ACT Government
Major Projects Canberra

City to Commonwealth Park Light Rail

EPBC Preliminary Documentation Submissions Report

November 2020

Version Control

Version	Issue Date	Prepared By	Reviewed By	Details
0	October 2020	SB, MG	MS, AmC	Draft
1	November 2020	SB, MG	MS, AmC	Final

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EXECUTIVE **SUMMARY**

The ACT Government is extending light rail to Woden, starting with Stage 2A which will see the operational network between Gungahlin and the City extended to Commonwealth Park.

Major Projects Canberra (MPC), on behalf of the ACT Government, is responsible for managing the design and development of light rail Stage 2A. This is a complex project requiring a number of Territory and Commonwealth approvals. As part of the approvals process, a referral was submitted to the Department of Agriculture, Water and Environment (DAWE) under the Commonwealth *Environment, Protection and Biodiversity Conservation* (EPBC) *Act* in 2019, outlining the project's proposed route along London Circuit and Commonwealth Avenue and anticipated environmental and planning impacts. Subsequently, DAWE determined that the project was to be assessed as a "controlled action" through preliminary documentation.

The preliminary documentation was prepared in accordance with Section 95A(3) of the EPBC Act, and the controlling provision under the EPBC Act ('listed threatened species and communities' (Section 18 and 18A) and Commonwealth land (Section 26 & s27A)). The preliminary documentation recognised the socioeconomic impacts and benefits the project would bring to Canberra, as well as considering key aspects of environmental significance, such as the impacts to the critically endangered golden sun moth population.

These documents were placed on public exhibition from Monday 17 August through to Monday 14 September 2020, with feedback sought from community and interested stakeholders over an extended period of 20 business days.

During the public exhibition and submission period a total of 44 submissions were received from the community and other stakeholders, with 10 submissions directly relevant to matters outlined in the preliminary documentation. This Submissions Report provides response to matters raised during the exhibition period, and includes the contribution these comments have made to the project development.

In addition to the EPBC Act approvals, the ACT Government will seek approval though a Development Application from the ACT Planning and Land Authority, and a Works Approval from the National Capital Authority. Both of these approvals' processes will seek community and stakeholder comment on project plans to further assist in the refinement of design development.

1.0 Project overview

Light Rail Stage 2A is a 1.7-kilometre proposal which runs between the existing Alinga Street stop to a new terminus on Commonwealth Avenue opposite Commonwealth Park (the Project). The proposed route runs down the middle of Northbourne Avenue then onto the west side of London Circuit and onto Commonwealth Avenue, with a stop at Edinburgh Avenue and a stop at the northern end of Commonwealth Avenue (City South). Substantial work required to support the light rail includes the construction of a new intersection between London Circuit and Commonwealth Avenue and the creation of a rail bridge over Parkes Way.

The key features of the Project are described below and form part of the design which will be further developed during the detailed design phase of the project:

- A 1.7-kilometre light rail track running from the current Alinga Street terminus down the middle of London Circuit and onto Commonwealth Avenue terminating at Commonwealth Park.
- A new light rail stop at Edinburgh Avenue.
- A new light rail stop at City South.
- A terminus at Commonwealth Park.
- A new dedicated light rail bridge over Parkes Way.
- One “scissor crossover” to allow light rail vehicles to reverse direction.
- Wire-free technology reducing overhead line equipment and visual impacts - especially in areas of cultural value and high visual amenity.
- Relocations or upgrades of utilities.
- Landscaping features sympathetic with Canberra’s design as envisioned by the Griffin Legacy along with requirements set out in other Territory and Australian Government landscaping policies.
- ‘Green tracks’ running along Commonwealth Avenue that involve planting between and beside the light rail track.
- Upgrades or additional intersection layouts, traffic signal phasing amendments within the area.
- Modifications to pedestrian footpaths and crossings.
- Localised road widening and verge and kerb line changes.

2.0 Background to the EPBC Preliminary Documentation

In late 2019, MPC submitted an EPBC referral to DAWE that broadly described the Project. The referral documents were publicly exhibited on Monday 9 December 2019 for a period of 10 business days with comments invited.

The referral identified potentially significant impacts on the critically endangered Golden Sun Moth (GSM) contemplating a loss of up to 6.9 ha of GSM habitat as a result of the Proposed Action. The GSM population impacted by the Project was considered "distinct and isolated from other populations" nearby in Canberra. In accordance with the published guidelines the expected impacts from the Project constituted a significant impact requiring assessment and approval under the EPBC Act.

The referral also recognised the Project's potential impact on Commonwealth Land values.

These potential impacts included:

- Temporary and permanent amenity and landscape impacts along Commonwealth Avenue due to construction works, including the new intersection and bridge, and the introduction of new track and stop/ terminus infrastructure.
- Utility relocation works.
- Traffic management controls that would be introduced along the route during construction.
- Impacts on the Reserve Bank of Australia and Parliament House vista.

DAWE agreed with the project's position within the referral documents and determined that the project was a 'controlled action' and required assessment through preliminary documentation. The controlling provisions under the EPBC Act were identified as 'listed threatened species and communities' (Section 18 and 18A), namely the critically endangered GSM and Commonwealth land (Section 26 & s27A). In determining that the project would be assessed through preliminary documentation DAWE provided information requirements in early January 2020 that specified the expected information that MPC would need to provide within the preliminary documentation.

3.0 Public submission period

Chief Minister Barr and Minister Steel announced the public exhibition of the preliminary documentation at a press announcement on the 14 of August, encouraging the public to make comment on the Project's plans.

From Monday 17 August through to Monday 14 September 2020, documentation was made available online at www.yoursay.act.gov.au/light-rail-to-woden/epbc-stage2a with the offer to email or post to any interested parties who preferred this option.

To promote the exhibition period, MPC utilised print media (adverts in The Canberra Times and The Australian), social media and distributed electronic and hard copy project updates. The hard copy project update was distributed to over 1500 businesses and residents along the alignment with the targeted electronic mail sent to over 4000 registered community members and stakeholders.

Hard or electronic copies of the documentation were also sent to Registered Aboriginal Organisations (RAOs) and the United Ngunnawal Elders Council (UNEC), and on request to members of the public.

On advice sought from ACT Health and ACT libraries, it was determined that a physical display of documentation was not appropriate during the COVID-19 period, with the project team providing information and links to libraries for their reference that was available to pass on to interested stakeholders. To acknowledge this change in normal display periods, and in agreement with DAWE the exhibition period was extended to 20 business days (from the standard 10 business days) which allowed all interested stakeholders additional time to comment on the documentation.

4.0 Purpose and structure of this report

The Submissions Report supports the preliminary documentation by providing a response to matters raised during the exhibition period. Within this Submissions Report, MPC will consider all responses pertaining to the key issues raised by DAWE. This submissions report, along with a copy of all submissions received regarding the project and the final version of the preliminary documentation (including any adjustments to the project scope as a result of any issues raised), will be submitted to DAWE for consideration.

The final version of the preliminary documentation, including the submission report, is then required to be published for information. For clarity, issues not relating to the EPBC approvals process have been summarised in this report and will be considered by the project team within design development.

5.0 Submissions received

A total of 44 submissions were received during the public exhibition period, ten of which related to the topics specified within the Preliminary documentation. A submission was also received from EPSDD (Environment Division) providing concurrence for the general approach and content of the preliminary documentation.

Submission topics related to the preliminary documentation included:

- the acceptability or otherwise of impacts to GSM
- the appropriateness of offsets proposed, and
- support for the approach proposed to avoid, minimise, and offset impacts from the project.

Submission topics which did not relate to the preliminary documentation included:

- Need and justification for the project (including during the current Covid-19 circumstances)
- Alternatives to light rail, including electric buses and trackless trams
- Alternative alignments that should be considered instead
- Support for the project progressing
- Detailed comments on design aspects of the project or other comments about the broader City to Woden Light Rail projects.

Responses to the submissions focused on EPBC related issues can be seen in Section 6.0, with all other submissions responded to in Section 7.0.

In the interests of privacy, personal contact details and names of the submitters have not been identified in this report. Submissions have been grouped into common themes and answered accordingly with occurrence also indicated.

6.0 Responses to submissions specific to Controlling Provisions or Matters of National Environmental Significance (MNES)

6.1 Biodiversity - Golden Sun Moth

A total of seven submissions raised this issue.

Concerns about loss of biodiversity and threatened species

- **Concerns about the effectiveness of offsets (More information on how offsetting process will ensure accountability and no net loss of GSM)**

  Where a proposal is likely to have a significant residual impact on a Matter of National Environmental Significance (MNES) the EPBC Act allows for the provision of environmental offsets to compensate for such losses. The EPBC Act Environmental Offsets Policy (EPBC Offsets Policy) outlines the Australian Government's approach to the use of environmental offsets under the EPBC Act. It is intended to give proponents, the community and stakeholders with greater certainty and guidance on how offsets are determined and when they may be considered under the EPBC Act.

  For the Project, offsets are proposed under the NSW Biodiversity Offsets Scheme (BOS) to address the significant residual impacts to Golden Sun Moth. The NSW BOS and superseded BioBanking Scheme include provisions that allow for the proposed offset approach to meet the principles of the EPBC Act Environmental Offset Policy

  MPC has aimed to minimise the impact on GSM habitat and is implementing restoration measures where there will be no permanent impacts for this or other whole of government projects in the foreseeable future. MPC will work in co-operation with the Offset Management section within Parks and Conservation Group within EPSDD to trial innovative measures to enhance GSM habitat. These measures aim to improve restoration activities and will develop methods that can be implemented in future projects. The restoration activities will now be staged so that the SE cloverleaf (see map in **Appendix A**) will have had up to three years of restoration activities by the time there is to be disturbance to the eastern side of Parkes Way. This will enable monitoring and evaluation of the effectiveness of the trial before implementing preferred restoration measures within the eastern side of Parkes Way.

