with approximately one hundred community speakers, with the majority opposing the development.

2012 (April) PAC approves a 5 Year Trial to Billinudgel Property Pty. Ltd. for a Cultural Events Site MP 09_0028, at Yelgun, with strict conditions for ecological monitoring and environmental management.

2012 Federal Government lists Koala as 'vulnerable' under Commonwealth Threatened Species Act.

North Byron Parklands Cultural Events Site – Assessment of EIS and Associated Documents for State Significant Development Application (SSD 8169)

by Dr Martin Denny, 26th February 2018

I have read and adhere to the Uniform Civil Code Procedures Rules 2005 and the Expert Witness Code of Conduct.

Executive Summary:

1. Despite the conclusion in the EIS that "Comprehensive ecological monitoring surveys undertaken over the trial period before, during and after each event have demonstrated that the events have not resulted in any significant impacts to local biodiversity, including threatened species", there are a number of examples that show that some impacts from human generated light and noise have been recorded.
2. These are:
   - avoidance of illuminated blossoms by feeding flying-foxes,
   - increased wariness in Swamp Wallabies and a possible avoidance of the event area,
   - declines in bird populations on occasions with a loss of a number of 'bush birds' and,
   - a possible impact upon Koalas.
3. The extent of impacts from raised levels of noise and light within Billinudgel NR has not been assessed, yet the Nature Reserve (NR) is possibly more sensitive to anthropogenic impacts than the event site, and is considered as an area of high biodiversity and conservation importance.

To assess the biodiversity aspects of the proposed development I have read through the following documents:

- North Byron Parklands Cultural Events Site Environmental Impact Statement, December 2017
- Appendix B Land Use Structure Plan - Ecological Structure Plan
- Appendix G Environmental Health and Safety Management Manual
- Appendix H Compliance Tables – Project Approval Conditions
- Appendix I Compliance Tables – Parklands KPIs
- Appendix L North Byron Parklands Acoustic Assessment for Permanent Approval
- Appendix M Report on Visual Matters for Proposed Permanent Cultural Events Site

- Appendix N Biodiversity Assessment – Parts 1 and 2
- Secretary's Environmental Assessment Requirements
- State Significant Development Application for a Permanent Cultural Events Site and North Byron Parklands
- S.75W Modification Application North Byron Parklands
- SITG 08 APP A1 Ecological Assessment
- SITG 08 APP A2 Koala Survey & KPoM
- NBP Performance Report 1 – 2013-14
- NBP Performance Report 2 – SITG14
- NBP Performance Report 3 – 2014-15
- NBP Performance Report 4 – Dec 2016
- NBP Performance Report 5 – Dec 2017
- Technical Paper Ecological Assessment and response to Director-General's Environmental Assessment Requirements – June 2010
- Response from the Proponent to Commissions briefing enquiries – March 2016
- North Byron Parklands SEPP no. 44 Koala Monitoring Report – October 2017
- Fitzgerald M (2014) North Byron Parklands Biennial Fauna Survey, Report for North Byron Parklands

After reading these reports and from a short literature review of the impacts from anthropological light and noise on fauna, I make the following comments.

First, some general comments about the overall impact assessment process.

a. The current biodiversity assessment process under the *Environment Planning and Assessment Act 1979* is now firmly based upon the presence of a limited number of species and ecological communities. Focus is upon flora and fauna species that are listed as Threatened or those generated by the Biodiversity Assessment Method Calculator ('Credit Species'). It is no longer necessary to describe or assess total biodiversity values of an area by including all species located and taking an overall view of that area's importance. Such a restricted approach to assessing the biodiversity value of an area and the potential impacts from a development falls short of the overall aims of previous and current Acts.

   Consequently, it is difficult to find any listing of fauna species found in the festival site and surrounds. Some of the supporting documents do list all species and can be used to determine the biodiversity values of the area, but this is not addressed in the EIS and Appendices.

b. There is a tendency in the EIS to state that a particular assessment or procedure will be undertaken "by a suitably qualified ecologist", yet there is no definition or description of what this person is. Is it one that is accredited to undertake the assessment under the Biodiversity Assessment Method (BAM) or someone with suitable academic qualifications? In my opinion, a Certified Practicing Ecological Consultant, as endorsed by the Ecological Consultants Association of NSW (ECANSW), would be suitably qualified.

On reading through the numerous periodic reports listed above, it is clear that a detailed assessment was undertaken regarding flora and fauna. In particular, analysis of survey data has been thorough and it should have been reported more fully in the main EIS document. Examples of detailed analysis of survey data are provided in the annual Performance Reports where multivariate analyses (e.g. Binomial Deviance Ordination Analyses) is given for the Before-During-After survey data for birds and microbats (e.g. see Performance Report#3, MP0930028 Covering Falls Festival 30-31 December 2014 and 1 – 2 January 2015, and Splendour in the Grass 24 – 27 July 2015 operating at North Byron Parklands Appendix B2 Results and Analyses of Event Impact Monitoring Data) 1 December 2015). Unfortunately, the detailed assessment concentrates upon the total numbers of species and ignores changes in individual species.

Consequently, this does mean that some of the conclusions given in the EIS are not as clear cut as they seem. Although the EIS states that there are no changes in fauna populations over time within the North Byron Parklands (NBP), there several examples given within the specialist reports that show some effects from the events at the NBP. For example:

1. Monitoring during Splendour in the Grass (SITG) 2017 saw "overall bird counts fall from before to during and after, bird and species counts were lower than overall average values" (Table 17, Appendix B1 *Ecological Performance Report year 5*, also Table 3).
2. There are examples of results from individual bird transect surveys that show lower than average species counts that "may reflect adverse influences of noise and close human presence" (Appendix A to NBP Performance Report 3 2014 – 15, p. 17).
3. Several of the bird species monitored during the Falls Festival in 2017 showed a decline in numbers during the event which did not recover afterwards (see Appendix A EIM Data, Appendix B1 *Ecological Performance Report year 5*). These include the Golden Whistler, Rufous Whistler, Silvereye, Sacred Kingfisher, Little Shrike-thrush and White Scrubwren. These are mainly species that are bush-dependant and some are considered to be 'of concern'.
4. The NBP – Performance Report 1 – 2013-14 observed that there were lower than usual bird counts in some forest blocks close to the event.
5. Nearly all of the specialist reports state that "Flying-foxes avoided brightly illuminated blossom but exploited this resource soon after lights were

switched off, and in the interior of less brightly illuminated trees at variable distances from light towers".

6. Several of the specialist reports state that "Patterns of data indicate the possible development of increased wariness in local Swamp Wallabies" (e.g. pages 20 and 26, NBP Performance Report 3 – 2014-15). Although Swamp Wallabies are located nearby to the NBP e.g. Marshall's Ridge, there is little evidence of occupation within the site.

It can be argued (as the EIS does) that these species will recover and move back into their usual ranges. However, whilst the events are in progress, many animals do not exhibit their normal mode of behaviour and this could, over the long-term, result in a decline in population numbers. Restriction of food for flying-foxes during the events is one example. Another example would be the movement of fauna, particularly bush birds, away from their normal home areas resulting in increased competition with individuals living in their established home range.

Although the Marshall's Ridge wildlife corridor is mentioned within the EIS and associated documents, the possibility of any disruption of this corridor due to edge-effects from the Parklands and the continued use of the Parklands is not addressed. Although the majority of the Parklands comprises cleared grassland, the area would still be used as part of the Marshall's Ridge corridor. However, the more frequent use of the area for large and noisy events will limit its use for the movement by fauna.

Although there has been a detailed analysis of the impacts from the events at NBP one aspect appears to have limited attention. This is the impacts from the developments upon the biodiversity utilising Billinudgel Nature Reserve (NR). Billinudgel NR is located adjacent to the NBP and one part is surrounded by the Parklands on three sides. Although there will be no direct impacts from clearing or construction upon the NR and its flora and fauna (there is probably some impacts from event attendees entering the NR), there could be considerable effects from two more amorphous entities, noise and light.

According to the noise report (Appendix L), Billinudgel NR is within an area called Zone 1, i.e. closest to the actual events. Appendix L states that the acoustic limits on noise generated from the events in this zone between 11 am and midnight will be 60dBA and 70dB (lin) at low frequencies. Between midnight and 2 am the limits will be 45 dBA and 60 dB (lin). There are no levels (lumens) of light incursion given in the EIS but the illumination will be high.

The EIS discusses indirect impacts but does not concern itself with Billinudgel NR and there is little discussion on noise and light as impacting factors. The argument used in the EIS is that once these two factors are removed, i.e. when there are no events, fauna will return to their normal home areas. This is argued from the basis that fauna numbers (birds and bats) recover after each event. As mentioned above, there is no consideration of long-term impacts.

The impacts from noise and light are discussed in the *Ecological Assessment of Splendour in the Grass 2008 at North Byron Shire Parklands* report. Assessment of

impacts in this report is based on data on impacts from noise and light on fauna and is mainly drawn from interviews with zoologists familiar with species known from the NBP. It is admitted in this report that there was little published information on these impacts. However, since 2008 there is a considerable body of information about the impacts from noise and light upon fauna (and flora). Consequently, I offer a short selection of part of the literature on this subject.

"Noise pollution affects birds in myriad ways, including (1) physical damage to ears; (2) stress responses; (3) fright–flight responses; (4) avoidance responses; (5) changes in other behavioural responses, such as foraging; (6) changes in reproductive success; (7) changes in vocal communication; (8) interference with the ability to hear predators and other important sounds; and (9) potential changes in populations. Reactions to noise depend on the type of noise produced, including frequency, loudness, consistency, and duration. Some species react more negatively to noise than others. Colonial birds are highly susceptible to noise because when one bird reacts, many or all birds in a colony will react similarly, whether the group responds directly to the noise or to the first bird(s) that responded. "[1]

"We identified seven potential effects of light and noise that should be considered in future development planning in Australia: 1 Ecological community composition could potentially be negatively impacted in the immediate vicinity of the source, and for large distances surrounding the source, depending the sensitivity of the organism and the nature of the lighting. This could also have flow-on effects to other parts of a protected area, through competition for resources. Behavioural plasticity will help some organisms to adjust to the new environment, but not all organisms are able to adapt to a changing environment. 2 Reproductive success in birds, moths and frogs in the area close to the source could potentially be significantly reduced, which in turn will also have further effects on trophic relationships and community composition. 3 Niche competition changes could occur between species, where there is resource partitioning or when diurnal species become active at night or exploiting the congregation of insects around a light source. This could put greater pressure on key resources and reduce a species' fitness in the changed environment. 4 Loss of ecosystem function with the loss of organisms that are unable to adapt to the light, noise or increased pressure, such as predation, competition and foraging. For example, the local extinction of one organism in an area could have flow-on effects and impact other organisms in the ecosystem. 5 Effects on existing and reintroduced animals could cause substantial changes in foraging, and antipredator behaviour and reproductive success. This may not only effect existing fauna, but also the re-establishment of reintroduced species and their long term survival in protected areas. 6 Reduction in effectively conserved habitat in a protected area due to loss or reduced usable habitat and/or resource values to biodiversity. Such effects are likely to be overlaid on top of predicted effects of climate change on biodiversity "[2].

"Effects of lifetime exposure to artificial light at night on cricket (*Teleogryllus commodus*) courtship and mating behaviour. Chronic exposure to bright light at night may affect some aspects of mate choice and reproductive behaviour in this insect" [3].

"Birds breeding in heterogeneous landscapes select nest sites by cueing in on a variety of factors from landscape features and social information to the presence of natural enemies. We found different effects of noise and landscape features depending on species, with strong effects of noise observed in breeding habitat selection of *Myiarchus cinerascens,* the Ash-throated Flycatcher, and *Sialia currucoides*, the Mountain Bluebird. The average treatment site registered at 70.87 dB(F), and the average control site 60.24 dB(F)" [4]

"Continuous noise can reduce acoustic detection of birds by ~50%, which can lead to biased estimates of species richness and community diversity. Surprisingly, continuous noise levels by only 5–10 dB(A) above fairly quiet ambient levels can result in severely biased estimates" [5].

"Road density and light pollution were included in 'best' models to explain glider activity (a negative influence), and noise pollution negatively influenced sugar glider occurrence. Novel solutions need to be developed to lessen the effects of anthropogenic factors (such as light and noise) on patches of native vegetation retained in urban areas for conservation purposes" [6].

"Fifty decibel conversation (approximately library speaking volume) caused declines of 35 percent in total detections and 33 percent in detected species richness. Birds reacted similarly to 60 dB (approximately the volume of an excited child): average detections declined by 39 percent and detected species richness by 37 percent" [7].

"Number of nearby visitors and noise level affect vigilance in captive koalas. Studies show that an increase in visitor noise treatment resulted in increased time spent vigilant in the koalas" [8].

"Aversive behaviour by koalas (*Phascolarctos cinereus*) during the course of a music festival in northern New South Wales, Australia. The potential for short-term disturbances such as music festivals to significantly influence the ranging patterns of koalas warrants recognition of possible longer-term ecological consequences for planning and management purposes" [9]

"Human-generated noise pollution directly impacted habitat use and nest success of birds (Francis *et al*., 2011a). Declines in densities of woodland and grassland bird species have been shown to occur at noise thresholds between 45 and 48 dB, respectively; while the most sensitive woodland and grassland species showed declines between 35 and 43 dB, respectively "[10].

"With a noise increase of just 3 dB – a noise level identified as "just perceptible to humans" – this increase corresponded to a 50% loss of listening area for wildlife. Other data suggest noise increases of 3 dB to 10 dB correspond to 30% to 90% reductions in alerting distances for wildlife, respectively. Impacts of noise could thus be putting species at risk by impairing signalling and listening capabilities necessary for successful communication and survival" [11].

"A study found that traffic noise, and other sources of intense, broadband noise deterred bats from foraging in areas where these noises were present presumably because these sounds masked relevant sounds or echoes the bats use to locate

food. Furthermore, foraging efficiency of an acoustic predator, such as the greater mouse-eared bat (*Myotis myotis*) is greatly decreased by anthropogenic noise" [12].

"Mining machinery noise has negative effects on the Eastern Blue-tongued Lizards behaviour and welfare" [13]

This relatively short selection of studies and conclusions provides an insight into the relative effects from human generated light and noise that is above the natural levels. Information from the literature shows that increased noise and light will affect a wide range of fauna taxa. Birds, bats, marsupials (even Koalas), lizards and insects are all known to be affected by raised levels of light and noise to various degrees. This is to be expected, as communication between individuals is reliant upon calls or songs [14]. Also, seeking prey and avoiding predators relies upon the ability to hear external sounds. The masking of calls and external noise results in changes in behaviour, such as during breeding, and long-term population differences. Studies show that birds can be affected at dB levels of about 35 and changes in behaviour occur if sound levels are raised by 5 – 10 dB. Newport *et* al [2] tabulate hearing ranges and sensitivities of different taxa and give sensitivity values between 10 and 60 dB for amphibians, 10 and 20 dB for reptiles and 20 dB for mammals.

The impacts from light and noise are dismissed within the EIS by stating that no changes in animal numbers occur after an event, even though this is contradicted by several examples given above.

Nearly all the studies and assessments regarding impacts from noise and light are focussed on the actual NBP, i.e. within the event area. In this area, a high proportion of the land is highly disturbed and it would be expected that fauna would have adapted to a certain extent to that disturbance. But what about land that is still in relatively pristine condition - Billinudgel NR, for example?

Billinudgel NR was dedicated, pursuant to the *National Parks and Wildlife Act 197*4 (NP&W Act), as a nature reserve in April 1996. Two areas of 189.5 hectares and 166.6 hectares were purchased in late 1996 and dedicated as an addition to the NR in 1997. The total area of the NR is now approximately 713 hectares [15]. According to the Billinudgel NR Plan of Management [15] nature reserves are considered to be valuable refuge areas where natural processes, phenomena and wildlife are protected and can be studied. Nature reserves differ from national parks as they do not include provision of recreation opportunities as a major objective of their management.

The purpose of a nature reserve is defined under the NP&W Act as being:

- the care, propagation, preservation and conservation of wildlife;
- the care, preservation and conservation of natural environments and natural phenomena;
- the study of wildlife, natural environments and natural phenomena; and
- the promotion of the appreciation and enjoyment of wildlife, natural environments and natural phenomena.

In other words, nature reserves are of higher value in the scale of conservation areas in NSW.

The Billinudgel NR Plan of Management states that the following specific management objectives apply to this NR. These objectives are directly associated with the protection of those natural and cultural heritage values which are special to this NR. They are:

- protection of Billinudgel wetland and its diverse flora and fauna;
- protection of wet sclerophyll forest found adjacent to the wetland;
- preservation of primary over-wintering habitat utilised by a range of migratory fauna;
- protection of the wetland peat deposit as a site of scientific interest;
- conservation of Aboriginal sites and the cultural significance of the landscape;
- protection of habitat used by specialist fauna including wetland and rainforest species and species dependent on old growth elements; and
- promote the value of continuous native vegetation as habitat for fauna and flora, and as movement corridors for nomadic, seasonal and migratory species.

The impacts from increased light and noise on fauna within Billinudgel NR conflict with the management objectives of this nature reserve, particularly the protection and preservation of the diverse wetland and the migratory fauna.

The problem with assessing impacts from noise and light is that both entities are relatively amorphous and can spread over a large area. However, it is possible to measure and monitor the effects from both noise and light, as shown in the selection of studies given above.

Yet, this has not been undertaken to any extent within Billinudgel NR, an area of high biodiversity and conservation values, despite extensive surveys and impact assessments for the Parklands events. To date, monitoring of biodiversity within Billinudgel NR has consisted of the placement of one anabat recorder and two remote cameras, as well as some scattered bird transects. This monitoring protocol was introduced in 2010, thus there were three previous years without any baseline information about the biodiversity within Billinudgel NR, although monitoring had occurred within NBP since 2007.

This is definitely not sufficient to determine whether there has been and is any impact from raised noise and light levels in Billinudgel NR. In addition, it appears that impacts from noise and light upon fauna may affect long-term changes to populations. None of these concerns have been addressed within the EIS and other surveys and assessments. This needs to be rectified by establishing a rigorous monitoring program within Billinudgel NR, with established ‘trigger points’ and a management plan.

CONCLUSIONS

Despite a plethora of reports, survey data and detailed analysis the assessment of impacts upon biodiversity within and surrounding the North Byron Parklands from the Cultural Events is, in many aspects, inadequate. By concentrating upon a limited number of flora and fauna species (Threatened species and Credit Species) impacts

upon individual species from anthropogenic noise and light, as well as high numbers of attendees, is not addressed. Numerous examples can be found within the supporting documents analysing survey data that show that a number of species will be affected. In addition, there is no assessment of long-term changes in individual species.

Added to these inadequacies is the lack of assessment from edge effects and other indirect impacts upon Marshall's Ridge wildlife corridor. One further major inadequacy is the lack of any short-term and long-term assessment of the effects from anthropogenic light and noise, and attendee incursion upon the important Billinudgel Nature Reserve. There has been inadequate monitoring of the flora and fauna within the Nature Reserve and no long-term monitoring has been proposed – this is an important aspect overlooked in the overall assessment process.

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26th February 2018

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A Review of the Effects of Human Intrusion and Disturbance on Wildlife; Reference to a Proposed Permanent Cultural Events Site at Yelgun, NSW







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David Scotts





A Review of the Effects of Human Intrusion and Disturbance on Wildlife; Reference to a Proposed Permanent Cultural Events Site at Yelgun, New South Wales

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Summary

This review aims to highlight the potential significant impacts of increased human intrusion and disturbance on wildlife and seeks to place those impacts within the context of a planned permanent cultural events site at Yelgun, on the north coast of New South Wales. Human intrusion and disturbance refer to the effects of human activities such as movement and congregating of people, increased noise, artificial night lighting, pedestrian and vehicular traffic and other indirect impacts, which intrude on wildlife, but do not involve direct destruction of habitat. Such "non-consumptive disturbances" are often associated with outdoor recreational activity occurring in parklands, reserves and other areas that also function as wildlife habitat. The impact of human disturbance on wildlife is subtle compared to overt forms of disturbance such as deforestation and chemical pollution, which have immediate destructive effects, but human disturbance has insidious and cumulative effects on wildlife (Price 2008). In the context of this review we are primarily considering human-induced effects as manifestations of the impacts of activities associated with a cultural festival site (e.g. elevated people presence, periodic intense noise, artificial lighting, potential changes to species compositions and interactions).

In sensitive species, human activity within or adjoining wildlife habitat elicits various stress-related responses ranging from physiological responses (e.g. changes in chemical and hormone balances), to altered activity and time budgets (e.g. more vigilance and less foraging), to more drastic changes in activity known as escape or flight response (e.g. cessation of feeding or breeding behaviour and vacation of an otherwise suitable area of habitat) (e.g. Blumstein 2003; Price 2008; Ambrose 2009). Research on avifauna generally shows that a large proportion of species in a given area of habitat subjected to human disturbance exhibit behaviour consistent with stress, avoidance or disruption, and the evidence points to other major fauna groups being affected in parallel fashion. These effects have obvious implications for the maintenance of species richness and population viability of threatened species in conservation reserves and other habitat areas affected by encroaching human activity.

Research shows how the level of human disturbance determines the degree of likely impacts on the wildlife that reside, or utilize habitats within or nearby to the site of disturbance. Quantification of the relationship between disturbance type and intensity and the response of biota is not possible with a high degree of precision, but the general trends in the relationship have been demonstrated by research. As group size and disturbance intensity increase, the negative effects on wildlife overall also increase, although there may be species (often exotic) which adapt to exploit new types of habitat created. Intense and concentrated disturbance will tend to alienate habitat within the activity site, exacerbate edge effects emanating into adjoining reserves or protected areas, and increasingly affect sensitive wildlife species. At Yelgun, the sudden intrusion into the landscape of large concentrations of people, high levels of noise, artificial night lighting and other impacts are likely to act as an intense disturbance on a high proportion of species.

Research indicates that for relatively small groups of people in parks and reserves, human activity may exert a direct disturbing effect on avifauna up to 100m from the

activity and considerably greater edge effect distances have been demonstrated for other fauna. Artificial night lighting can have a severe impact on nocturnal insect fauna, undermining the foodweb of consumer species dependant on this resource base. The use of yellow sodium vapour lights in place of normal white lights can greatly reduce this impact, but the extirpation process continues to operate, as insects are drawn in from surrounding habitat albeit at a lower rate (some insects are actually more attracted to yellow sodium lighting).

The effect of noise on wildlife has only recently been considered a potential threat to animal health and long-term survival. Noise can be frightening and disturbing to animals which vary tremendously in their response to noise ranging from apparent near indifference to various escape and flight behaviours. Other common behavioural responses to noise include elevated stress levels, acoustic adjustment and habitat avoidance.

The research reviewed herein indicates that the consequence of intense human disturbance is likely to be avoidance or abandonment of habitat and changed behaviour patterns by a proportion of the vertebrate fauna. On a wider scale this may adversely affect the sustainability of local populations of threatened fauna species, which depend on the surrounding matrix as well as Billinudgel Nature Reserve to maintain viable local populations. A major negative impact of human disturbance on a number threatened fauna seems highly likely from research which demonstrates that the impact of human disturbance is proportional to the intensity of disturbance as measured by group size. One research study found that the relationship between recreation intensity and bird density was log linear, indicating that the exclusion process was exponential (i.e., doubling the amount of recreation activity (people-presence) quadrupled the disturbance effect). The implications if group size (or disturbance intensity) is in the thousands or tens of thousands are obvious, given that in one of the studies reviewed demonstrable effects on wildlife resulted from a relatively subdued music event attended by 200 people.

Research supports the expectation that as intruder group size increases, the negative effect of human disturbance extends further. Consequently a larger area of habitat may be vacated as species withdraw to a perceived safe distance, or move to another area of habitat if available. Fernandez-Juricic (2000) explains how important it is that human disturbance loads are incorporated in management decisions at local and regional scales. It is clear that a legislated land-use planning process is urgently needed for protecting nature conservation areas with appropriate land-use buffer zones. The Yelgun location supports suites of threatened species but requires restoration to enhance long-term viability of wildlife, not further disturbance.

With regard to the proposed cultural events site at Yelgun, there is a tacit assumption that Billinudgel Nature Reserve will act as a refuge or source of unoccupied available habitat for individuals displaced from the festival site by human disturbance. Putting aside the likely impacts of elevated human disturbance as an edge effect on the reserve itself, this assumes that there is available habitat; the reserve is not already at carrying capacity for that species given food resources and predator activity; and that increased density within the reserve will not affect long-term survival and fecundity.

Arguments could be made either way, but essentially we do not know with any certainty what the exact effects of a massive increase in human disturbance (relative to the current situation) will be, but there is a significant risk that survival and fecundity of local populations will be adversely affected, resulting in population declines.

Possible mitigating circumstances for large scale human disturbance at Yelgun include habituation and buffer zones. The term "habituation" is often misused to describe any observed moderation in wildlife responses to human disturbance and is often confused with tolerance which is the intensity of disturbance that an individual tolerates without responding in a defined way; tolerance is often mistaken for habituation (see Sec. 6.2). The phenomenon of habituation appears to depend on the frequency and the intensity of encounters. Wildlife is less likely to habituate to human disturbances entailing either low frequency or high intensity. In the case of the proposed cultural events site at Yelgun, it would appear that human disturbance will be intermittent and probably very high in intensity, a combination least likely to result in habituation behaviour in wildlife.

Narrow buffer zones are unlikely to be effective in mitigating potential loss of wildlife diversity at the Yelgun locality, because of the intensity of human disturbance associated with a large cultural events site and its close proximity to core and matrix habitat (of regional conservation significance). Rather than narrow buffer zones, it is suggested that conservation areas established in rural landscapes that then become subject to increasing pressure from development, require a graded system of land-use buffer zoning that explicitly recognises the level of human disturbance associated with different land uses and their impact on wildlife.

Definitions

connectivity: The degree to which a landscape facilitates or impedes movement among resource patches.

core areas: Reservoirs for the conservation of plant and animal populations and for the maintenance of ecological processes; typically the largest, most intact blocks of habitat and the areas most likely to support diverse habitats and intact faunal assemblages; comprising in large part the system of dedicated conservation areas (Nature Reserves, National Parks etc.).

edge effects: The zone where one land use or vegetation type changes abruptly into another, also referred to as an ecotone; the edge zone may be anthropogenic (e.g. forest into agriculture or grassland into road) or natural (e.g. wetland into forest or heath into forest). Often, however, the edge is more subtle such as mature/regrowth forest or forest community 1/forest community 2.

ecological pattern: the structure (ie. configuration and condition) of habitat within a landscape.

ecological process: the dynamics or interaction between biota and environment that maintain the ecosystem and its manifold functions; for example, species migration, pollination, productivity, biogeochemical cycling.

habituation: a process involving a reduction in response over time as individuals learn that there are neither adverse nor beneficial consequences of the occurrence of a stimulus.

hard matrix: Areas surrounding reserves where ecological processes are alienated by other land-uses.

human disturbance: Applied in the context of this report to mean human activities other than direct clearing or destruction of habitat that have an adverse on wildlife, such as massing of people, increased noise, artificial night lighting and pedestrian and vehicular traffic.

matrix areas: Areas and land-uses surrounding reserves and other protected habitats.

noise: a sound of any kind; environmental noise often refers to unwanted sound; sound is often measured in terms of intensity (as decibels (dB)) and frequency (kHz); the decibel (dB) is a logarithmic unit of measurement that expresses the magnitude of intensity relative to a specified or implied reference level. Since it expresses a ratio of two quantities with the same unit, it is a dimensionless unit.

non-consumptive (human disturbance): human activities that do not cause obvious changes to the physical environment but nonetheless can affect wildlife adversely.

sensitisation: the opposite to habituation - increased behavioural responsiveness over time when animals learn that a repeated or ongoing stimulus has significant consequences for the animal.

soft matrix: Areas surrounding reserves where some level of ecological intactness and integrity is maintained.

tolerance: the intensity of disturbance that an individual tolerates without responding in a defined way.