  In areas where restoration activities are not possible due to permanent impacts, offsets will be obtained in-line with ACT and NSW Biodiversity Schemes. Under the NSW Biodiversity Offset scheme, landowners who establish a biodiversity stewardship site (which offer offsets for sale) must instigate a management plan approved by the Biodiversity Conservation Trust that requires management initially for a 20 year period. The landholder is required to report annually to the trust against performance criteria developed in the management plan. Landholders are subject to auditing and other compliance activities by the Trust or NSW Department of Planning, Industry and Environment.

- **Request for clarity on how interjurisdictional biobanking will work between ACT and NSW Biodiversity Offsets Scheme**

  Although MPC endeavoured to identify a suitable offset site within the ACT, no such site could be identified. In discussions with DAWE, it was indicated that due to the limited availability of land for offsets within the ACT, a precedent existed where suitable sites could be identified in NSW and utilised. This process had been adopted on the Mugga Quarry Project (EPBC Reference 2018/8151). The method of converting the offset requirements under the ACT system to those required under the NSW system was developed and endorsed by DAWE. The locations which are being investigated for the current project are on the ACT/NSW border and thus within close regional proximity to the site of impact.

- **Habitat destruction should be avoided** (Insufficient actions are in place to preserve the GSM species)

  In response to the submissions received from public exhibition of the Preliminary Documentation, MPC has undertaken detailed analysis of the scope of work in the South East Cloverleaf and refined the impact area to ensure that the existing population of GSM will be maintained as far as practicable, by limiting work activities to the minimum feasible extent. Refer to Section 8.0 for further detail on this.

  In undertaking the approval process under the EPBC Act, MPC has adopted a whole of government approach in assessing the impacts in the area. As such, areas that are to be impacted by the construction of Stage 2A of the light rail which have development programmed by other Government Agencies will not be restored. This can be seen in **Figure 1** below which includes areas in the western cloverleafs and western side of Parkes Way which are planned (subject to future planning approval processes) to be used for the s63 development and Acton Waterfront.

- **GSM relocation logistics requested (Risk of diseases and parasites to GSM population)**

  GSM would be collected from the western side of Commonwealth Avenue prior to disturbance and placed within the SE Cloverleaf. Refer to Section 8 for further detail.

- **Focus on African Love Grass, Witch Grass and Madagascan Fireweed during weed management processes.**

  As detailed in the GSM Habitat Restoration Framework presented in **Appendix A**, there will be quarterly monitoring of weeds throughout the restoration activities. MPC will ensure that there is a strong focus towards management of African Love Grass, Witch Grass and Madagascan Fireweed during weed management processes by documenting these species in management plans.

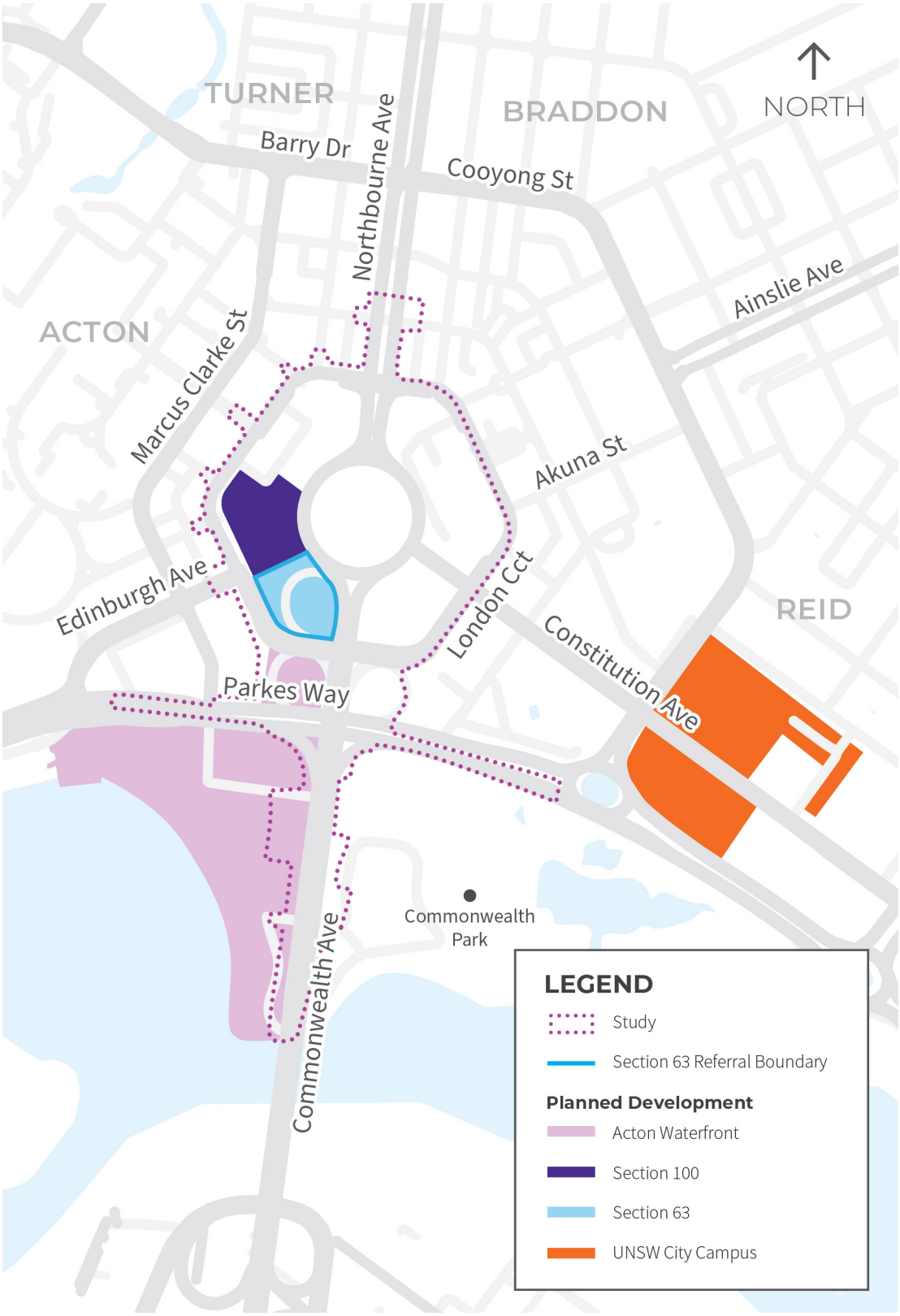

Figure 1 – Map detailing other planned development within the Light Rail corridor

- **Transparency on how ACT's Golden Sun Moth Action Plan (2017) and ACT Native Grassland Conservation Strategy (2017) are integrated into preliminary documentation**

  Throughout the assessment process, as well as during restoration activities, monitoring of GSM populations will continue to occur in line with the GSM Action Plan.

  In restoring the SE Cloverleaf and eastern section of Parkes Way MPC will implement a number of objectives/actions from the GSM Action Plan as shown in table below:

Objective	Action	Indicator	How implemented on Stage 2A
Improved understanding of the species' ecology, habitat and threats	Undertake or facilitate research on habitat requirements, techniques to manage habitat, and aspects of ecology directly relevant to conservation of the species.	Research undertaken and reported and where appropriate applied to the conservation management of the species.	At the commencement of works MPC, in co-ordination with the offset section of Parks ACT, will implement a number of initiatives to target broad leaf exotic grasses, which are not favoured by GSM , and then re-instate native grasses which will promote GSM.
Enhance the long-term viability of populations through management of adjacent grassland to increase habitat area and connect populations, or to establish new populations.	Manage grassland adjacent to the species' habitat to increase habitat area or habitat connectivity. If suitable habitat exists, re-establish populations where they have become locally extinct.	Grassland adjacent to or linking habitat is managed to improve suitability for the species (indicated by an appropriate sward structure and plant species composition). If suitable habitat exists, research and trials have been undertaken to establish new populations.	Within the SE cloverleaf the area of impact is that which does not have habitat which is suitable for GSM (i.e. broadleaf grasses). Restoration activities will focus on establishing suitable habitat to hopefully increase population size.

  The ecological assessment that formed the basis of the preliminary documentation categorised the habitat quality as being of low quality as it is Chilean Needle Grass dominated habitat. The areas that are being restored will be reinstated with native grasses from areas which had native grass content with the aim of improving the ecological condition in line with the Native Grassland Conservation Strategy. Measures indicated above also correlate to improving the grassland ecology condition with the Grassland Conservation Strategy.

- **Support for the GSM measures and planned offsets outlined in the documentation**

  Noted

- **Support for the environmental benefits of light rail**

  Noted

6.2 Social and economic impacts

A total of three submissions raised issues associated with the social and economic impacts of the project. These issues included matters relating to:

- The character of the Stage 2A project site and how this may be compromised
- Project construction impacts in the City West area
- Concerns around impacts to the Commonwealth Avenue vista and the “Bush Capital” aesthetic
- Concerns that grass tracks will create hazards (become muddy, slippery in winter) and adversely impact the vista
- Concerns around overhead wires
- Concerns around light rail technology infrastructure (risk of the removal of a sub-station from plans)

The project recognises the special importance of the area through which it passes. A key component of the project is the commitment to proceed with a wire-free design, that will minimise the visual impacts through the City area and Commonwealth Avenue. The light rail vehicles (LRVs) will be fitted with an on-board energy storage system to provide power through the wire-free section of the network. This technology also enables the system to store energy from the renewably powered grid and regenerative braking from the LRVs and uses this to manage energy consumption more efficiently.

The detailed landscape design solutions for the project are continuing to undergo further development with the objective of enhancing the quality of the public realm along the route. An irrigated landscaped trackform on Commonwealth Avenue which was developed in response National Capital Authority advice, will ensure that the landscaped character of the corridor is retained and enhanced. Such landscaped trackforms have been successfully utilised in numerous cities around the world, including in Australia (Melbourne and Adelaide).

In relation to potential construction impacts as a result of the project, detailed construction management plans will be developed to ensure that construction activities are undertaken in a manner that mitigates or reduces the potential impacts to residents and businesses. This will include, for example, undertaking particularly disruptive work like intersection closures outside of peak times, or engaging residents, businesses and other key stakeholders to develop location specific mitigation strategies during construction phases. These management commitments will be presented in greater detail, for further public consultation during the Works Approval and Development Application phases of the project that are a requirement of the National Capital Authority and the ACT Planning and Land Authority respectively.

7.0 Other submissions received unrelated to preliminary documentation or MNES

Canberrans have been a part of an ongoing conversation about the future of the light rail network since 2011. This has involved engaging with businesses, the community and key stakeholders about the light rail network, project development and planning.

As part of our commitment to robust and ongoing community engagement, we are holding the conversation online and in public spaces, answering questions and listening to feedback on how we can improve light rail outcomes.

During the EPBC public exhibition period, MPC received a range of feedback from the community and stakeholders both positive and negative in nature.

Key positive comments received related to:

- Sustainability and low environmental impact aspects of light rail
- The convenient public transportation option that light rail offers
- Support for the City to Woden route
- A general eagerness for the next stage(s) to be built quickly

Key concerns raised in general submissions related to:

- The need and justification of light rail
- An assessment of the alternative public transport options to light rail
- The cost of the project
- The method of public consultation
- Various comments around the next stages of light rail beyond City to Commonwealth Park

A number of the general submissions which did not relate to MNES related to Stage 2B (Commonwealth Park to Woden) and further stages of the light rail network. This feedback will be assessed by the project team during project development but also during future environmental approval stages. DAWE has determined that Stage 2B will be assessed through an Environmental Impact Statement (EIS) pathway which involves a rigorous environmental and planning approvals process prior to construction. As with Stage 2A, both Territory and Commonwealth approvals will be required to bring light rail from Commonwealth Park to Woden.

The EIS for Stage 2B is expected to take approximately 18 months and will amongst other aspects require a detailed analysis of the project's route, environmental and heritage assessments, and consultation with a range of local and Commonwealth stakeholders.

As planning and design for the project develops, the public will be invited to provide comment at a number of statutory and informal stages. Although these submissions are not related to the EPBC Approval process for the Project, in the interests of completeness, the following table identifies the nature of these issues raised and provides a response.

Topic category	Frequency of topic**	Issues/Concerns	Response
Light Rail Stage 2A – City to Commonwealth Park			
Need & justification	High	• Need for better integration between light rail routes and buses • Project should be postponed until economy recovers from COVID-19 • Time required for project planning and construction • Suggestion that the ACT Government has a strategic planning problem and that employment should be spread out to different town centres • Stage 2A stops will increase traffic congestion on Parkes Way • Clarification around pedestrian overpass or underpasses	• The next stage of light rail will play an important role in the economic recovery of the ACT, encouraging development and investment in key areas of the city whilst supporting the creation of local jobs. • The project is part of the broader vision of extending the network to Woden and is a crucial enabling project for further stages of our city-wide light rail network. The light rail network will contribute to the development of Canberra as an economically and environmentally sustainable city. Integrating bus services with future light rail stages is critical to facilitating a connected public transport network and an integrated transport system. • Whilst the broader Stage 2 (Commonwealth Park to Woden) will terminate in Woden, it will serve residents, workers and visitors all along the route from Gungahlin. Light rail is part of the larger ACT public transport network and will service customers taking a variety of journeys. • A business case sets out how a project will be delivered, and the business case for Stage 2B will be considered in the future once the Commonwealth planning processes are further progressed. This will follow an extensive Environmental Impact Statement, which will involve multiple opportunities for engagement and community consultation. • There is no current plan for a pedestrian overpass or underpass on Commonwealth Avenue but rather new signalised pedestrian crossings along the light rail route, allowing pedestrians to disembark from the light rail and access event space at Commonwealth Park and the Acton waterfront similar to what exists on Northbourne Avenue. Again, these stops will service local Canberrans but also visitors to the city which make a fiscal contribution to our city when they visit.

Topic category	Frequency of topic**	Issues/Concerns	Response
Alternatives to Light Rail	High	• Electric buses a more current/appropriate public transport option • Relevance of light rail technology • Alignment of light rail and road traffic • Appropriateness of light rail versus Autonomous Rail Rapid Transit or Trackless Tram Systems	• Stage 2 (A and B) will serve residents, workers and visitors all along the route from Gungahlin. light rail is part of the larger ACT public transport network and will service customers taking a variety of journeys as well as contribute to a more compact urban form. • We are committed to reducing our carbon footprint and easing congestion on our roads. All transport modes have a role to play in meeting the mobility and access needs of Canberrans. Improving the public transport network provides greater travel options for Canberrans, and delivers on the Government's social, economic and environmental objectives. • The ACT Government has identified and demonstrated light rail as the optimal mass transit mode choice to deliver its transport and city objectives. The ACT continues to explore other technologies • Electric buses have been trialled in the ACT (https://www.transport.act.gov.au/news/news-and-events-items/2020/october-2019/electric-bus-trial-results) as part of the plan to transition to a Zero-Emission fleet by 2040 at the latest. Buses and light rail are both part of the future transport mix for the ACT.

Topic category	Frequency of topic**	Issues/Concerns	Response
Cost	High	• Public spending should be invested in alternate areas including social welfare, education and health • Concern around the cost of light rail project with particular concern after the COVID-19 pandemic and subsequent economic downturn • Cost to individuals utilising light rail perceived as too high	• By 2036 it is expected that 270,000 people will live, work or study within one kilometre of the broader Stage 2 corridor. By investing now in future public transport, Canberra will be able to avoid some of the congestion issues experienced in other cities and enable a more sustainable urban form. Infrastructure Australia has determined that the costs of road congestion in Canberra will nearly double over the next decade without substantial investment. • The ACT Government is also investing in education, health, aged care, bus services, employment support, and youth assistance through a variety of programs including the Canberra Hospital Expansion. • Cost benefit assessments undertaken indicate that for every dollar spent on delivering light rail from Gungahlin to Woden, the return to the Territory is $1.20[1].
Environment	Low	• Concern around the visual of replanted trees and grasses with reference to landscaping in Stage One • Concern around light rail tracks damaging the environment	• The majority of landscaping activities for the project will occur on Commonwealth Avenue, an area that is subject to National Capital Authority Works Approval. • New landscaping will be guided by the National Capital Authority's landscaping and tree planting advice, and respond to the National significance of Commonwealth Avenue. The landscaping treatment will likely be very different to the treatment installed on Northbourne Avenue, which is a dryland (non-irrigated) native "urban meadow". Commonwealth Avenue is likely to be substantially more formal, with irrigated landscaped trackform (not concrete as on Stage 1).

[1] Light Rail Stage 2A Business Case, 2019, pg. 123, available at https://www.transport.act.gov.au/__data/assets/pdf_file/0003/1412634/Stage-2A-Light-Rail-Business-Case-redacted.pdf

Topic category	Frequency of topic**	Issues/Concerns	Response
Public consultation	Low	• Concern that ACT Government's efforts to gather community feedback have been insufficient • Concern around the lack of publicly available cost analysis and business case information • Concern around the timing of consultation with the public on the Stage 2A area	• Referral documentation was placed on public exhibition in December 2019, the first formal statutory engagement process for the project. • We're currently engaging residents, community groups, businesses and organisations while we're in the early planning and design phase for Stage 2A. • This consultation has involved establishing a Community Reference Group, who we consult with closely to ensure a diverse range of viewpoints are heard and taken on board. • As contractual arrangements for the delivery of the project are yet to finalised, it would be premature to release the commercial aspects of the redacted business case for the project, as this could prejudice value for money outcomes the Territory is seeking to achieve.

Topic category	Frequency of topic**	Issues/Concerns	Response
Light Rail Stage 2B – Commonwealth Park to Woden			
Need & justification	Low	• Concern regarding a perceived reduction of parking as a result of Stage 2B • Concern around the staged approach for Canberra Light Rail • Concern around the loss of the 'Bush Capital' look on Adelaide Avenue as a result of light rail • Concern around stop locations and availability of a 'park and ride'	• The exhibition of Preliminary Documentation for the project did not include any details of the separate project Light Rail Stage 2B Commonwealth Park to Woden. Light Rail Stage 2B is the subject of a Commonwealth Environmental Impact Statement (EIS) process. These issues are noted and will be investigated and responded to in detail in the EIS. • Light Rail Stage 2B will be a catalyst for the transformation and revitalisation of Adelaide Avenue, and this will include a coordinated approach to transport and land use planning. The corridor will evolve on a precinct by precinct basis in tandem with light rail stops, and the precincts will reflect the unique characteristics of the surrounding neighbourhoods. Strong connections of these places to the light rail will be a key principle of success. This will result in better places and an enhanced look, feel and function for the corridor.