1 Introduction

1.1 Purpose

Human activities that affect wildlife and their habitats are pervasive and increasing. The effects of these activities are manifested at all ecological scales, from short-term changes in the behaviour of an individual animal through local extirpations and global extinctions (Steidl and Powell 2006).

Study of the response of wildlife to different types of "non-consumptive" human disturbance, that is, activities involving impacts such as increased noise, vehicle traffic, artificial night lighting, pedestrian traffic and recreation, rather than direct clearing or destruction of habitat has become an important field of ecological research. This topic generally falls within the science of behavioural ecology and research in Europe and North America, and increasingly in Australia, has generated a large body of published literature, providing insight into its effect on wildlife (e.g., Geist *et al.* 2005, Price 2008, Price and Lill 2008, Parris *et al.* 2009).

The purpose of this discussion paper is three-fold: -

(i) to review the current state of knowledge concerning the effects of different forms of human disturbance on wildlife, based on a review of scientific literature published in reputable, peer-reviewed journals;

(ii) to discuss the ecological effects of intensified land-use on conservation areas with special reference to a cultural events site proposal at Yelgun in Byron Shire, adjoining Billinudgel Nature Reserve; and

(iii) to highlight the need for planning legislation that protects nature conservation areas with suitable buffer zoning and land-use hierarchies, to safeguard conservation areas established in rural landscapes from spreading urbanisation/intensification of land-use.

The discussion paper was commissioned by CONOS (Conservation of North Ocean Shores) and prepared by ecologists David Scotts and Dr Andrew Benwell. The review was prepared in the context of a proposed music and cultural festival site on 640ha of land owned by North Byron Shire Parklands (NBSP) at Yelgun in Byron Shire, northern NSW. The proposed site has long been recognised as having high conservation value (see Appendix 2) due to the presence of a wide range of threatened fauna species (*Threatened Species Conservation* (TSC) *Act* (1995)), its location straddling a mapped regional wildlife corridor (Scotts 2003), inclusion of pre-existing 7(k) habitat protection zones (Byron Local Environmental Plan 1988 (Amendment No. 51) and abutment to Billinudgel Nature Reserve (NSW NPWS 2000).

An alliance of local conservation groups including CONOS is opposing the cultural events site proposal which is presently being assessed by the Department of Planning under Part 3A of the *Environment Protection and Assessment (EP&A) Act (1979)* on the grounds that it would violate local and regional planning controls, have an adverse effect on threatened species and local biodiversity and result in negative edge effect impacts on Billinudgel Nature Reserve. (Other environmental and socio-economic objections of these groups are not considered in this paper, which is concerned only with ecological issues.)

As there is a lack of information concerning how local fauna, and threatened species in particular, respond to types of festival per se, or the complex of activities associated with carrying out large cultural events, we have reviewed the likely impacts of elevated human disturbance through other surrogate studies of human disturbance and wildlife responses.

The discussion paper begins by describing how the effects of human disturbance must be considered in terms of ecological processes operating at local and landscape scales. We describe landscapes in terms of interconnections of reserves, buffers, corridors and matrix (surrounding) areas, highlight the critical importance of the matrix and its influence on remnant natural areas. We then go on to review scientific literature relating to the effects of particular types of human disturbance on wildlife, including the direct threats of people presence, noise and artificial night lighting, as well as indirect threats of edge effects, habitat degradation and the flow-on effects of associated impacts. We then look at what is known about the effects of human disturbance impacts on particular fauna groups. We also review potential mitigation of human disturbance impacts and discuss potential consequences of elevated human disturbance in both a generalized context and also in relation to Billinudgel Nature Reserve and its environs.

1.2 Fauna of the Yelgun Cultural Events Site and Billinudgel Nature Reserve

Both the Yelgun cultural events site and adjoining Billinudgel Nature Reserve support a diverse vertebrate fauna, including a high number of threatened fauna species. This area, formerly known as Marshall's Ridges and the Billinudgel Swamp has been the subject of numerous ecological studies starting with Gilmore *et al.* (1986). Studies demonstrate that the vertebrate fauna, including the majority of threatened species, utilise both the Nature Reserve and the surrounding matrix of private land composed of a mosaic of cattle grazing pasture with scattered trees and embedded patches of habitat of various types. The habitats found in this area represent examples of productive lowland ecosystems that are poorly represented in the reserve system.

The number of threatened fauna species known or likely to use habitats within the proposed Yelgun cultural event site and Billinudgel Nature Reserve is in excess of 30 species (Wildlife Atlas 2009). Nineteen threatened species are known to use the area are listed in Appendix 1.

2 The Importance of Matrix Areas in Landscape Conservation

2.1 Interconnectedness: patches, buffers, corridors and matrix areas

A predominant paradigm within the modern fields of conservation biology and landscape ecology revolves around the concept of "interconnectedness". Lindenmayer and Franklin (2002) stress the concept of interconnectedness and outline that its acceptance reinforces the premise that "… the small network of existing conservation reserves is crucial for the health of ecosystems extending far beyond their borders". Lindenmayer and Franklin then turn the premise upside down: "… *if the matrix can be affected by what happens in (the relatively small) reserves, how much greater is the effect of the matrix on reserves?*" This review assumes that the long term welfare of biodiversity requires the maintenance of interconnected and functionally operational landscapes at all spatial scales. Matrix areas, those outside reserves and other protected habitats, are vital in that context. A "soft" matrix (where some level of ecological integrity is maintained) will facilitate on-going functioning of natural systems while a "hard" matrix (where ecological processes are alienated by other land-uses) is likely to compromise ecological viability at local, landscape and regional spatial scales.

A widely accepted conceptual model for regional landscape conservation planning describes linked protected area networks, which comprise large core areas, buffers and corridor links, as essential elements within the broader context of an integrated approach to landscape conservation. It is important to note that, while the most ecologically intact areas should always form the basis for protected area networks, core areas, buffers and corridors need not be free of past disturbances. Indeed, the positive correlation between the productivity of a site and its past or present disturbance (Braithwaite *et al.* 1984; Gilmore 1990; Pressey *et al.* 1996; Laurance 1997; Eby *et al.* 1999) means that many important areas have either been cleared or modified. These areas usually retain their inherent productivity, may support remnants of previous species assemblages, and may be candidates for ecological restoration (Recher 1993; Saunders *et al.* 1993; Simberloff *et al.* 1999). Core areas, where conservation is the principal aim, are central to protected area networks (Bennett 1998; Soulé & Terborgh 1999). They are reservoirs for the conservation of plant and animal populations and for the maintenance of ecological processes. Core areas need not necessarily be formally reserved (Bennett 1998). In any landscape, core areas are typically the largest, most intact blocks of habitat; the areas most likely to support diverse habitats, intact faunal assemblages, and to maintain natural disturbance regimes (Bennett 1998).

Where conservation is an important component of a wider multiple land-use regime, buffers can be integrated into protected area networks but are usually supplementary to formal reserves, core areas, or linking corridors. Buffers can be important as zones where exploitative management approaches are ameliorated and integrated with conservation orientated approaches to minimise impacts on adjacent reserves, core areas and corridors (Bennett 1998; Groom *et al.* 1999). The integration of buffers into protected area networks must recognise that they are likely to be sensitive to and change in quality depending on the prevailing land-use regime.

Connectivity, the degree to which a landscape facilitates or impedes movement among resource patches (Bennett 1998), relates particularly to the movement of fauna

and is fundamental to the conservation of natural ecosystems (Noss *et al.* 1997; Beier & Noss 1998; Lindenmayer 1998; Bennett 1998). It follows that landscape configurations promoting movement of fauna and habitation will have benefits for the overall persistence of species and ecological processes they facilitate. Wherever habitat occurs there is some degree of connectivity. The tenets of landscape ecology engender a holistic consideration of ecological processes whereby all habitat patches within a landscape are connected, that is, they exchange biotic or abiotic material at some level, irrespective of our ability to quantify it. That connectivity is often characterised and mapped as linking corridors, but connectivity can also be facilitated through a 'soft' matrix. Habitats that facilitate connectivity, be they embedded within corridors or within the broader matrix, are areas where conservation efforts may be focused in order to maintain, or enhance, regional conservation potential.

At Yelgun, where a major cultural events site is proposed, all the elements of an integrated conservation network currently exist. The locale includes a formally reserved core (Billinudgel Nature Reserve), supplementary habitats of known high conservation value (some zoned 7k for environmental protection) variously occurring as buffer, corridor and matrix elements, and additional areas of suitably "soft" matrix. The landscape connectivity values of the matrix and corridor areas have been formally recognized by a series of planning programs (see Scotts 2003, DECC 2009, Byron LEP Amendment 51) and a judicial investigation (Commissioner Cleland 1997). As identified and formally mapped by DECC (2009) the Yelgun locale qualifies as a regional priority landscape for reservation and restoration due to its known and predicted conservation values at local, landscape and regional scales (see mapping included in DECC 2009).

2.2 Human intrusion & disturbance: altered landscape patterns & processes

Human-induced landscape changes typically involve alteration to habitat pattern (e.g. the physical loss, fragmentation or degradation of habitat) and ecological processes (e.g. altered system dynamics impacting fundamental demographic relationships and energy or nutrient regimes) (Lindenmayer and Franklin 2002). Many pattern impacts are obvious and generally receive most attention within development impact assessments. But process impacts can be subtle, slower to manifest and harder to detect, predict or characterize within the context of a short-term impact assessment. Nevertheless process impacts can be far-reaching in terms of their impacts on biodiversity and natural systems. In dealing with the potential impacts wrought by elevated human disturbance we are dealing mainly with impacts on landscape and population processes.

2.3 Edge effects: deleterious impacts of developments adjoining natural areas

The concept of "edge" is not easily defined (Lidicker and Koenig 1996, Lindenmayer and Fischer 2006) but it is directly applicable to consideration of the impacts of elevated human disturbance adjacent to protected areas. When one community-type changes abruptly into another an objective edge, or ecotone, is formed. These edges may be anthropogenic (e.g. forest/agriculture or grassland/road) or natural (e.g. wetland/forest or heath/forest). Often, however, the edge is more subtle and due to changes in ecological processes rather than change in ecosystem structure or pattern. In the context of this review we are primarily considering human-induced edge effects

as manifestations of the impacts of activities associated with a cultural festival site (e.g., elevated people presence, periodic intense noise, artificial lighting, potential changes to species compositions and interactions).

Edge effects can be "soft," where the transition between different patch types is gradual, or "hard," at boundaries with marked contrasts in vegetation structure or other features. The ecological edge relating to a particular disturbance is the result of interactions between the kind and intensity of the disturbance event (a music festival imposed within an already fragmented landscape in the context of this review) and the ecological dynamics within the adjacent, undisturbed, or at least more natural, environment (Lindenmayer and Fischer 2006).

Edges can be classified according to the kinds of impacts they have on abiotic processes or on biota (Lindenmayer and Fischer 2006). Examples of abiotic edge effects include altered wind penetration, light and noise levels. The impacts of abiotic edge effects can extend tens or hundreds of metres from an edge, depending on various factors including prevailing weather conditions (Lindenmayer and Fischer 2006). Biotic edge effects refer to changes in ecological processes, community composition, or species interactions (Lindenmayer and Fischer 2006). The latter may include increases in diseases, pathogens, predators, competitors and can extend hundreds of metres into vegetation remnants (Angelstam 1990, Laurance 1997).

Not all species respond negatively to edges, and some taxa can be more common within edges than elsewhere in a landscape. These may be introduced or exotic species (e.g. feral cat, Red Fox), but also include "generalist" native species (e.g. Australian Magpie, Noisy Miner, Pied Currawong) which find favourable conditions within disturbed environments.

Another question concerns the width of edges and the magnitude of an edge effect. For forest edges it has been found that abiotic effects penetrate up to 50 m into the forest. The invasion of exotic plants and penetration by predators and nest parasites, however, may extend beyond 500 m or more (Wilcove 1985). Similarly, species dependent upon forest interior habitats may respond to edge effects at some distance from the actual boundary (Lidicker and Koenig 1996). The magnitude of an edge effect is dependent upon the parameter of interest- whether it is an environmental variable (e.g. air temperature), an ecological process (e.g. rate of organic matter decomposition), or a community interaction (e.g. predation of one species by another) (Lindenmayer and Franklin 2002).

There exists a body of evidence to show that the processes that occur at habitat edges alter the ecologies of many kinds of habitat islands (Angelstam 1990, Lindenmayer and Franklin 2002). It follows that human influences which exacerbate or favour processes that facilitate edge effects, for example activities that promote the ingress of predators or competitors into natural areas or result in altered community composition, are a threat to local biodiversity.