Topic category	Frequency of topic**	Issues/Concerns	Response
Alternative routes	Medium	• Route selection should consider the Canberra Hospital precinct • Suggestion to tunnel under the lake • Suggestions to utilise both bridges (King and Commonwealth) plus electric vehicles • Suggestion to include additional and dedicated bus routes • Concern around efficiency and timing of selected route • Concern around traffic disruptions as a result of project construction	• The exhibition of Preliminary Documentation for the project did not include any details of the separate project Light Rail Stage 2B Commonwealth Park to Woden. Light Rail Stage 2B is the subject of a Commonwealth Environmental Impact Statement (EIS) process. These issues are noted and will be investigated and responded to in detail in the EIS. • Taking light rail to Canberra Hospital would involve a number of significant challenges, including relocating a high-pressure gas main on Hindmarsh Drive, and would not align with the overall light rail network strategy. For passengers a stop at the intersection of Hindmarsh Drive and Yamba drive would require a 700m walk from the stop to the main hospital entrance, which is only 200m shorter than a direct pedestrian route from the Woden Town Centre. Further, the hospital is well served by the existing bus network. • If you are interested in being part of a Community Reference Group for Stage 2B, please feel free to get in touch and we can add you to the growing list of community members interested in this exciting new stage.
Environment	Low	• Concerns about tree removal on Commonwealth Avenue	• The detailed landscape design solutions for the project are continuing to undergo further development with the objective of enhancing the quality of the public realm along the route.

**Frequency of topic: Low = 1-5 mentions, Medium = 6-10 mentions, High = 11-15 mentions

8.0 Changes to the proposal

The timing and method of restoration activities have been further developed following input from government bodies and environmental groups following the exhibition of the Preliminary Documentation. Specific measures which are to be applied to the restoration of areas likely to be only temporarily impacted as a result of the Project are outlined in **Appendix A**. The net effect of these adjustments is expected to result in a slightly reduced impact relative to the impacts identified in the previously exhibited draft preliminary documentation.

Consultation with key stakeholders and the public will be ongoing as this project develops to consider key areas of interest including heritage, the environment, urban realm and construction impacts. This consultation will contribute to project design development but will also form part of the Project's statutory environmental approvals process

Appendix A

Golden Sun Moth Habitat Restoration Framework

City to Commonwealth Park Light Rail

November 2020 - Golden Sun Moth Habitat Restoration Framework

Version Control

Version	Issue Date	Details
0	June 2020	Draft Framework
1	November 2020	Framework updated following responses from public exhibition of Preliminary Documentation and further input from EPSDD

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PREAMBLE

This is a framework document only, to accompany the Preliminary Documentation for the Light Rail Stage 2A (the Project). The purpose of this document is to outline the management activities that will support restoration activities required to reinstate Golden Sun Moth habitat following construction of the Project. The content of this Framework would be updated to reflect ongoing discussions with relevant stakeholders, and any relevant conditions that may be identified during the determination of the Proposal (through either of the Development Application or Works Approval processes, or the determination of the EPBC Act assessment via Preliminary Documentation. Ultimately this Framework would include actions and management strategies that would ensure all relevant conditions of any environmental approvals issued for the project are implemented to enable effective restoration of Golden Sun Moth habitat.

1.0 Introduction

1.1 Purpose

The purpose of this **Golden Sun Moth Habitat Restoration Framework** is to specify management actions that will support the restoration of Golden Sun Moth habitat as a result of temporary impacts from the Light Rail Stage 2A construction (the Project) in the "**south east cloverleaf**", and the **eastern median of Parkes Way** (see **Figure 1**). As part of the broader environmental management for the Project, a comprehensive Construction Environmental Management Plan (CEMP) will operate throughout the construction phase, with a key objective relating to Golden Sun Moth management being the avoidance of unnecessary clearing of existing Golden Sun Moth habitat within the south east cloverleaf, and the eastern median of Parkes Way.

1.2 Timing for restoration works

Restoration activities are planned to occur as soon as practically feasible following disturbance activities within the south east cloverleaf and the eastern Parkes Way median. The Proposed Action would take approximately four years to construct. Broadly, it would involve multiple work stages that could take place at different times in different locations along the route. The exact timing of each stage and work activity in a given location would depend on the final design, contractor specifications and requirements, consultation feedback, and any restrictions and constraints set by the ACT and Australian Governments. Construction would be staged and will likely involve five key phases of work, as detailed in the following sections.

1.2.1 Phase 1: Early works

Early works would involve:

- Site investigations and setting out access routes and no-go zones.
- Establishment of a compound within the northern section of the carpark at Acton.
- Carrying out utility adjustment, relocation, protection and installation works.

This phase of works is anticipated to be for nine to twelve months in duration.

Restoration Activities: Disturbance in the south east cloverleaf would occur during this stage of construction after which restoration activities would commence. As detailed in Section 5.1 and Section 5.2 several adaptive management techniques will be trialled in this area which, if successful, will be implemented in the restoration of the eastern side of Parkes Way.

1.2.2 Phase 2: Main Civil works – Raising of London Circuit and associated works

The raising of London Circuit will provide an at-grade signalised intersection at the junction of London Circuit and Commonwealth Avenue. This requires undertaking civil works to remove existing roadway infrastructure prior to filling above London Circuit to achieve design levels approximately in line with Commonwealth Avenue existing levels. Removal of the two existing concrete bridges that cross London Circuit will also be required, with traffic moved to a contraflow around the active worksite during the staged removal of each bridge.

This stage of works is anticipated to be approximately 24 months in duration. It is not anticipated that there will be any additional disturbance to the GSM restoration areas during this stage of works. Through this period there will be the continuation of restoration activities in the south east cloverleaf.

1.2.3 Phase 3: Main Light Rail construction works

This phase would include three key works packages: stop and terminus construction, track works, and road works. All works packages would involve common activities including earthworks and excavations, the use of heavy equipment and machinery, the movement of materials and waste, and general surface and foundational works. This stage of works is anticipated to be approximately 24 months in duration.

Restoration Activities: Construction of the additional bridge over Parkes Way will require disturbance of the eastern median of Parkes Way. Restoration of this area of Golden Sun Moth habitat would occur as soon as possible after there is confidence that additional construction activities will not be required

1.2.4 Phase 4: Testing and commissioning

This phase would involve running trials of the light rail vehicles to test the rails, stops, equipment, and service reliability. Post-works management and monitoring of habitat restoration works would also occur during this phase.

1.2.5 Phase 5: Handback

An audit inspection would be carried out to address any defects after which the light rail and road would be handed over to the appointed operational and maintenance entity. Habitat restoration works are expected to occur for a three year period in each area after habitat disturbance is complete.

2.0 Description of the Project

The Project involves the construction and operation of a 1.7-kilometre light rail extension between the existing City to Gungahlin light rail terminus at Alinga Street to a new terminus on Commonwealth Avenue opposite Commonwealth Park. It would include two other stops at Edinburgh Avenue and at the northern end of Commonwealth Avenue (City South). The light rail would run down the middle of Northbourne Avenue, the west side of London Circuit and then the median of Commonwealth Avenue. Additional work needed to support the light rail would include construction of a new intersection between London Circuit and Commonwealth Avenue and the creation of a new rail bridge over Parkes Way.

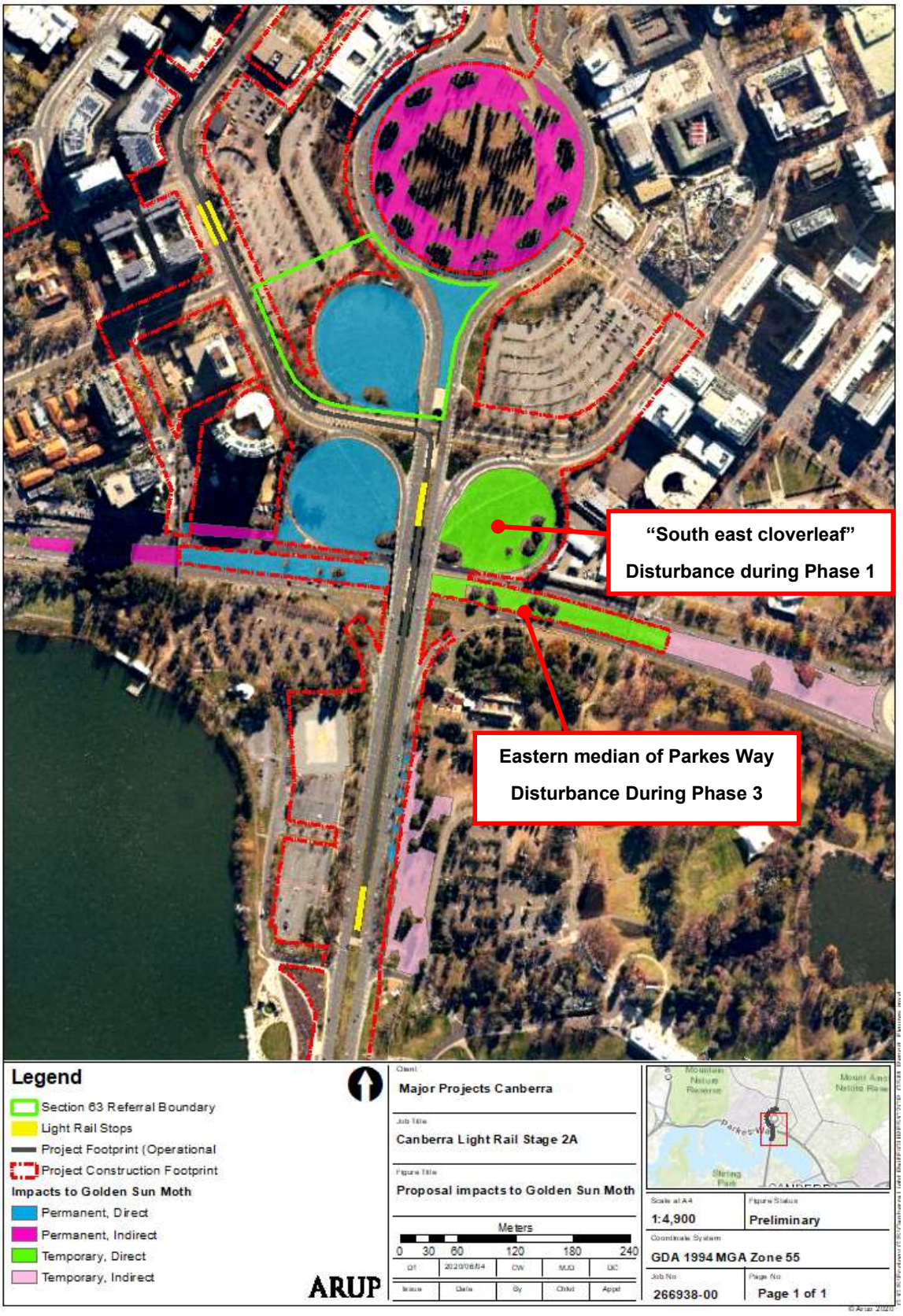

Figure 1: Project area, including areas of proposed Golden Sun Moth habitat restoration activities, that are the subject of this Framework (South east cloverleaf and eastern median of Parkes Way).