Edge effects impacting upon reserves or other protected areas can be significantly reduced in intensity and depth by management strategies undertaken within the adjoining matrix to reduce the contrast in structural and biophysical conditions (Lindenmayer and Franklin 2002). Conversely, intense and concentrated disturbance impacts within the matrix will exacerbate edge effects emanating into the reserve or protected area.

3 Non-consumptive Human Disturbance

3.1 Definition

Virtually all human activities can affect wildlife populations either positively or negatively. Activities that are likely to have adverse effects can be divided into those that function primarily by altering the physical environment (or habitat) in a relatively permanent way and those that cause changes to an animal's behaviour. Examples of the former are well known and include clearing of vegetation, forestry and agriculture. The ecological effects of these activities are readily apparent and have been relatively well studied.

Perhaps less obvious in their ecological impacts are those 'non-consumptive' human activities that do not cause obvious changes to the physical environment but nonetheless can affect wildlife adversely (Steidl and Powell 2006). Examples include recreational activities such as bushwalking, bird watching and boating, which are all common activities for visitors to reserves and other natural areas. Within the context of this review, a music/cultural festival represents a form of non-consumptive human activity. As these types of activities escalate within, and adjacent to, reserves and other protected areas, sensitive wildlife species may be increasingly affected (Steidl and Powell 2006).

The magnitude of effects of non-consumptive human disturbances on wildlife is influenced by many factors including the type, duration, frequency, intensity, location, and timing of the disturbance, as well as the particular species of interest (e.g. Burger 1991, 1998; Olson *et al.* 1997; Shirley *et al.* 2001; Bright *et al.* 2004; Fernadez-Juricic *et al.* 2002; Price 2008; Ambrose 2009).

Recognition of human disturbance as a threat to wildlife is beginning to disseminate into mainstream Australian consciousness as formal studies are undertaken (e.g. Price 2008, Price and Lill 2008, Ambrose 2009). Recently the Department of Environment, Climate Change and Water (NSW) recognized 'human interference' as a key threat in developing recovery actions for incorporation within the (draft) Northern Rivers Regional Biodiversity Management Plan (DECC 2009). However, in many circumstances, non-consumptive human disturbance, and activities associated with it, is also an indirect facilitator of other threats such as weed and pest ingress into natural areas, disease and pathogens, and demographic effects (see section 3.2.2 below).

Below we review the direct threats to wildlife of a cultural events site within an area of recognised high conservation value posed by major increases in three human disturbance processes – people presence/human congregation, artificial night lighting and noise.

3.2 Direct threats associated with human disturbance

Effects of human disturbance on wildlife may be harder to identify than more obvious physically destructive disturbances (e.g. habitat loss). Nevertheless detrimental impacts have been documented and direct effects, some with potential consequences extending to lowered overall genetic fitness for impacted individuals and populations (Price 2008), are apparent.

3.2.1 People presence

Human activity can result in many different types of disturbance (e.g. noise, artificial night lighting and grouped presence of people). Here we are concerned with a specific type of disturbance – that brought about by the mere presence of humans. Although most people intend no harm to wildlife, research has shown that in many situations wildlife perceive humans as potential predators and that humans in effect represent "predation-free predators" (Frid and Dill 2002, Beale and Monaghan 2004a). The response of wildlife (birds being the most frequently studied to date) to human presence varies between species and also between individuals of the same species. Real predation attempts and human disturbance both redirect the target bird's time and energy expenditure away from other important activities, such as reproduction and feeding, so both are likely to impact negatively on genetic fitness (Price 2008). In sensitive species the presence, or approach, of humans elicits various stress-related responses ranging from physiological responses (e.g. changes in chemical and hormone balances), to altered activity and time budgets (e.g. more vigilance and less foraging), to more drastic changes in activity known as escape or flight response (e.g. cessation of feeding or breeding behaviour and vacation of an otherwise suitable area of habitat) (e.g. Blumstein 2003; Price 2008; Ambrose 2009). Therefore, although it may appear subtle compared with more destructive impacts (e.g. deforestation), human presence can have insidious and cumulative effects on wildlife (Price 2008). As human influences expand at an ever more rapid rate, remaining natural habitat areas will become vital for the conservation of biodiversity. Many people believe that visiting bushland areas has little or no impact on wildlife or the environment. This is a dangerous assumption and may ultimately counteract the positive conservation benefits of habitat protection and ecotourism. We need to develop conservation strategies that protect species, assemblages and communities in the face of increased human presence (Blumstein *et al.* 2005).

A number of factors can affect the measured or observed response of wildlife to the presence of people (the disturbance response), for example, the species, animal size, disturbance source (e.g. pedestrian, dog walker etc), location of bird (or other animal), number of people, resource availability, direction of approach, rate of approach and starting distance, and even the colour of a researchers clothing (Blumstein *et al.* 2005, Fernandez-Juricic *et al.* 2005, Blumstein 2006, Price 2008). These factors can be used as 'approach tolerance indicators' or predictors of species response for managing bird populations or other fauna groups, but it is essential to consider the variability of responses by different species to a given factor as well as possible interplay between factors.

The cultural context of a country can also affect wildlife responses. Burger and Gochfeld (1991) carried out a unique study where they compared the flush distance of resident and migratory species in India, where the Hindu religion forbids people from harming any living animal. The authors were interested to examine whether migrant species passing through countries where they are commonly disturbed and hunted would be less tolerant of humans than the Indian resident species. Indeed, migrant status was found to be one of the most significant predictors of flush distance.

It is worth noting that studies have demonstrated that it is not necessary for humans to undertake a direct disturbance action for a disturbance impact to be manifested (Fernandez-Juricic *et al.* 2005). The mere presence of people in the vicinity of a

sensitive species, or individual, is in itself sufficient to illicit a disturbance response in many species and is likely to result in altered behaviours, energy budgets, and even vacation of foraging or breeding areas (Fernandez-Juricic *et al.* 2005).

3.2.2 Effect of group size / disturbance intensity

Van der Zande *et al.* (1984) studied the effect of outdoor recreation on breeding bird species in woods adjacent to residential areas in the Netherlands. Data was collected from 6 woods used for passive recreation, representing a relatively high level of human disturbance. They found that increase in human group size was still of significant importance even where intensity was always within the high class and when only common birds species were present. This study included graphs illustrating a threshold of maximum recreation intensity above which a certain species would disappear. Out of 13 species studied in detail, 8 showed significant negative correlations with recreation intensity (visitor traffic). The negative correlations can be regarded as an indication of an effect of recreation or level of people activity upon bird densities. There was a sequence of susceptibility amongst bird species. Notably, the relationship between recreation intensity and bird density was log linear, indicating that the exclusion process was exponential (i.e., doubling the amount of recreation activity (people-presence) quadrupled the disturbance effect).

Similarly, van de Zande and Vos (1984) reported on a study conducted in grove and hedge habitats on a lake shore in the Netherlands. Visitors and breeding birds were counted in the breeding season in 1977 and 1978 (before a car park was opened) and in the breeding season in 1980 (after the car park had opened). All but one of the 12 most abundant species showed a negative difference between experimental units and control units (pre- and post car park) indicating a disturbance effect. It was concluded that "the tendency of most species to be present in lower numbers in 1980 on the parts that had increased in recreation intensity cannot be explained by chance alone and must be regarded as an effect of recreation". Also, "the impacts upon bird densities found in this study can be expected in a recreation intensity range on a standard day between 7.8 and 37.0 visitors per hectare" (van de Zande and Vos, 1984 p. 258)

In an Australian study by Geist *et al.* (2005) titled 'Does intruder group size and orientation affect flight initiation distance in birds?' three different group size treatments (measures of people presence) were applied to Currawongs and Crimson Rosellas. No effect was seen in Currawongs, but group size affected flushing in Crimson Rosellas. "Remarkably, the effect was present with the addition of a single person" and the study concluded that "intruder number should be better integrated into estimates of set back distance to manage human visitation around sensitive species" (p.71). Burger and Gochfeld (1991), in the Indian study referred to above, also found that the larger an approaching group the less it was tolerated and some species were never found near humans (e.g. bustards and flycatchers).

Increases in human recreational activity or group size do not always result in declines in bird density, but generally the positively affected species will be exotic, a native species adapted to human modified habitats, or a species with the same general habitat preference as people. As an example of the latter situation, Bright *et al.* (2004) found that human-made structures and recreational activity had no significant affect on numbers and distribution of New Zealand dabchicks (a grebe). The number of man-made structures was actually positively correlated with the number of grebe, however,

this indicated that they prefer the same habitat as humans (e.g. sites protected from prevailing winds and specific shoreline topography). Similarly, Price (2008) makes the point that tolerance of humans appears to be a major factor contributing to the success of some species such as the Common Mynah and Noisy Miner in disturbed landscapes of south-east Australia.

Summarizing some of the research on the effects of people presence on avifauna shows that in many situations increasing levels of pedestrian/recreation activity results in reduced bird species richness and overall abundance of individuals within 10-100m of that activity. Similar effects are observed for mammals. The tolerance (alert distance) of common adaptable bird species appears to be roughly in the range of 10-20m (Fernandez-Juricic *et al.* 2001). The documented tolerance of less common species appears to be in the order of 20-100m (Fernandez-Juricic *et al.* 2005). Studies indicate that alert distance increases with increasing intruder group size and van de Zande *et al.* (1984) found that this relationship was log linear or exponential. Research supports the expectation that as intruder group size increases, alert distances extend further. Consequently a larger area of habitat may be vacated as species withdraw to a perceived safe distance, or move to another area of habitat if available. Fernandez-Juricic (2000) explains how important it is that human disturbance loads are incorporated in management decisions at local and regional scales. It is clear that a legislated land-use planning process is urgently needed for protecting nature conservation areas with appropriate land-use buffer zones.

The research reviewed above demonstrates how the size of human groups is important in determining the scale of the disturbance effect and appropriate buffer zones. Beale and Monaghan (2004a) concluded that there is a need to ensure that set back distances to prevent the disturbances adversely affecting the foraging and breeding behaviour of wildlife are determined by the *largest party likely to visit a site*. The complexity of derived impacts is indicated by their suggestion that "fixed set back distances and buffer zones are likely to be inappropriate in conservation situations where the numbers of visitors to wildlife areas fluctuates spatially and temporally" (p.335).

3.2.3 Elevated people presence within fragmented landscapes

In Madrid, Fernandez-Juricic (2000) studied the effects on avifauna of pedestrian activity (i) within-park (fragments); in three large parks and (ii) between-park (fragments); in 30 parks ranging from 0.4ha to 100ha in area. Within fragments, increasing levels of pedestrians reduced species richness and overall abundance of individuals. Between fragments, after controlling for fragment size effects, the pedestrian rate was negatively related to species richness in two breeding seasons. Fernandez-Juricic comments that "..it is worth considering how human presence could disrupt bird patch-selection and fragment occupation in other habitats, particularly those which are of conservation value". The author continues, "… human disturbance effects turn out to be particularly relevant in endangered habitats (namely wetlands) and outdoor recreation areas (national parks, reserves, etc) that harbour threatened species." (p.253). Fernandez-Juricic (2000) goes on to say "Irrespective of the relatively independent effects of area, isolation and (human) disturbance, interactions among them could trigger synergistic effects. For instance, area could interact with disturbance increasing its negative effects in small fragments." Because small fragments have higher edge/area ratios than large ones, applying similar disturbance

loads could decrease the proportion of suitable area of small fragments beyond that in large ones.

From his observed results Fernandez-Juricic (2000) concludes that "… higher disturbance loads (in this case human disturbance) could decrease fragment (population) densities, increasing local extinction probabilities." "As such high disturbance loads (high people presence) ought to be incorporated in management decisions at local and regional scales" (Fernandez-Juricic, 2000 p.254).

The conclusions of Fernandez-Juricic (2000) echo a warning regarding the potential impacts of elevated people presence within and adjacent to protected areas, particularly within landscapes that are already fragmented. Human disturbance may act to intensify the effects of fragmentation, reducing landscape suitability (Soule *et al.* 1992). The potential implications for Billinudgel Nature Reserve and those smaller fragments and remnants within the Yelgun location that are zoned 7k for environmental protection, in the face of the proposed cultural events site, are apparent.

3.2.4 Artificial night lighting

The effects of artificial night lighting on biodiversity can be particularly lethal to insects, which are, of course, a fundamental component of most ecosystems (terrestrial and aquatic). Research indicates that dark zones in the landscape have a much richer insect fauna than do lighted zones. In a study described by Eisenbeis (2006) that attempted to determine the capacity of light traps to capture insects relative to the supply of insects in the local area, all the aquatic insects emerging from a mountain stream were counted and the next night all the insects flying to a street lamp positioned near the bank were counted. It was found that different taxa of aquatic insects reacted differently, but in many instances light catches significantly outnumbered the number of emerging insects. "Therefore, the lamp had a long-distance effect for light susceptible insect species and many more insects are attracted than potentially would be found in the immediate surroundings of a lamp. By extrapolation, if there were a row of streetlamps along a stream, a species could become locally extinct in a short time" (p.288-9). Professor Gerhard Eisenbeis describes this process whereby night lighting sucks insects out of surrounding habitat as the "vacuum cleaner effect" (Eisenbeis 2006).

In older publications, entomologists frequently reported extremely large light trap catches of the order of 50,000 per trap per night. Although simple figures do not allow statistical evaluation, much lower numbers are now caught indicating progressive decline in insect populations. Malichy (1965) reported from observations at a newly built and strongly illuminated fuel station there was high initial flight activity of insects but that numbers diminished rapidly in subsequent years indicating significant change in local insect populations caused by the vacuum cleaner effect. In Germany, 1.5 million individual mayflies were caught in a single night on an illuminated bridge surface. In Germany, steep gradients in insect abundance exist between the few remaining natural habitats and urban areas (Eisenbeis 2006).