2.1 Matters of National Environmental Significance

The Project is undergoing assessment in accordance with the EPBC Act through Preliminary Documentation. The matters of national environmental significance likely to be affected by the Project are restricted to low-moderate quality Golden Sun Moth habitat.

3.0 Training

The Project Environmental Manager is responsible for ensuring that personnel and subcontractors under their control have the requisite competencies, skills and training to carry out their assigned tasks and for identifying additional training and competency requirements. The Project Environmental Manager is responsible for ensuring training records are maintained.

Prior to the commencement of restoration activities the Project Environmental Manager, in conjunction with other staff, will approve an induction program to be delivered to all personnel and subcontractors' personnel involved in the project prior to, or as soon as practical after commencement. The program will address environmental safeguards, safety, emergency procedures and incident reporting and management. The Project Environmental Manager is responsible for ensuring that records are maintained of all Project related training.

4.0 Auditing and Reporting

Audits provide lead indicators for potential incidents and provide important information for corrective action and review of management arrangements and procedures. Audits by an external party will be conducted for this Project at the frequencies set out in **Table 1**. Issues identified during audits will be recorded and corrective action implemented. Compliance monitoring will be undertaken routinely to measure the success of restoration activities. Details of compliance activities can be seen within **Table 2**.

Table 1 Audit schedule

No.	Audit / Reporting	Timing
1	Framework Compliance	Within four weeks of commencement of restoration activities
2	Framework Compliance and review of corrective actions from Audit 1	Four months after restoration activities complete
3	Annual Reporting, detailing progress on all Actions identified in Section 6, including details on monitoring, performance, non-conformances and corrective actions.	March every year

4.1 Incident management

Incident reporting will be implemented to record any safety or environmental non-conformances or incidents. Incidents will be investigated and followed up and, where relevant, corrective actions nominated.

5.0 Restoration Activities

This section outlines the key activities relating to the restoration of Golden Sun Moth habitat following construction disturbance. The following activities identified in **Table 2** have been developed having regard to the outcomes of the ecological assessment completed for the EPBC Preliminary documentation and through discussions with experienced grassland ecologists within ACT Government.

The timing and method of restoration activities have been further developed following input from government bodies and environmental groups following the exhibition of the draft Preliminary Documentation. The impact to the SE Cloverleaf will now be one of the first activities of the project which will allow restoration activities to occur during the first Stage of the project. This will allow a number of adaptive restoration techniques to be trialled which, if successful, will be utilised in the restoration of Parkes Way which will be impacted at that latter stage of the Project for the installation of a bridge over Parkes Way. Specific measures which are to be applied to the restoration of the south east cloverleaf are described in Section 5.1 and Section 5.2.

The majority of food grasses for GSM are C3 grasses which indicates that restoration attempts should be implemented in the cooler months so planting of seedlings should commence in Autumn to give these plants the best chance at establishment. Studies show that seedlings (or tube stock) resulted in faster restoration of GSM habitat then seeding did (O'Dwyer and Attiwill 2001[1]). Tube stock should be planted to a density of between 40-80% of the available area and should be augmented with seeding. No bark or other materials will be placed around plantings with areas between seedlings left as bare earth.

[1] O'Dwyer, C., Attiwill, P.M. 2001. Restoration of a Native Grassland as Habitat for the Golden Sun Moth *Synemon plana* Walker (Lepidoptera; Castniidae) at Mount Piper, Australia. Restoration Ecology.

Table 2: Key restoration activities

#	Action	Timing	Monitoring Requirements	Monitoring Timing	Performance Indicators	Responsibility	Corrective Action
1	**Native seed collection** To the extent possible, collect native seed stock prior to clearing, for use in the revegetation of disturbed areas	Prior to construction	N/A	N/A	Seed collected of native larval food plants identified in previous ecological surveys	Rehabilitation contractor to ensure native seeds are available prior to commencement of works.	N/A
2	**Population lift from disturbed areas within project area** **Prior to disturbing areas to the west of Commonwealth Avenue (s63, SW Cloverleaf etc)** translocate GSM larvae to areas for restoration in the SE cloverleaf. Translocation methods will be based on successful techniques which have been used in a pilot program on the Majura Parkway Program and refined during the recent Dudley St Golden Sun Moth Translocation (Umwelt, 2020[2]). This would involve using a mattock or backhoe plough, the soil will be churned and searched for the larvae by hand. These will then be deposited into the "non-impact area" of the SE Cloverleaf. The source sites within the western cloverleafs will be selected on the basis of previous GSM larvae detections and/ or the presence of good quality habitat.	Prior to construction activities on the western side of Commonwealth Avenue. The larvae must be translocated in spring when they become active.	Specialist ecologist to monitor GSM populations in the restoration areas after relocation has occurred.	Annually during GSM flying period between November and January	Discussion with GSM specialists from Parks indicated that it is impossible to develop performance indicators to measure the success of translocation due to the likelihood of a large proportion of the relocated larvae remaining dormant and also that the survival rate is approximately 10% (SMEC, 2014[3]).	MPC will be responsible for managing specialist ecologists undertaking translocation of GSM. ACT Government Environmental Offsets/Parks – Responsible for overseeing and guiding translocation of GSM.	NA
3	**Protection during establishment** Establish a 'no-go' zone using fencing outside the site boundary and communicate to all staff. Ensure territory maintenance crews do not mow area 2 years after initial restoration activities are completed or when directed in the instance where the area is restored prior to the 2-year period and the grass is becoming overgrown.	Immediately following completion of restoration activities	Conduct regular audits to ensure 'no-go' areas are being adhered to.	Weekly until active construction within 50m of the site is complete	No evidence of construction access within 'no-go' areas. Fencing integrity Induction records	MPC Project Manager and Construction Contractor Project Manager are responsible for implementing measures	- Training - Non-Conformance Reporting - Option to cease work for repeated breaches.
4	**Photo monitoring** Collect representative photos from designated photo points. Photo points will be located approximately 20m apart indicative locations for photo points in the SE cloverleaf and eastern median of Parkes Way can be seen in **Figure 2**.	Prior to construction, during construction and post construction for two years	A minimum of eight points to be established at the north-west corner of each vegetation monitoring plot	Once planting of native plants has occurred monitoring will be completed twice a year	Photo records indicate an increase in native grass populations and decrease in exotic species.	MPC will be responsible for managing biannual monitoring. ACT Government Environmental Offsets/Park – Responsible for overseeing results of photo monitoring and providing advice and direction.	- To be determined through audit process

[2] Umwelt 2020 Briefing Note: Dudley Street Golden Sun Moth Translocation
[3] SMEC 2014 Arboreteum Golden Sun Moth Larvae Retrieval

#	Action	Timing	Monitoring Requirements	Monitoring Timing	Performance Indicators	Responsibility	Corrective Action
5	**Erosion and sediment control** Implement erosion and sediment control plans in accordance with the EPA approved plans. Ensure storage of equipment/stockpile areas in proximity to worksite are within shaded areas that have less potential to be GSM habitat.	During construction	Monitor compliance with erosion and sediment control plans weekly. Conduct periodic inspections with the EPA.	Weekly during construction	Compliance with EPA approved plans	MPC Project Manager and Construction Contractor Project Manager are responsible for implementing measures	- Training - Non-Conformance Reporting - Potential for construction ceasing in accordance with disciplinary measures under *Environment Protection Act* 1997
6	**Native re-planting** As soon as practicable after disturbance complete as necessary: - Soil testing - Soil preparation - Restoration with appropriate tubestock *Rytidosperma sp*. to 40% density augmented with seeding	Progressively following construction activities Preferably in autumn	Wallaby grasses; *Rytidosperma carphoides*, *R. auriculata*, *R. setacea*, and *R. eriantha* to 40% densities and other NTG components that GSM show preference for or are suspected of using (Austrostipa for example)	After establishment of restoration native planning the specialist rehabilitation contractor will complete quarterly inspections involving additional planting, watering and weeding for at least one year.	Develop performance indicators around: - % C3 Cover - % native grass cover - Grass biomass - % bare ground - % exotics	MPC will be responsible managing rehabilitation contractor. Specialist rehabilitation contractor: responsible for preparation of land and planting of preferred grasses in disturbance areas. Responsible for providing reports after monitoring events of success/failure. ACT Government Environmental Offsets/Park – Responsible for overseeing results of quarterly inspections and providing advice and direction.	- Replanting native seeds if required. - Weed management if exotics spread into rehabilitation area
7	**Landscape establishment** Maintain plantings for not less than twelve months post planting	Up to 12 months post construction disturbance	Monitor to ensure plantings are adequately maintained and that maintenance is continuing for at least two years and until 85% of plants are established.	Post plantings for 2+ years	Plantings are adequately maintained and 85% of plants are established within 12 months post disturbance	Specialist rehabilitation contractor is responsible for preparation of land and planting of preferred grasses in disturbance areas. Responsible for providing reports after monitoring events of success/failure.	- If plantings are not adequately maintained, and suffer from attrition, replant, and review establishment care. - Non-Conformance Reporting
8	**Weed management** Undertake ongoing management of weed invasion (other than Chilean Needle Grass) within the restored areas. Focus towards known weeds that have the potential to invade including African Love Grass, Witch Grass and Madagascan Fireweed	Up to 3 years post construction disturbance	Monitor for weed invasion within the restored areas: - Establish two monitoring points in each of the two restoration areas - Monitor monthly for changes in weed status (compare to baseline surveys)	Quarterly.	No increase in weed abundance or number of weed species compared with baseline measurements.	MPC E&A will be responsible managing rehabilitation contractor. Specialist rehabilitation contractor: responsible for management of weeds. Responsible for providing reports after monitoring events of success/failure. ACT Government Environmental Offsets/Park – Responsible for overseeing results of quarterly inspections and providing advice and direction.	- Non-Conformance Reporting - Increase in weed management efforts