Rare species are endangered by artificial lighting in Europe where 85% of the land surface is subjected to artificial night sky brightness 10% greater than natural night sky brightness (Longcore and Rich 2008).

Shirley *et al.* (2001) investigated the impact of a music festival, and associated artificial lighting, on a maternity colony of Daubenton's Bat (*Myotis daubentonii*) in north England. They observed that any delay in "lights out", at the end of a particular evening, significantly impacted bat emergence time. This species forages for insects over water and insect availability is known to decrease quickly after sunset; therefore bats need to forage as soon as possible in order to meet constraining energy budgets. Any loss of early evening foraging time is likely to be a critical factor for this species' energy budget, particularly for lactating females (Shirley *et al.* 2001). Within the context of the current review, it is worth noting that the music festival referred to by Shirley *et al.* (2001) features 'early church music' and caters for 200 people. The festival is held in close proximity to the bat roost, in fact in the same large stone building. Human disturbance impacts, including levels of artificial lighting, will be many times greater for the proposed cultural events site at Yelgun. Impacts and consequences for bats that may roost nearby or even forage within the vicinity of a large festival site remain unknown but are conceivably significant.

Studies have found that lamp type may influence impacts on insect fauna and that the ratio of insect captures using high pressure sodium and high pressure mercury lamps is 0.45 for all insects and 0.25 for moths (Eisenbeis 2006). This is a large reduction, but it remains apparent that insects would still be vacuumed from the surrounding landscape, *albeit* at half the rate.

Artificial night lighting removes vast numbers of insects from ecosystems and has the potential to influence the foraging regimes of many nocturnal insectivorous species. Studies are precious few in this regard but any alterations to insect, and other nocturnal invertebrate, population dynamics and species composition caused by artificial night lighting may have cascading effects and impacts on existing predator-prey dynamics. It is not improbable that flow-on impacts could be significant for suites of predatory nocturnal insects, frogs, reptiles, birds and mammals.

Generally, artificial night lighting is only considered from an aesthetic standpoint and its ecological effects are ignored. However, these are potentially far reaching, particularly with regard to insects which form a basis of food chains. The effects of artificial night lighting on species, habitats and ecosystems is only likely to be mitigated in the development process if a policy and legal framework exists to regulate environmental impacts from this particular human disturbance (Rich and Longcore 2006). It is worth noting that light pollution is now regarded as a major environmental issue in Europe, partly because of its ecological impacts and some countries have started to legislate to control its proliferation (http://www.darksky2007.si/).

3.2.5 Human-induced noise

Noise pollution, as it affects humans, has been a recognized problem for decades, but the effect of noise on wildlife has only recently been considered a potential threat to animal health and long-term survival. Noise can be frightening and disturbing to animals which vary tremendously in their response to noise ranging from apparent near indifference to various escape and flight behaviours (Memphis State University 1971). Approaching research on the impact of noise from a holistic perspective, Dr B. Krause found that in undisturbed natural environments, vocalising species divide up the soundscape so that the frequencies of sounds emitted by each species are distinct

and non-overlapping ("a biophony"), as in a symphony orchestra, which is one reason why communities of organisms coexist so well. The intrusion of man-made noise, depending on the level of human activity and intensity of sound, may interfere with the sound niche space so that some animals can't make themselves heard and disrupting communication, foraging, and breeding behaviour patterns (http://www.acousticecology.org/wildlandbiology.html).

As is the case for humans, in many circumstances noise can be considered an animal stressor with potential impacts on physiological, psychological and behavioural characteristics of individual animals or populations (Memphis State University (1971), AMEC Americas Limited (2005)).

Response to noise disturbance cannot be generalized across species or even within species. An animal's response to noise can depend on a variety of factors, including (AMEC America Limited 2005):

- intensity
- frequency distribution
- duration
- number of events
- variation over time
- rate of onset
- noise type, e.g., white noise versus harmonic or pure tones
- existence and level of ambient (background) noise
- time of year
- time of day (many animals might rely on auditory cues more at night than during the day (Larkin *et al.* 1996).
- animal activity and location
- age and sex class
- past experience (Larkin *et al.* 1996)

Potential effects of noise on wildlife are numerous, and include(AMEC America Limited 2005):

- acute or chronic physiological damage to the auditory system
- increased energy expenditure
- physical injury incurred during panicked responses
- interference with normal activities, such as feeding
- impaired communication among individuals and groups

The impacts of these effects might include habitat loss through avoidance, reduced reproductive success and mortality. Generally speaking, noise thresholds for species are unknown, evidence for habituation is limited, long-term affects are generally unknown, and how observed behavioural and physiological response might be manifested ecologically and demographically are poorly understood and seldom addressed (Brown 2001, AMEC Americas Limited 2005).

The inability to hear important environmental cues as well as signals from other animals because of the presence of other noise is called masking. Masking of signals of significance to animals may result in difficulties in finding mates, in escaping predators, and in communicating with other members of the same species. However, little is known about these effects in animal communication (Wollerman and Wiley 2002), even though masking might be one of the most significant effects of a general

increase in background noise on most vertebrates (AMEC Americas 2005). Amphibians, whales and birds are obvious candidates for such effects, but vocal communication is part of the behaviour of many other species. The biological implications of signal masking will depend greatly on the function of the signal and its context (OSB 2003). For example, male frogs call to attract females for mating and to defend territories from rival males. Female frogs of some species prefer lower-pitched calls, which indicate larger, more experienced males. Noisy environments can interfere with this communication process, and create problems with respect to detection, discrimination and localization of appropriate signals. In a healthy population, there might be little effect, but in a severely depleted population, interference with mating via acoustic cues could be serious (OSB 2003). Parris *et al.* (2009) report the phenomenon of frogs calling at a higher pitch in a situation of high traffic noise apparently constituting a trade-off between audibility and attractiveness to potential mates. These authors found evidence that the spectral characteristics of *Litoria ewingii* calls are changing with increasing road-traffic noise, but insufficiently to reverse the masking effect of noise. Given the large and increasing proportion of habitats around the world that are affected by roads and other noises mediated by people this phenomenon has the potential to affect many populations of frogs that are already vulnerable to threats such as habitat loss and fragmentation, pollution, and disease (Campbell 1999, Stuart *et al.* 2004). Parris *et al.* (2009) discuss the trade-offs facing frog populations exposed to chronic noise. The point of relevance here is that frog populations in such circumstances are impacted to the extent that natural call characteristics, evolved over millennia, are suddenly inadequate in the face of an elevated human disturbance regime. In the case of chronic highway noise Parris *et al.* (2009) state that frogs will suffer substantial acoustic interference, which, if translated into reduced breeding success, could eventually lead to the local extinction of populations in otherwise suitable habitats. The implications for intermittently high levels of noise associated with an activity such as a music festival remain patently unclear but impacts on frog populations within and adjacent to the proposed site appear highly likely.

Responses to noise disturbance might have impacts on the energy budget of wildlife (AMEC Americas 2005). For example, Stockwell *et al.* (1991) found that the winter foraging efficiency of desert bighorn sheep (*Ovis canadensis nelsoni*) in Grand Canyon National Park was reduced by 43% as a result of disturbance from helicopter overflights. Indirect evidence suggests that habitat loss is a potential impact of noise disturbance. For example, the distances of woodland caribou from such disturbances as roads, seismic lines and well sites were so large that 22 to 48% of their preferred habitats were avoided in their northern Alberta study area (Refs in AMEC Americas 2005).

Typical behavioural responses to traffic noise include elevated stress levels, acoustic adjustment and road avoidance. Researchers link traffic noise with reduced bird diversity and species abundance adjacent to roads to distances of up to 1,750 metres from highways through forests and further through other habitats (e.g., van der Zande *et al.* 1980, Trombulak and Frissell 2000). An important Australian study in this context is the work of Dawe and Goosem (2007, 2008), who examined the effects of traffic noise on wildlife in the Qld wet tropics. They found that abundance of bird species most dependent on rainforest increased significantly with distance into the forest, with greatest abundances found in the forest interior (100 and 200 metres from the edge). Species richness of rainforest-dependent birds was also greatest in these

interior zones. No rainforest obligates were recorded at the edge zone. By way of contrast, opportunist species not normally associated with rainforest were found only at the edge zone. Nine of eighteen species showed significant differences in dominant song frequencies between individuals recorded at the edge of the forest closest to traffic noise and individuals recorded in the forest interior. Traffic noise at the edge of the forest was louder at ground level than in the canopy, whereas traffic noise levels in the forest interior were greater at canopy level than near the ground. Traffic noise was still a significant component of the acoustic environment at two hundred metres inside the forest away from the rainforest edge.

The dominant frequency of traffic noise in the studies by Dawe and Goosem (2007, 2008) on the Kuranda Range was 1 kHz however traffic noise caused changes to the forest sound frequency spectrum from 31.5 Hz to 2 kHz, which has the potential to blanket areas in which some bird and frog species communicate, particularly at the edge of the forest. Modelling prepared for the Kuranda Range Road Upgrade Impact Assessment Study by acoustic engineers underestimated road noise at the edge by 17 to 31 dB. In some cases, the edge of the road was approximately four times as noisy as had been modelled.

Dawe and Goosem (2007) in their literature review section note that other studies of acoustic responses to noise by fauna (mostly birds) have been predominantly laboratory-based, finding traffic noise to impede the recognition of mating calls in five North American frog and toad species, and to induce raised amplitude levels in songs or calls of tree swallow nestlings, zebra finches, lovebirds, African bush shrikes, nightingales, canaries and budgerigars. They also note that field experiments have found some temperate birds overcome the blanketing effects of traffic noise by singing louder or by making adjustment to the pitch of their songs. This may impact their general fitness by requiring expenditure of greater amounts of energy. Birds singing songs with higher dominant frequencies appear, in some cases, to be less affected. Anthropogenic noise in the range of 65-85 dB(A) caused flight and alert responses in birds and behavioural changes (Dawe and Goosem (2007).

In reporting on the findings of their study in south-eastern Australia, Parris *et al.* 2009 refer to studies demonstrating a variety of responses to road-traffic noise that have been observed in birds (e.g., singing at a higher pitch; singing louder, changing singing patterns to avoid peak traffic periods) and frogs (e.g. altered chorusing behaviour, interference with advertisement call perception). The relative impacts of these responses, in terms of overall fitness and breeding success remains unclear but decreases in the species richness and relative abundance of frogs have been observed hundreds of meters away from a highway in eastern Ontario, Canada (Eigenbrod *et al.* 2009).

The Environmental Impact Statement for New Acland Coal Wetalla Water Pipeline Project (SKM 2009) found that the amount of information available on the effects of general construction noise on Australian fauna is relatively sparse. It was noted that noise affects fauna differently from humans and the effects can vary from serious to non-existent in different species and situations. Direct physiological effects of noise on fauna are difficult to measure in the field and a lot of the impacts are observed by behavioural changes. For repeated construction noise, some form of habituation may occur and the animals may simply maintain activities in their natural habitat after an initial period of acclimatisation. An issue of concern may arise when acclimatisation does not occur.

Research into the effects of noise disturbance on individual animals, their habitat and the ecosystems in which they reside, is required to determine "safe" levels of exposure. Larkin (1996), in a recent review of the effect of military noise on wildlife observed that, research is hampered by a preponderance of small, disconnected, anecdotal or correlational studies as opposed to coherent programs of controlled experiments. Gathering ecological information that is meaningful in determining safe noise level guidelines for species, even within a representative sample of habitat types, is going to be difficult to achieve. Prudence is going to require application of the precautionary principle in most management regimes. Most of the studies on noise and animals can be placed into categories: field observations, field-based experiments and laboratory-based experiments. Baseline studies, while not measuring effect, provide critical information on natural acoustic environments in which organisms live and against which measures of intrusive human generated noise can be assessed. Brown (2001) found that, overall, work in this area is still sparse and sporadic (and much of the information is only available in unpublished documents and government reports). Much of the literature deals with the impact of military activities, seismic and other exploration activities and the influence of transport noise. Very few studies in this field have designed experiments with a level of precision that can identify a threshold stimulus below which the target animal is unlikely to experience detrimental effects. Habituation to noise could enable animals to increase tolerance but, as with humans, anecdotal evidence of habituation is inadequate, and will need to be tested by appropriate studies. The influence of habituation, and overall tolerance to acoustic disturbance, are areas that require further investigation. There is still an absence of understanding how observed behavioural and physiological effects translate into ecological consequences for wildlife.

Radle (2007) provides a succinct perspective regarding the imposition of noise impacts on wildlife; "Most researchers agree that noise can affect an animal's physiology and behaviour, and if it becomes a chronic stress, noise can be injurious to an animal's energy budget, reproductive success and long-term survival. Armed with this understanding it should follow that humans would attempt *to minimize the threat to wildlife by reducing the amount of noise that they are exposed to in natural areas;* but this has not been the situation. Natural areas continue to be degraded by human-made noise, wildlife continues to suffer from these disturbances, and to date the majority of the debate revolves around the egocentric demands of people to either produce more noise in nature (through motorized recreation, scientific research, military exercises etc.) or experience natural areas in the absence of anthropogenic noise."

3.3 Indirect threats associated with human disturbance

The impacts of elevated levels of human disturbance, associated with a major cultural events site can be direct (see section 3.2 above) or indirect. Indirect threats may be less obvious but nonetheless severe in terms of long-term impacts.