#	Action	Timing	Monitoring Requirements	Monitoring Timing	Performance Indicators	Responsibility	Corrective Action
9	**GSM and GSM habitat monitoring**	For 3 years post construction disturbance	The *Conservation Effectiveness Monitoring Program* (an overarching ecosystem condition monitoring framework) will be used to inform the specific monitoring requirements	Annually during GSM flying period between November and January Biannually after planting for first years then annually if native re-planting establishes	In addition to Action #5, consider further indicators utilised by the *Conservation Effectiveness Monitoring Program* (see Appendix A)	MPC E&A will be responsible managing specialist ecologists monitoring GSM population and habitat. Act Government Environmental Offsets/Park – Responsible for providing advice on monitoring findings	- Failure for GSM to recolonise restored areas will necessitate the procurement of additional offsets
10	**Population lift** Should GSM show no emergence after 3 years, consider translocation of ovipositing females from adjacent sites to the restored sites. Ensure any species translocated are within proximity to the project site to reduce the risks of disease or parasites.	Only to be considered 3 years post construction disturbance	Specialist ecologist to monitor GSM populations in the restoration areas.	Annually	Develop performance indicators around: - % C3 Cover - % native grass cover - Grass biomass - % bare ground - % exotics Which would indicate improved habitat for GSM.	MPC will be responsible managing specialist ecologists for translocation of GSM. ACT Government Environmental Offsets/Park – Responsible for overseeing and guiding translocation of GSM.	- Failure for GSM to recolonise restored areas will necessitate the procurement of additional offsets

5.1 Restoration Activities specific to the South East Clover Leaf

The disturbance area for the south east cloverleaf has been refined to ensure that the existing population of GSM will be maintained as much as possible. The area to be maintained is the north western section of the cloverleaf which can be seen in Figure 1 and is displayed as the no impact area. This area has been targeted to be retained as it has a higher proportion of Chilean Grass in comparison to the southern section adjacent to the disturbed area which has broad leaf grasses which are not a food source for the Golden Sun Moth. This will allow maintenance of the existing GSM population in this area where the remainder of the SE cloverleaf is being restored. At the conclusion of the disturbance the area impacted with be restored in line with the activities detailed in **Table 2.**

5.2 GSM Habitat restoration trial area

At the commencement of works Major Projects Canberra, in co-ordination with the Offset section of Parks, will implement a number of initiatives to target broad leaf exotic grasses, which are not favoured by GSM, and then re-instate native grasses which will promote GSM. As the impacts to the to the SE Cloverleaf will be the first activity of this project, to allow the relocation of utilities prior to the conducting civil works, this will be the area where initiatives are trialled. Measures which are deemed to be successful will then be implemented to restore impacted areas in Parkes Way where construction works will not happen until the final stage of the project. Identified trial areas can be seen in **Figure 1**.

Possible adaptive approaches within the trial area:

The trail area is small and only suitable for trailing one or two factors that could be manipulated. Two possible adaptive management approaches could be having different cover/heterogeneity amounts within the trial area and different irrigation treatments of the grasses.

An adaptive management approach to the heterogeneity/density of plants within plots could be undertaken to determine if GSM prefer different levels of heterogeneity of grasses. For example, at patchy arrangement of 80% grasses could be done in a proportion of the site and a more heterogenous arrangement of 50% cover of native GSM grasses / 50% bare ground. Depending on findings the cover variation or density of cover could increase. These two levels of heterogeneity/density levels will be trialled in Area A and B after targeted removal of broadleaf grasses as mentioned above.

An adaptive management approach to irrigation frequency and the effect on root extension in grasses could also be undertaken. GSM spend most of their life cycle underground feeding on grass roots. Having frequent and high amounts of irrigation and deficit irrigation (i.e. 13mm of water per week – enough to ensure survival) in half of the trial area. Differences in irrigation has been demonstrated to impact root extension. Depending on the method of watering the trial of this method could be dependent on gaining Works Approval from the National Capital Authority as there is not an existing water supply to the SE Cloverleaf. This approach is proposed to be trialed within the disturbance area with this section being broken up into two sections (north and south) after restoration activities have been undertaken in this area for a 12-month period and native grasses have returned.

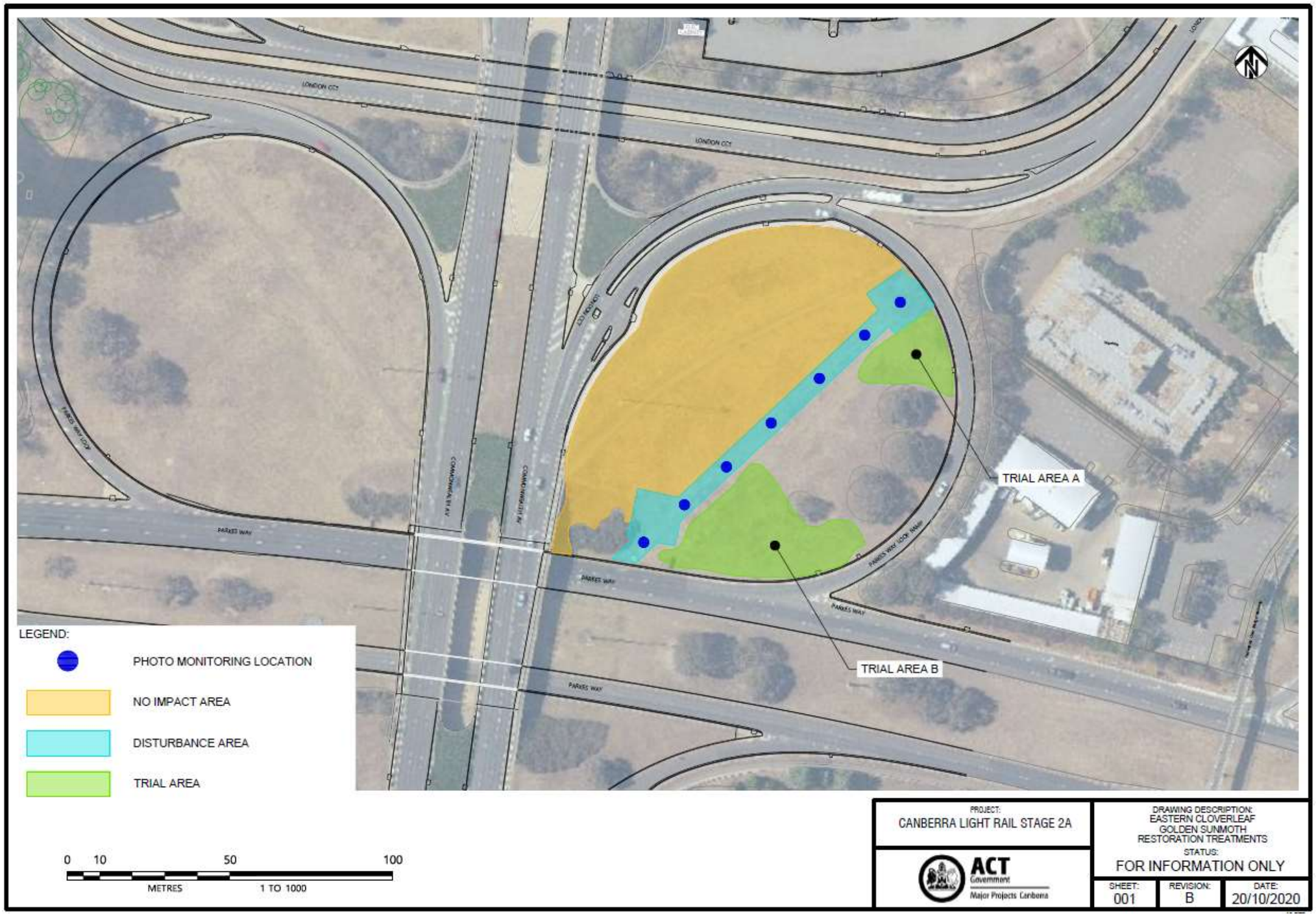

Figure 1: South East Cloverleaf

Appendix A

Conservation Effectiveness Monitoring Program (ACT Government, 2017)

ACT Government

CONSERVATION EFFECTIVENESS MONITORING PROGRAM: AN OVERVIEW

RENEE BRAWATA, BEN STEVENSON AND JULIAN SEDDON

Environment Division

Technical Report
April 2017

ACT Government
Environment, Planning and Sustainable Development

Title:

Conservation Effectiveness Monitoring Program: an overview

Environment Division

EPSDD

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http://www.environment.act.gov.au

Telephone: Access Canberra 13 22 81

Disclaimer

The views and opinions expressed in this report are those of the authors and do not necessarily represent the views, opinions or policy of funding bodies or participating member agencies or organisations.

Front cover (clockwise from left): Monitoring woodland flora; backpack electro fishing and strategic burning for grassland restoration. All Photographs: Conservation Research

CONTENTS

SUMMARY

The Conservation Effectiveness Monitoring Program (CEMP) is an overarching ecosystem condition monitoring framework for the ACT conservation estate. Monitoring is an integral part of evaluating the effectiveness of management actions in achieving nature conservation objectives. There are also many legislative, policy and management requirements for the ACT Government to monitor condition of biodiversity in nature reserves.

CEMP aims to create a coordinated, systematic, and robust biodiversity monitoring program that will allow us to detect changes in ecosystem condition within reserves, evaluate the effectiveness of management actions in achieving conservation outcomes and provide evidence to support land management decisions. A key component of the program is to develop monitoring plans for the eight identified ecosystem units within the ACT reserve system.

This document gives a brief summary of the purpose of CEMP and the rationale behind the adaptive management approach central to the CEMP framework. Its intent is to provide a background as to how and why the CEMP framework was developed including the choice to use ecosystem units to monitor changes in condition over time. Within this document the selection of indicators and metrics within an ecosystem is explained, in addition to a detailed summary of the symbology and classification used to report condition of indicators within ecosystem monitoring plans. The aim is to provide managers, contributors and other users with an easy to use resource that enables interpretation of symbology and summaries found in each of the CEMP ecosystem monitoring plans.

The CEMP reporting framework enables an assessment of the efficacy of management actions, identification of knowledge gaps and the prioritisation of future research. Through consolidating information on ecosystem condition and increasing accessibility of this information across ACT Government, CEMP aims to provide a data-rich decision support tool to inform strategic planning and assist management in conserving ecological values within the ACT reserve system.

1. INTRODUCTION

1.1 BACKGROUND

In Australia and internationally, natural resource agencies are increasingly embedding monitoring programs into reserve management to enable efficient evaluation of enhancement programs and actions (Parks Victoria, 2014b; Parks Victoria 2014a; Parks and Wildlife Service Tasmania 2014; WWF 2005; Hockings et al. 2013; Metsahallitus 2012; Gilliagan et al. 2005). Efficient and correctly established monitoring programs may also be used as a strong decision support tool (Lindenmayer and Likens 2010; Westgate et al. 2012), assist with ensuring effective resource allocation to programs (Hockings et al. 2006; Fancy et al. 2009), help improve park management planning (Vos et al. 1999; Hockings et al. 2006; Fancy et al. 2009) and may provide information suitable for engagement and education of stakeholders, thereby promoting appreciation of biodiversity values and fostering a conservation ethos in the broader community (Stevenson and Seddon, 2014).

Nature reserves, encompassing over half of the land area in the Australian Capital Territory (ACT), were established to protect the rich biodiversity values of the region and are managed by the ACT Government's Parks and Conservation Service (PCS). A 2011 investigation by the Commissioner for Sustainability and Environment into the Canberra Nature Park recommended that a nature reserve monitoring strategy be developed to ensure that threats to reserves were quickly identified, and that information was readily available to ensure better decision making in reserve management. For the purpose of this document, reserve areas refer to areas listed under the Territory Plan as national park, nature reserve, or wilderness area. They include Bimberi Wilderness Area, Canberra Nature Park (CNP), Googong Foreshores (GF), Jerrabomberra Wetlands (JW), Lower Cotter Catchment (LCC), Molonglo River Nature Park (MRNP), Mulligan's Flat Nature Reserve (MF), the Murrumbidgee River Corridor (MRC), Namadgi National Park (NNP), Tidbinbilla Nature Reserve (TNR) and all biodiversity offsets areas.

Stevenson and Seddon (2014) reviewed the extent and type of current monitoring programs across ACT reserves, and provided recommendations to improve the quality and sharing of information collected from these programs so that data may contribute meaningfully to reserve management. Stevenson and Seddon (2014) showed that while monitoring was taking place in ACT reserves, much of the data from these programs was not being collated and presented to reserve managers in a suitable format to inform decision making (Hockings et al. 2004). Additionally, monitoring of conservation outcomes and management actions were rarely linked; most management programs were evaluated by reporting on management actions as opposed to reporting changes in reserve condition or conservation outcomes. Other issues included a lack of coordination across monitoring programs (including the absence of formalised data collection, storage protocols and procedures), leading to an inconsistency of sampling methods between agencies; little integration of management actions and monitoring programs (including volunteer programs) and a large focus on mandated monitoring (such as threatened species monitoring conducted to meet legislative requirements) often providing little insight into the status of biodiversity more broadly. Such mandated monitoring is rarely driven by specific well formulated questions relevant to management with rigorous experimental design, therefore is usually ineffective for informing any meaningful management action (Lindenmayer & Likens, 2010).

Noting the presence of these issues in current monitoring, Stevenson and Seddon (2014) summarised the following important principles of effective monitoring and evaluation programs:

1. Management questions should inform research and monitoring. These questions need to be adaptive and may change over time;
2. Monitoring programs must include or be linked to evaluating conservation outcomes;
3. Conceptual models should be developed to build an understanding of ecosystem processes and relationships and to define critical assumptions;
4. All stakeholders must be engaged in the monitoring program to ensure acceptance;
5. Dedicated, on-going funding is required for biodiversity monitoring and evaluation;
6. Consistent and explicit monitoring protocols need to be developed and a program leader needs to oversee their implementation to maintain data integrity;
7. The monitoring program should use data from current monitoring programs where appropriate;
8. Systems must be developed to ensure the monitoring program is embedded as a land management decision support tool.

Adoption of these principles into a holistic monitoring program would enable a strong paradigm shift from mandate and reactive monitoring into an active adaptive management framework. In response to these findings, the ACT Government commenced the development of an overarching condition monitoring program for ACT nature reserves. The Conservation Effectiveness Monitoring Program (CEMP) was initiated to address the recommendations by the Commissioner for Sustainability and Environment (2011) and to incorporate improvements highlighted in the review by Stevenson & Seddon (2014). The overarching goals of the CEMP program were to:

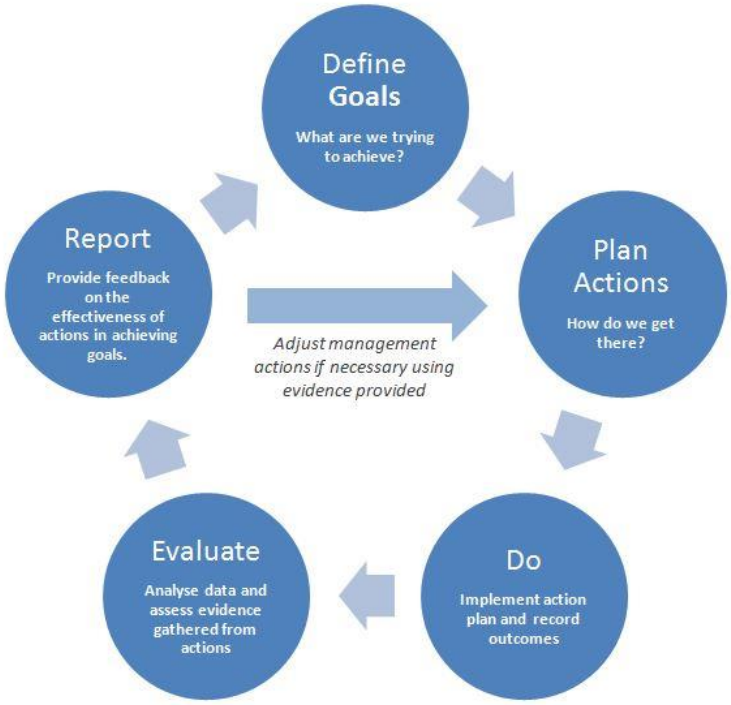
- Detect and report change in the condition of reserve ecosystems and the level of stress imposed by threatening processes;
- Evaluate the effectiveness of management actions at protecting and enhancing ecological values and reducing the impact of threats;
- Provide information to support evidence-based decision making;
- Identify knowledge gaps and areas requiring further targeted research and monitoring;
- Encourage ACT Government staff, community groups and research institutions to contribute towards biodiversity monitoring and research in nature reserves in the ACT.

The program would act as an important tool for evaluating the effectiveness of management actions in achieving conservation outcomes (Possingham et al. 2012); provide information to support land management decisions through evidence based assessment (Lindenmayer and Gibbons 2012) and help address the monitoring requirements of policy and management. A further desired outcome of the program was to develop a coordinated, systematic, and robust biodiversity monitoring program that enabled detection of early signs of change to reserve condition. In this way, the CEMP framework could provide the vital feedback linkages currently absent between management programs and monitoring to generate positive conservation outcomes (Reid et al. 2013).

1.2 THE ADAPTIVE MANAGEMENT CYCLE

An active adaptive management approach ensures management actions are constantly improved through an ongoing learning cycle that encourages research and investigation into best management practice (Allen, 2007; Hockings, et al., 2006). The stages of a typical adaptive management cycle involve recognition of what the desired achievement is (**Goal**), a plan on how this goal may be achieved (**Plan**), actions to carry out the plan (**Do**), a review or assessment on whether the actions achieved the goal (**Evaluate**), communication of this review to other stakeholders (**Report**) and then a decision to either adjust management actions (make a new **Plan**) or even adjust primary goals if necessary (Figure 1).

Figure 1. The stages of the adaptive management cycle as applicable to CEMP



Monitoring the effectiveness of management actions in achieving the stated **goals** is a key component of any adaptive management process (Hockings, et al., 2006). Protecting and conserving natural and ecological values, as defined in management and operational plans for ACT reserves, is the core business of the Environment Division of the ACT Government, Environment and Sustainable Development Directorate. While the Parks and Conservation Service (PCS) is the land management agency, the overarching **goals** are driven by statutory obligations that align with legislative requirements. Action **plans** (for example, action plans for a threatened species or the boarder Reserve Operational Plans (ROPs)) align with these **goals** and form the basis of reserve Plans of Management (POM).