3.3.1 Habitat degradation

It is clear that access to suitable habitat is fundamental to the persistence of individual species and loss of suitable habitat will threatened a species' survival (e.g. Lindenmayer and Fischer 2006). Habitat can be lost rapidly or it can degrade in

quality over time. Habitat degradation means that many attributes of the original habitat remain, but the quality of the habitat is reduced for the given species or community of interest. For example, the quality of the habitat may be diminished in ways that do not preclude individuals of a particular species from persisting, but prevent them from breeding. Habitat degradation is common in landscapes subject to human modification (references in Lindenmayer and Fischer 2006). Processes that lead to reduced foraging opportunities, increased predation, harassment or competition, or reduced reproduction potential contribute to overall habitat degradation and reduced long term population viability.

Lindenmayer and Fischer (2006) make the point that habitat degradation can be a species-specific process and, as a result, it can occur somewhat independently of vegetation deterioration. This can make habitat degradation difficult to detect, particularly for less common, more cryptic species. A species may appear to be flourishing at one point in time but slowly disappear off the radar. Apparently suitable habitat may still be present, and even appear unchanged, but conditions may have deteriorated in subtle ways. The species or population may persist at reduced densities and, if long-lived (e.g. some large cockatoos and owls), its demise and reduced viability may go undetected until too late. In this context it is important to note that the on-going presence of a species within a modified habitat or landscape does not necessarily indicate a healthy situation; the habitat may in fact be chronically degraded but the species persists. In such cases an extinction debt (Tilman *et al.* 1994, Lindenmayer and Fischer 2006) remains to be paid.

The threat of habitat degradation appears relevant within the context of a cultural events site. The direct impacts of elevated human disturbance associated with music or other festivals discussed above, all have the potential to degrade habitat. The results may not be obvious, particularly in the short term, as the habitat mosaics remaining embedded within the festival site or within the adjacent Billinudgel Nature Reserve may appear unchanged. However, if ecological processes have been undermined to the extent that the habitats are degraded then ecological impacts may be severe in the long term.

3.3.2 Indirect impacts of human disturbance

The construction, establishment and running of a permanent music festival site brings with it significant levels of human activity and associated infrastructure. Three direct impacts have been considered and discussed in section 3.2:

- Episodic intense concentrations of people (Sec. 3.2.1 to 3.2.3);
- Episodic intense noise levels (Sec. 3.2.5);
- Episodic elevated levels of artificial lighting (Sec 3.2.4).

There is a suite of indirect impacts that are also likely to be facilitated by the activities associated with a permanent music festival site. Some of these have been alluded to as part of discussion of direct impacts because they are likely to flow-on from non-consumptive human disturbance within and adjacent to natural areas as a result of alterations and imbalances to ecological processes. Most are considered formal threats to regional biodiversity by DECC (2009) (now DECCW) and, within the context of the proposed permanent festival site at Yelgun, most are likely to impact high

conservation value habitat areas embedded within the festival site (zoned 7k for environmental protection) and the adjoining Billinudgel Nature Reserve; they include:

- Demographic and small population effects (e.g. Potential desertion of habitat by sensitive species; highly likely altered species compositions (fauna and vegetation communities) in response to altered foraging opportunities; likely elevated ingress of generalist native competitors suited to disturbed systems at the expense of more specialized native fauna);
- Pests (e.g. Inevitable elevated ingress of pest species such as Cane Toad, Red Fox, Cat, Black Rat, House Mouse associated with festival catering, enhanced roading, presence of garbage and other human waste);
- Weeds (e.g. Unavoidable ingress of seeds and other propagules of weed species on construction equipment, vehicles and people);
- Inappropriate fire regimes within embedded and adjacent protected areas (e.g. Festivals occurring within periods of high fire danger will result in higher likelihood of accidental or deliberate (arson) fires);
- Disease and pathogens (e.g. Elevated likelihood of the ingress and establishment of pathogens such as the Cinnamon fungus (*Phytophthora cinnamomi*) associated with construction equipment and vehicles);
- Human interference (e.g. Elevated likelihood of direct contact with, and persecution of, native fauna including insects, frogs, lizards, snakes, Koala, possums, wallabies, flying-foxes and bats);
- Chemicals and waste (e.g. Elevated likelihood of accidents involving chemicals and human waste with contamination risk for drainage lines, creeks and other habitats).

4 Effects of Human Disturbance on Major Faunal Groups

Section 3 has considered the impacts of elevated non-consumptive human disturbance and in that context we have included reference to all faunal groups. This section provides some additional information gleaned from the literature of relevance to the impacts on fauna of activities associated with a music festival site. In an effort to be succinct and avoid repetition as much as possible we also refer to section 3 of this review in regard to certain species and studies.

4.1 Invertebrates

Terrestrial invertebrates may act as good indicators of habitat quality and the overall state of ecosystems (e.g. Hochuli *et al.* 2004). Terrestrial invertebrates are affected by habitat fragmentation and subsequent disturbance in many systems and they are a valuable potential measure of an area's ecological integrity because they mediate many fundamental ecological processes (e.g. pollination, herbivory, predator-prey balances, seed dispersal, decomposition) (Hochuli *et al.* 2004). They also form strong associations with plant assemblages (e.g. Panzer and Schwarz 1998). As such, impacts on invertebrate assemblages may have far-reaching influences on the long-term welfare of natural areas.

One of the most obvious impacts of increased human disturbance on wildlife is the impact of artificial night lighting on insects (see section 3.2.4). Most people have seen how swarms of moths, beetles and other insects are drawn to street lights and outdoor lighting, often with fatal consequences. The attraction is apparently due to the structure of the insect compound eye and the internal navigation mechanism of insects which confuses an artificial light source for the moon or stars (Walker 2007). Outdoor lighting has greatly increased in recent decades as urban areas expand. Frank (1988) describes how outdoor lighting disturbs many aspects of moth behaviour including flight, navigation, vision, migration, dispersal, oviposition, mating, feeding and crypsis. In addition it may disturb circadian rhythms and photoperiodism, as well as expose moths to increased predation by birds, bats, spiders. Frank (1988) noted that despite the destruction of vast number of moths in light traps, diverse moth biota have been found in urban environments, however, some moth populations may be disrupted or eliminated; reducing exposure to lighting may help protect moths in small, endangered habitats.

Insects have differing levels of attraction to different light spectra. Bhattacharya and Mishra (1995) tested eight insect species and found all were most strongly attracted to natural light and least to blue light. Eisenbeis and Hassel (2000) compared insect attraction to white mercury (HME), orange sodium (HSE) and sodium-xenon vapour lamps (HSXT). By using sodium vapor street lamps (HSE), the number of insects caught in light traps was reduced significantly by more than 50%, and in the case of Lepidoptera by about 75%. By using HSE lighting, the 44,000 insects caught during the experiment would be reduced to 22,000. In Germany again, Kolligs (2000) also found that sodium vapour lamps attracted fewer insect species and individuals than mercury vapour lamps. However, for swift moths (Hepialidae) and the geometric moth *Idaea dimidiata*, more individuals were recorded at the sodium-vapour lamps. No significant correlation was found between the size of a light source and the

number of Lepidoptera attracted by it. Included in the light trap catches were 31 beetle species of the Red List of Schleswig-Holstein (the regional locality of the study).

4.2 Amphibians

Laboratory experiments have demonstrated that dark-adapted frogs exposed to rapid increases in illumination may be temporarily "blinded" and unable to gather visual information on prey, predators, or conspecifics until their eyes adapt to the new illumination. Permanent increases in nocturnal illumination may facilitate or inhibit a variety of behaviours. Foraging may be facilitated in frogs that hunt around lights because the ambient illumination is increased to a level that allows the frogs to see prey or because lights attract abnormally large quantities of prey (e.g., insects). Reproductive activity may be inhibited in species that normally reproduce only at very low illuminations. Increased illumination may allow predators to see frogs that may not normally be visible to them. Circadian rhythms, activity patterns, and intraspecific visual communication may also be affected by increased illumination. Much more field and laboratory research is necessary to assess the full extent of direct and indirect effects of artificial night lighting on the behaviour, ecology, and evolution of frogs (Buchanan 1993).

We have already discussed the impact of noise on frog populations (see section 3). Traffic noise was found to impede the recognition of mating calls and impact mating behaviour in studies from Australia (e.g. Parris *et al.* 2009) and overseas. Parris *et al.* (2009) discuss the trade-offs facing frog populations exposed to chronic noise and conclude that in such circumstances frogs will suffer substantial acoustic interference, which, if translated into reduced breeding success, could eventually lead to the local extinction of populations in otherwise suitable habitats. The implications of intermittently high levels of noise associated with an activity such as a music festival remain patently unclear but impacts on frog populations within and adjacent to the proposed site appear highly likely.

Other impacts of increased human disturbance on frogs relate directly to their requirement for breeding sites with good quality water. Any increase in the run-off of contaminants and pollutants associated with human activities such as road building, car park consolidation and general construction has the potential to impact frog breeding potential (e.g., see Campbell 1999 for numerous references). Similarly, altered hydrological regimes associated with activities such as re-routing drains or providing fill (road-base) to consolidate car parks and roads can have implications for resident frog populations. Typically, in coastal north-east NSW, human influences impact sensitive frog species, including threatened species, to a greater degree than more resilient generalist native species or introduced species such as the Cane Toad, *Bufo marinus*. Seabrook (1993) states that cane toads are less abundant within natural remnants and more abundant within the agricultural / suburban landscape. So any “urbanisation” of an area (perhaps the impacts ~20,000 people and associated infrastructure are akin to periodic urbanisation) has the potential to lead to increased prevalence of this pest. Cane Toad may be transported on-site in vehicles, particularly catering trucks and may find favourable conditions within the human-modified landscape and more “urbanised” conditions than currently exist at Yelgun.

4.3 Reptiles

Increased human disturbance and presence within natural and semi-natural environments has the potential for detrimental impacts on reptile faunas. Likely impacts, in the context of urban remnants, are outlined by White and Burgin (2004) and include:

- direct human interference resulting in death or removal of individuals that are perceived as a threat to human safety (e.g. goannas, snakes, tortoises);
- direct human interference resulting in death or removal of individuals that are perceived as a novelty by visitors (e.g. lizards, tortoises, small goannas and snakes);
- Increased presence of predators (e.g. fox, cat, black rat);
- Increased likelihood of fire;
- Potential direct habitat trampling or removal (e.g. firewood).

4.4 Birds

Birds have been the most studied of the major faunal groups with regard to the impacts of human disturbance. Avoidance of human disturbance is expected to influence habitat selection by sensitive bird species, particularly when it is intense or long-lasting (Beale and Monaghan 2004a, b; Fernandez-Juricic *et al.* 2005; Price 2008). Observed and documented impacts include:

- Physiological responses reflecting stress effects;
- Altered time and energy budgets leading to lowered genetic fitness;
- Habitat desertion;
- Depression of breeding success;
- Altered species assemblages with sensitive species being replaced by more common, generalist native or introduced species.

In that context, it appears that certain types of birds may be more sensitive to human disturbance impacts. The work of several authors including (e.g., Blumstein 2006) suggests that larger species may be most susceptible, although that is not a universal finding. Some raptors have been known to permanently abandon territories due to human disturbance leading to local population declines (e.g. Carrete *et al.* 2002, references in Price 2008). Cascading effects are also possible whereby the loss or reduction in one species influences predators or prey associated with that species (references in Price 2008). As estimated predation risk and available energy vary seasonally, tolerance of humans is also likely to vary seasonally. So human disturbance during breeding periods is likely to induce greater response and impact overall.

In relation to birds as a group it is worth reiterating reference to the work of Fernandez-Juricic (2000) who studied the impacts of human disturbance on birds within landscapes that are already fragmented and noted that impacts can be synergistic. In this context area could interact with disturbance increasing its negative effects in small fragments. The implications of such a relationship for small remnants

of protected habitat at Yelgun (zoned 7k for environmental protection due to their high conservation values) is clear; further to that Billinudgel Nature Reserve is itself a remnant within a landscape that is largely fragmented and degraded (see section 7).

Waterbirds, or waders, have received a fair bit of attention with regard to human impacts as they often occur in close proximity to areas favoured by humans for recreation such as estuaries and beaches (e.g. Burger 1991, 1998; Burger and Gochfeld 1991; Pfister *et al.* 1992; Burton *et al.* 1996). Ambrose (2009) reviewed the effects of recreational boating on waterbirds and found that boating disturbance during the breeding season was predicted to produce adverse impacts on six species through increased absence from the nest, predation of eggs, reduced nest building and nest failure. Outside the breeding season, boating disturbance was predicted to impact five species. One might question the relevance to the proposed cultural events site at Yelgun of a study of boating disturbance on waterbirds. However, such studies indicate how resident bird communities are affected by the intrusion of human disturbance. It is not unreasonable to predict that the avian community presently found within the Yelgun site and edges of Billinudgel Nature Reserve would be affected by human disturbance associated with large cultural events in analogous fashion to the effects of recreational boating on waterbirds. The sudden intrusion into their surroundings of large concentrations of people, high levels of noise, artificial night lighting and other impacts are likely to act as an intense disturbance on a high proportion of bird species.

The research reviewed above indicates that the disturbance impact associated large concentrations of people, high levels of noise, artificial night lighting and other indirect impacts is likely to result in avoidance or abandonment of habitat within the events site and adjoining Billinudgel Nature Reserve by a significant proportion of the vertebrate fauna. On a larger scale this may adversely affect the sustainability of local populations of threatened fauna species, which depend on Billinudgel Nature Reserve and the surrounding matrix to maintain viable local populations. Research demonstrating that the impact of human disturbance on fauna is positively related to the intensity of disturbance as measured by group size (see Section 3.2.2) indicates that cultural events involving thousands of patrons may have a severe negative impact on fauna, including threatened species, within the events site and adjoining Billinudgel Nature Reserve.

4.5 Mammals

The impacts of a music festival, albeit a much smaller affair than that proposed at Yelgun, on a resident bat colony (Shirley *et al.* 2001) have already been discussed in section 3.1. Shirley *et al.* (2001) make the point that "The effect of human disturbance on bats has been documented for autumn shelters and hibernacula, the result of which is to cause the bats to abandon their shelters for winter roosts earlier than undisturbed bats." Given the apparently precise, precarious, and largely uncharacterized, patterns with which bats utilize roost sites any impacts of human disturbance that might influence roost use, temporally or spatially, are likely to be significant. As stressed by Shirley *et al.* (2001), more research and targeted monitoring is needed regarding the effects of human disturbance on bat ecology.

As with other faunal groups, different mammal species display different levels of tolerance and sensitivity to disturbance pressures mediated or facilitated by elevated human presence. The impacts of intense periodic human activity associated with a

music festival site have many parallels with the impacts of urbanisation (see section 3.2.3); in fact the periodic, but regular, impact of large crowds, together with permanent and episodic infrastructure, is at least akin to periodic, regular urbanisation. In an investigation of the impacts of urbanisation in and around Melbourne, Victoria, Van der Ree (2004) noted that certain mammal species had disappeared from urbanised landscapes while others had persisted. Small ground mammals, including quolls, bandicoots and echidnas, appear to be particularly susceptible to human-related disturbance impacts (Van der Ree 2004). The causal agents of disturbance and the mechanisms for mammal species' susceptibility remain unclear but are likely to include combinations of the impacts already discussed as associates of elevated human disturbance levels including increased predator and competitor levels, altered community species composition and dynamics, as well as direct disturbance effects (see section 3).

5 Generalized Consequences of Elevated Human Disturbance

As already stressed the response of wildlife to elevated human disturbance varies between species and also between individuals of the same species. Responses of individual species and major faunal groups, as reported in the literature, or in relation to the principles of landscape ecology, have already been discussed (see sections 3, 4 above). The following is a discussion of generalized response patterns and the potential applicability of buffers.

5.1 Wildlife response measures

Understanding the short and long-term consequences of interactions between humans and wildlife requires that relevant response measures be chosen and implemented in field studies (Steidl and Powell 2006). Table 1 is an extract from Steidl and Powell (2006) and illustrates potential impact parameters and serves as a list of generalized consequences of elevated human impacts on wildlife.

Table 1. Potential response measures for assessing effects of human activity on wildlife and wildlife populations.

Appropriate study period	Measure
Short-term	Physiological responses — heart rate, stress hormones
	Behavior and activity budgets
	Space and habitat-use
Long-term	Reproductive success and productivity
	Survival or mortality rates
	Abundance or density
	Distribution or occupancy rates
	Species richness
	Species diversity

5.2 Demographic consequences

Many studies have shown that animals will avoid areas where humans are present and that some species show a greater degree of avoidance than others (Gill *et al.* 2001). It is assumed that species showing the greatest degree of avoidance require the greatest consideration and protection within conservation planning regimes, however, this assumption is often made without any data or knowledge of actual demographic consequences. From a conservation perspective, *human disturbance of wildlife is important only if it affects survival or fecundity and hence causes a population decline.* Do observed effects of elevated human disturbance (e.g. avoidance, displacement, interrupted breeding) actually result in population decline?

Gill *et al.* (2001) surmise that a high availability of habitat sites elsewhere, allowing animals to move readily, can result in a strong decrease in numbers even when the fitness costs of disturbance are low. The contrary may also apply; animals with no suitable habitat nearby will be forced to remain despite the disturbance, even if the fitness costs are high. This argument hinges on the availability of other *unoccupied*

habitat areas. Males generally divide habitat into territories, which they defend aggressively from invasion by other males. The sizes of territories are determined by resource availability. Individuals may die resulting in a territory being unoccupied, but such opportunities are probably relatively few. Individuals forced to exist in suboptimal habitat or small areas on the edge of territorial mosaics probably seldom breed and may have a high mortality rate (e.g., Pulliam 1988, With and King 2001).

This concept has some resonance with regard to the Yelgun situation where resident and migratory faunal species exist in a landscape that is inherently productive (as evidenced by its land-use history) but consequently already somewhat fragmented and compromised from a resource availability perspective. So, nomadic species such the Grey-headed Flying-fox (a threatened species at state and federal levels) might continue to forage within the landscape over the autumn-winter period when nectar is scarce elsewhere and when favoured coastal feed tree species are generally flowering (see Eby *et al.* 1999). But this may reflect an adherence to historical seasonal foraging patterns or a lack of options elsewhere. A similar scenario could be painted for other species at Yelgun, including the Koala. It cannot be assumed that the persistence of animals within disturbed landscapes and habitats represents viable populations, healthy ecosystems, or adequate baselines from which to assess disturbance impacts. They may be persisting under suboptimal conditions having already been subjected to habitat loss and fragmentation impacts. Without alternative measures such as measurement of stress levels or overall reproductive success their viability cannot be assumed. A pertinent point here is that the imposition of further stresses and impacts, in the form of a music festival, will exacerbate current edge effects. The Yelgun location supports suites of threatened species but requires restoration to enhance long-term viability of wildlife, not further disturbance.

Gill *et al.* (2001) make a valid point, that interpretations of 'alert distance' can be misconstrued; birds may remain, in the face of a disturbance, even though they are stressed, because they have no other reasonable habitat to go to; and birds may fly to feeding grounds elsewhere without any change in overall population number. However, there is also abundant evidence that 'Alert Distance' (AD) and ' Flight Initiation Distance' (FID) (indices that are commonly applied in studies of human impacts on birds) are indicators of perceived predation risk and good predictors of the effects of disturbance (Beale and Monaghan 2004a). Avoidance behaviours reduce population viability, as a proportion of available habitat is avoided or rendered non-available, as a consequence of disturbance. Avoidance has the potential to affect survival and fecundity, but the actual fitness cost in terms of these parameters needs to be quantified before AD or similar measures can be used as reliable estimates of the impact of disturbance on populations (Gill *et al.* 2001).

Human disturbance may also produce a cascading effect on non target species. If a species flees, other species that benefit from its presence may be adversely affected; predator species increase to exploit abandoned nests (Price 2008). Field studies/observations are needed before effects of disturbances of different intensity can be predicted with any confidence but observed alterations to species assemblages and communities are good indicators of demographic impacts.

The reproductive success of wild birds subject to human disturbance is often negatively affected (e.g., Beale and Monaghan 2004b). In addition to stimulating increased nest defence and altering nest site choice, the presence of humans can increase egg and chick mortality, nest desertion, premature fledging and acute and

chronic stress and decrease parental care, singing frequency and nestling mass gain (references in Price 2006). Stress may not only affect breeding adults, it can also be stimulated in offspring by transference of stress hormones. Even moderate levels of stress can have detrimental effects on cognition, behavioural development and learning ability and health including skeletal calcification and induced osteoporosis later in life. Parents should nest in areas that will increase their reproductive success, reduce the chance of predation and / or decrease the number of encounters with people (Price 2008).

With regard to the proposed cultural events site at Yelgun, there is a tacit assumption in the ecological assessment, that Billinudgel Nature Reserve will act as a refuge or source of unoccupied available habitat for individuals displaced from the festival site by human disturbance. Putting aside the likely impacts of elevated human disturbance as an edge effect on the reserve itself, this assumes that there is available habitat; the reserve is not already at carrying capacity for that species given food resources and predator activity; and that increased density within the reserve will not affect long-term survival and fecundity. Arguments could be made either way, but essentially we do not know with any certainty what the exact effects of a massive increase in human disturbance (relative to the current situation) will be, but there is a significant risk that survival and fecundity of local populations will be adversely affected, resulting in a population decline.

6 Mitigating Circumstances

At this point, two possible mitigating circumstances need to be considered – (i) buffer zones and (ii) habituation.

6.1 Buffer Zones

An important goal of wildlife management is to promote coexistence between wildlife and people by creating buffer zones. 'Alert distance' (AD) and 'flight initiation distance' (FID) or flush distance are commonly applied as measures of this disturbance effect and various metrics are used to express it quantitatively. For example, MAD or minimum approach distance is defined as the point at which 95% of individuals become alert (Fernandez-Juricic *et al.* 2005). Typically, buffer areas are estimated with a formula based on empirical estimates of the distance at which humans disturb animals (Fernandez-Juricic *et al.* 2005). "There are two general steps to develop buffer areas. Managers first estimate the distance at which humans should be separated from wildlife (minimum approaching distance), and then the areas where humans should not encroach to avoid displacing wildlife (buffer areas)" (Fernandez-Juricic *et al.* 2005, p.226).

Alert distance is a conservative indicator of bird tolerance of specific situations. The alert distance for 4 common bird species in 5 large wooded fragments in Madrid (Spain) was found to be 9-18 metres (Fernandez-Juricic *et al.* 2001). In the case of grassland birds in Argentina, the MAD of 5 species studied (4 endemic) varied from 20 to 100m, depending on the species and the type of metric used (Fernandez-Juricic *et al.* 2005). These results should only be applied to the bird species studied, but they suggest that habitat areas should be separated from humans by a minimum of 100m to prevent disturbance of sensitive species. Similar MAD's might be expected for avifauna in other types of habitat. Alert distances can be used to design footpaths for visitors with enough undisturbed areas for birds to forage and breed and for pedestrians to enjoy their visit. From a conservation perspective, a significant difference between alert and flight distances underscores the need to consider alert distances as a more conservative indicator of tolerance, because it includes a buffer zone in which birds may adapt their reactions to the behaviour of visitors (Fernandez-Juricic *et al.* 2001).

A study by Beale and Monaghan (2004a) emphasises how easy it is to misinterpret animal behaviour. They compared the flush distance of turnstones a group fed on supplementary mealworms every day for 3 days and in a control group. Birds whose condition had been enhanced by the mealworms showed greater responsiveness to human disturbance, flying away at greater distances from the observer, scanning more frequently for predators and flying further when flushed. This result shows how assessments based solely on behavioural measures may be inaccurate (i.e,. the most responsive or flighty animal may not be the most vulnerable). There is a kind of inconsistency in this argument though, as Beale and Monaghan (2004a) suggest that the richest feeding grounds (rendering wildlife in better condition and more responsive) would require less protection as the animals were not vulnerable, just responsive. However, surely these areas should have better protection because they enhance the health of wildlife populations. Buffers would enable optimum function, without unnecessary flushing caused by human disturbance.

With regard to the proposed cultural events site at Yelgun, consideration of buffer zones is relevant to habitat areas within the festival site (currently zoned 7k for environmental protection due to their recognized high conservation values) and land adjoining Billinudgel Nature Reserve. Byron Shire Council in its approval of the trial event (now overturned by the Land and Environment Court) specified a buffer distance of 20 m, but in the case of birds, available evidence on alert distance suggests that this may only be appropriate to common native and exotic species, Given the apparent scale of the cultural events site proposed at Yelgun and its close proximity to core and matrix conservation areas, it is doubtful wether it is possible to effectively mitigate the potential adverse impacts of human disturbance on local biodiversity using conventional buffer zones.

6.2 Habituation

Habituation refers to learned behaviour whereby wildlife constantly exposed to non-threatening human stimuli, learn that humans are relatively harmless, and disturbance response indicators such as 'alert distance' and 'flight initiation distance', consequently decrease in magnitude (Price 2006; Walker *et al.* 2006). This can be observed in nature conservation areas where birds and mammals are often "tamer" than outside the conservation area. Habituation depends on the frequency (e.g. number of encounters/day) and the intensity of encounters (group size, level of noise etc). Wildlife is less likely to habituate to low frequency and/or high intensity human disturbance. By establishing and enforcing the use of pathways in parks and reserves, birds habituate to predictable patterns of human movement. Similarly, some laboratory studies show that animals may become accustomed to noise, such that certain physiological reactions to noise no longer occur; this is often referred to as habituation (Memphis State University 1971). Habituation to intermittent noise, however, is reported to be less likely. In the case of the proposed cultural events site at Yelgun, it would appear that human disturbance will be intermittent and probably very high in intensity, a combination least likely to result in habituation behaviour in wildlife.

Studies have indicated that repetitive visitation can facilitate partial habituation. This is not inevitable as in another study, a number of gull species did not habituate despite relatively harmless human visitation (Price 2006). Habituation is affected by a number of factors such as intensity and duration of disturbance. It appears that even within a species certain individuals are less likely to habituate to disturbance than others (e.g. Martin and Reale 2008). An interesting study indicating the effect of habituation to human presence on bears was carried out by Olsen *et al.* (1997). The study compared the feeding behaviour of habituated and unhabituated bears to an extension of the tourist season on a salmon river in Alaska. During the extension period, unhabituated bears were fewer in number, reduced overall activity, delayed arrival and were generally less active.

Habituation is often raised as a mitigating circumstance where there is significant level of human disturbance to wildlife. Sometimes it is simply assumed that habituation will occur because wildlife is repeatedly exposed to anthropogenic disturbance. However, habituation is a complex behavioural process that is easily misinterpreted and requires systematic observation and experimentation to unravel its

effects (Bejder *et al.* 2009). While habituation represents a learning process over time, the term is often misused to describe any observed moderation in wildlife responses to human disturbance. Tolerance is the intensity of disturbance that an individual tolerates without responding in a defined way and is often mistaken for habituation (Nisbet 2000). When habituation, or its behavioural opposite 'sensitisation' occur, a range of potential explanatory mechanisms should be considered including (1) learning, (2) displacement (less tolerant individuals have moved affecting response spectra), (3) physiology (repeated exposure has caused physiological impairment) and (4) ecology (ecological factors account for habituation type responses, such as absence of suitable habitat to relocate to) (Bejder *et al.* 2009).

Bejder *et al.* (2009) conclude that "Studies of the effects of human activity on wildlife have often operated under the assumption that (1) the behavioural habituation of wildlife to anthropogenic stimuli is relatively easy to demonstrate, and (2) habituation-type responses imply an absence of detrimental consequences for targeted animals. We have shown that neither assumption is entirely correct and that the misinterpretation of scientific findings resulting from reliance on these premises can lead to inappropriate conclusions and potentially detrimental consequences for wildlife."

7 Land-use Buffer Zones

To maintain biodiversity in the Yelgun locality, a buffer strip between the proposed cultural events site and Billinudgel Nature Reserve may appear a constructive measure, but only if the Nature Reserve is viewed as an 'island' of natural habitat. As discussed in Section 2, the ecological sustainability of a core conservation area depends less on narrowly defined buffer strips, than on the structure and function of the surrounding matrix. A matrix with a normal 'rural' level of human disturbance and supporting broadly compatible land-use (including agriculture) is necessary to maintain ecological sustainability and realise regional conservation planning goals (e.g. DECCW 2009).

A buffer adjoining a reserve or other habitat area can represent a relatively narrow strip of land designed to provide protection from environmental impacts such microclimatic extremes, fire, weed invasion or human disturbance; or it can be designed as a wider zone of compatible or non-antagonistic land use. Such land-use zones do not necessarily require formal environmental protection zoning or management obligations, but entail land-uses that support matrix and core conservation values, as well as allowing an appropriate level of residential and economic use. Non-conflicting land-use might include rural residential living and livestock grazing that effectively provide *a land-use buffer zone* to maintain the locality's conservation values in the face of increasing regional development.

Effective conservation networks/reserve systems depend not just on the protection of core areas represented by formal reserves, but appropriate land-use zoning and buffers, interconnecting corridors and protection of high conservation patches within the surrounding matrix. Research on landscape-scale conservation planning demonstrates matrix areas, that is, areas surrounding formal reserves have a major effect on the integrity and sustainability of ecosystems within reserves. The long term welfare of biodiversity requires the maintenance of landscapes composed of core areas, buffers and inter-connecting links.

Regional landscape conservation planning is generally based on a model of linked protected area networks, where large core areas, buffers and corridor links form essential elements in an integrated approach to landscape conservation. At Yelgun, where a music festival is proposed, all the elements of an integrated conservation network currently exist. The locale includes a formally reserved core (Billinudgel Nature Reserve), supplementary habitats of known high conservation value (some zoned 7k for environmental protection) variously occurring as buffer, corridor and matrix elements, and additional areas of suitably "soft" matrix. The landscape connectivity values of the matrix and corridor areas have been formally recognized by a series of planning programs (see Scotts 2003, DECC 2009, Byron LEP Amendment 51) and a judicial investigation (Commissioner Cleland 1997). As identified and formally mapped by DECC (2009) the Yelgun locale qualifies as a regional priority landscape for reservation and restoration due to its known and predicted conservation values at local, landscape and regional scales (see mapping in DECC 2009).

The land-use planning system in NSW still allows development to occur right up the boundary of nature reserves, creating major problems for reserve management due to

the exacerbation of edge effects and degradation of habitat quality, mainly through direct and indirect impacts of human disturbance. There is a need to recognise that conservation reserves in developing landscapes are sensitive to changes in land-use in the surrounding matrix. A modification to the land-use zoning system designed specifically to direct development in a coordinated manner so as not to consume and degrade conservation values in designated natural areas is long overdue. Some land-uses are more compatible with conservation land-use than others, partly because they involve different levels of human disturbance. In designing a system of *land use buffer zones*, the degree of human disturbance implicit in permissible land-uses or zones would increase with increasing distance from core conservation areas in a hierarchical or gradational fashion. Explicit and systematic landscape-scale protection for conservation areas is urgently required to minimise future land use conflict, provide more certainty for land developers and security for conservation areas.

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Appendix 1: Threatened fauna species recorded on or within 1km of the proposed cultural events site at Yelgun

(Source: DECCW Wildlife Atlas 2010)

Species	Locality and Source	General Habitat Range
Amphibians		
Wallum froglet *Crinia tinnula*	Billinudgel NR	Floodplain swamp sclerophyll forest, heath, swamp, paddocks .
Wallum tree frog *Litoria olongburensis*	Jones Road private property	Floodplain swamp sclerophyll forest, heath, swamp, paddocks; adjacent hillslopes in rain
Mammals		
Common planigale *Planigale maculata*	Billinudgel NR	Wet and dry sclerophyll forest, rainforest.
Koala *Phascolarctos cinereus*	Billinudgel NR, study area	Prefers dry sclerophyll on fertile soils, also in wet sclerophyll and remnant vegetation.
Long-nosed potoroo *Potorous tridactylus*	Billinudgel NR	Wet sclerophyll, rainforest and heath with a dense ground layer.
Common blossom bat *Syconycteris australis*	Billinudgel NR, study area	Forest, woodland and heath with pollen and nectar producing plants.
Grey-headed flying fox *Pteropus poliocephalus*	Billinudgel NR, study area	Wet and dry sclerophyll forests.
Little bent-wing bat *Miniopterus australis*	Billinudgel NR, study area	Wet and dry sclerophyll forests, adjacent cleared land.
Eastern long-eared bat *Nyctophilus bifax*	Billinudgel NR, study area	Wet and dry sclerophyll forests, adjacent cleared land.
Birds		
Black bittern *Ixobrychus flavicollis*	Billinudgel NR	Swamp sclerophyll, remnant vegetation along creeks and drains.
Square-tailed kite *Lophoictinia isura*	Billinudgel NR, study area	Wet and dry sclerophyll forests, adjacent cleared land.
Red goshawk *Erythriotriorchis radiatus*	Billinudgel NR	Wet, dry and swamp sclerophyll forest.
Bush hen *Amaurornis olivaceus*	Billinudgel NR	Swamp sclerophyll, weedy regrowth vegetation.
Bush thick-knee *Burhinus grallarius*	Billinudgel NR	Dry sclerophyll and adjacent cleared land.
Wompoo fruit-dove *Ptilinopus magnificus*	Billinudgel NR	Wet sclerophyll and rainforest
Rose-crowned fruit-dove *Ptilinopus regina*	Billinudgel NR, study area	Wet sclerophyll and Camphor Laurel regrowth.
Eastern grass owl *Tyto capensis*	Billinudgel NR	Swamp, heath, woodland and paddocks with long grass.
Masked owl *Tyto novaehollandiae*	Billinudgel NR, study area	Dry sclerophyll forest and adjacent cleared land.
White-eared monarch *Monarcha leucotis*	Billinudgel NR, study area	Wet sclerophyll forest and advanced regrowth.

Appendix 2: Chronology of NSW Government Protection of the North Ocean Shores / Yelgun site

1985 SEPP 14 Wetlands No. 57 gazetted by NSW Dept. of Planning.

1987 NSW Labor Minister for Planning & Environment places Interim Conservation Order (ICO) over lands at North Ocean Shores / Yelgun following the bulldozing of culturally significant coastal lands.

1989 Large areas of North Ocean Shores / Yelgun Referenced by NPWS.
N.B. Only areas of high conservation value meet this criteria.

1990 Commission of Inquiry (COI) into Rezoning of Lands at Ocean Shores, North. Commissioner Simpson recommends the majority of lands be zoned for environmental protection due to the areas natural and cultural values.

1990 Survey uncovers 22 Aboriginal Archaeological sites & identifies Marshalls Ridge (Jones Road) as a Ridge of 'High Archaeological Sensitivity' (Navin, Canb.)

1994 The Natural and Cultural Values of the North Ocean Shores / Yelgun area, are listed on the Register of the National Estate, Canberra, as an 'Indicative Place'.

1995 NSW Coalition Government acquires 325 ha of SEPP 14 Wetlands and the Billinudgel Nature Reserve is created.

1995 NSW Labor Government places a 12 month Interim Protection Order over environmentally sensitive lands at North Ocean Shores / Yelgun.

1995 NSW NPWS Satellite Imagery highlights the Marshalls Ridge wildlife corridor as the only substantial link of native vegetation connecting coastal remnants through to the hinterland and World Heritage rainforests of the Mount Warning caldera.

1996 NSW Labor Government purchases a further 350 ha of environmentally sensitive lands at North Ocean Shores / Yelgun for additions to the Billinudgel Nature Reserve.

1996 NSW Labor Minister for Environment extends IPO for a further 12 months over North Ocean Shores / Wooyung lands.

1997 NSW Labor Government purchases a further 40 ha of culturally significant land at Wooyung for additions to the Billinudgel Nature Reserve.

1997 RTA redrafts section of Pacific Highway Upgrade at Yelgun to avoid impact on SEPP 14 Wetlands and the Billinudgel Nature Reserve.

1997 NSW Minister of Planning places a 'Stop-Work Order' over lands in the Marshalls Ridge (Jones Road) wildlife corridor to halt clearing in habitat areas.

1997 NSW Minister of Planning calls a Commission of Inquiry into the Rezoning of Lands at North Ocean Shores to resolve issues surrounding conflicting land uses i.e. environmental & agriculture.

1997 Commissioner Cleland acknowledges the scientific information supporting the environmental & cultural significance of Marshalls Ridge (Jones Road) wildlife corridor, despite its partial degradation. The Commissioner strengthened and expanded Byron Council's draft environmental zonings to prevent inappropriate development.

1998 NSW Minister of Planning adopts Commissioner Cleland's recommended zonings for North Ocean Shores / Yelgun and Amendment 51 of the Byron LEP is gazetted.

1998 RTA recognises the findings of Cleland COI and invests $3.5 million for a 'Cut and Cover' overpass to maintain connectivity to the Marshalls Ridge (Jones Road) wildlife corridor to enable a safe passage for fauna. This initiative was the first of its kind in NSW, possibly Australia. RTA invests a further $1 million on fauna mitigation devices i.e. underpasses.

2002 RTA acquires additional lands as 'Compensatory Habitat' in the Marshall's Ridge (Jones Road) locality to enhance the wildlife corridor servicing the Billinudgel Nature Reserve.

2002 A regionally significant Aboriginal archaeological site is discovered (Piper 2002) bringing the total of registered sites with NPWS to 32 for this precinct.

2002 NSW Labor Minister for Environment issues a 'Stop-Work Order' over the Marshalls Ridge (Jones Road) wildlife corridor to stop unauthorised clearing.

2002 NSW Labor Minister for Environment issues another 12 months Interim Protection Order over the Marshalls Ridge (Jones Road) wildlife corridor.
N.B. IPO's & ICO's are rarely enacted, however, NSW Labor Ministers have enacted this legislation on numerous occasions over this site.

2002 NSW Labor Minister for Environment writes to Byron Council reminding it to enforce Amendment No 51 of its Local Environment Plan.

2002 NSW Fisheries takes landowner to court over the clearing and pollution of Yelgun Creek. Landowner was convicted and ordered to rehabilitate.
N.B. Government agencies e.g. Byron Council, NPWS, Dept. of Agriculture & NSW Fisheries have spent valuable resources in numerous court battles defending the high conservation values of the site.

2004 Fire escapes into peat deposits along Marshalls Ridge and burns underground for months. (RFS, 2004) Toxic smoke was reported kilometres away and cases of respiratory problems, headaches and asthma were recorded by the NSW Health Department. (NRPH & DOCS, 2004)

2004 A second fire escapes into Reserve lands. A Declaration of Emergency [Sec. 44] was issued by the NSW Fire Service and the cost to the State was approx. $1 million. Fifty fire units, 5 helibombers and 120 fire fighters, including crews from the mid-north coast, battled the fire for 3 days until heavy rain extinguished the main blaze. An adjacent Primary School and housing estate were evacuated.

2004 Byron Council incorporates all forested areas and intervening pasture along Marshall Ridge (Jones Road) in their wildlife corridor mapping (BSC, 2004). In addition, all forest blocks are mapped as High Conservation Value, Koala Habitat and Threatened Fauna Habitat. (BCS, 2004)

2005 Director General of the NPWS places a 'Stop-Work Order' on lands within the Marshalls Ridge (Jones Road) wildlife corridor at North Ocean Shores / Yelgun. Landowner ordered to rehabilitate.

2006 Billinudgel Property Pty. Ltd. purchases 2 adjoining properties (256 ha) at North Ocean Shores / Yelgun and names the site North Byron Shire Parklands. Billinudgel Property Pty. Ltd. is a consortium of 14 people. One is the Owner/Director of 'Splendour in the Grass', another is the Executive Producer of 'Loud' & 'Noise' festivals, Sydney.

2008 Byron Council grants approval to hold a one-off 'Trial' festival for a Splendour in the Grass festival (DA No. 10.2007.462.1) at Yelgun. (1,000+ submissions received)

2009 Appeal lodged in the L & E Court against Byron Council's approval for a 'Trial' Splendour in the Grass festival.

2009 Judge Preston rules that Byron Council's approval of the DA was 'Invalid and of no effect'.

2009 *Northern Rivers Regional Biodiversity Management Plan*. (DECC, May 2009) Marshalls Ridge is identified as part of an important Climate Change Corridor.

2009 Billinudgel Property Pty. Ltd. submits a proposal to establish a Permanent Cultural Events site at North Byron Shire Parklands (Yelgun) under the 3A Major Project legislation with the NSW DoP.

2009 'Splendour in the Grass' announces that they are temporarily relocating their 2010 music festival to Woodford, Queensland.

2009 *Draft Far North Coast Regional Conservation Plan,* DECC 2009
The Billinudgel Range is identified as a rare east-west escarpment, that 'will be critical in terms of Climate Change and linkages with the Great Eastern Ranges corridor'. corridor'.