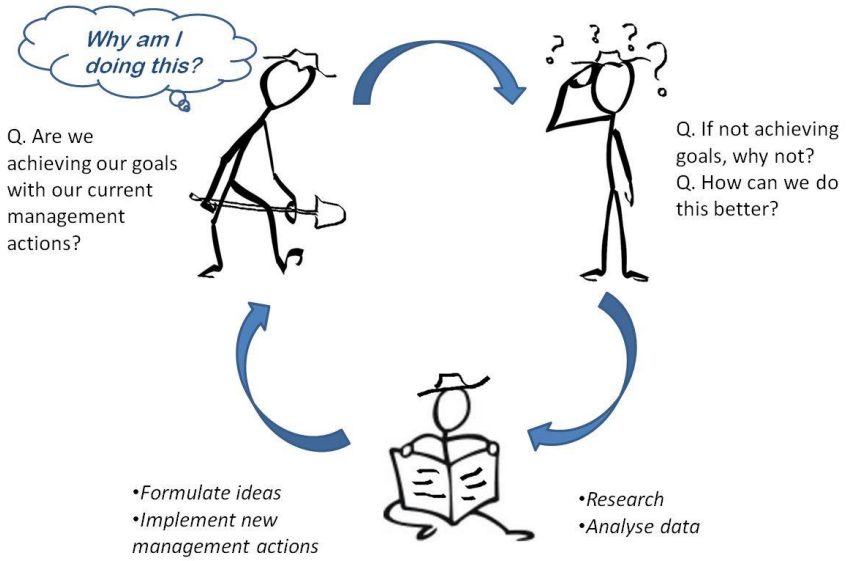
During the first stage of the CEMP program, a framework was developed to enable the systematic evaluation of the effectiveness of reserve management in the ACT. The framework was based on the adaptive management framework, where qualitative and quantitative information drawn from

current monitoring programs (the **Do** phase of the cycle) could be used to track progress toward achieving conservation **goals**. Using monitoring data, the framework could evaluate ecosystem condition and the effectiveness of reserve management programs in maintaining and/or enhancing natural values (the **Evaluate** phase). The outcomes of this process would then provide information, recommendations and feedback (the **Report** phase) to support adaptive, evidence-based decision making into the future (completion of the cycle back to the **Plan** phase) (Figure 1).

In this way CEMP aims to provided the **evaluation** and **reporting** capability for adaptive management by filling the currently missing links between the on the ground actions (the **Do** phase) and the **goal** setting and planning phases, for example by feeding into ROPs (the **Plan** phase) or helping to redefine strategic objectives. The review by Stevenson and Seddon (2014) showed that in the **Do** phase of the cycle, many current monitoring programs in ACT reserves only monitor trends in values of interest over time, with little or no data collected on possible causal agents and response to variations in management. There was also a lack of research questions and appropriate frameworks to focus monitoring efforts. CEMP aims to initiate the progression towards a more experimental approach to monitoring in the ACT through encouraging the simultaneous monitoring of probable causal agents, selecting monitoring sites that represent the variation in different management regimes and monitoring control sites in addition to sites where management actions are implemented (i.e. "active" adaptive management).

The information provided by the CEMP allows adaptation of management objectives and actions as the knowledge base increases, assisting in identifying research priorities and knowledge gaps and may assist in improving budgeting allocations over time to ensure resources are directed to priority programs and in ways that lead to improvements in the conservation values (Figure 2).

Figure 2. On-the-ground management and learning through doing in an adaptive management framework.



Biodiversity condition ↔ management and monitoring

How effective are our management programs in conserving our ecosystems?

2. AN ECOSYSTEM APPROACH

2.1 USING ECOSYSTEM UNITS IN THE CEMP FRAMEWORK

The review by Stevenson and Seddon (2014) highlighted the need to coordinate monitoring programs around explicit management questions derived from a conceptual understanding of the ecology of ACT ecosystems. The review recommended a framework for collecting and collating monitoring information using ecosystem units. The ecosystem units were broadly based on native vegetation formations identified by Keith (2004) in addition to management context. The combination of a management and ecosystems approach has the benefit of linking reserves with the broader landscape to promote a nil-tenure approach to natural resource monitoring, in addition to enabling a more targeted assessment of values, threats and processes specific to each ecosystem. Furthermore, this method provides increased synergies with statutory reporting requirements such as threatened species action plans (Stevenson and Seddon 2014).

Stevenson and Seddon (2014) identified eight ecosystems that were represented in ACT nature reserves. Most ecosystems were separated into either 'lowland' or 'upland' monitoring units to recognise the differing management needs and threats to the fragmented lowland communities of Canberra Nature Park compared to the more intact upland communities of Namadgi National Park, the Lower Cotter Catchment and Tidbinbilla Nature reserve. The following eight ecosystems are used in the CEMP program:

1. Lowland native grasslands
2. Lowland woodlands
3. Lowland forests
4. Aquatic and riparian ecosystems
5. Upland native grasslands
6. Upland woodlands
7. Upland forests
8. Upland bogs and fens

The CEMP project aims to development individual monitoring plans for these eight ecosystem monitoring units.

2.2 UNDERSTANDING ECOSYSTEM INTERACTIONS

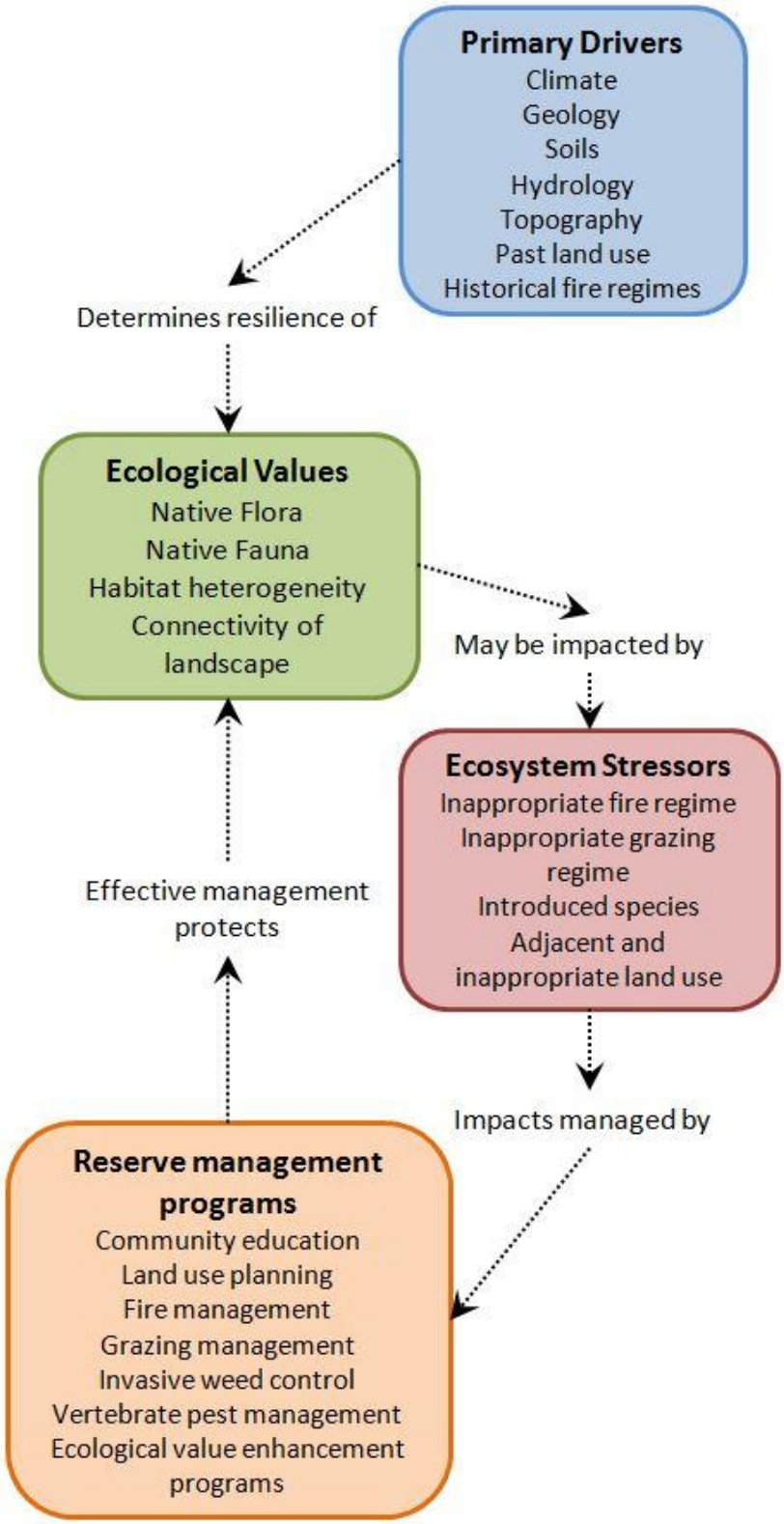
Monitoring ecosystem condition requires an understanding of the complex relationships and interactions between organisms and their environment. For each ecosystem, a conceptual model is created using an expert reference group. The conceptual model aims to demonstrate the current understanding of how the ecosystem functions and to identify the key influences that can potentially drive change in reserve condition. This includes defining key values, threats and interactions within each ecosystem.

For each ecosystem unit, CEMP incorporates a conceptual model of how primary drivers, ecological values, stressors and management programs interact and influence ecosystem condition within ACT nature reserves.

Key ecosystem influences, as derived from expert discussions, could be grouped into one of four categories: primary drivers, ecological values, ecosystem stressors and reserve management programs (Figure 3).

1. **Primary drivers:** These are the natural ecological drivers or historical processes that determine the distribution, composition and structure of ecosystems. In many cases they are the processes maintaining ecosystems in their natural states. Measures of primary drivers may include elements of landscape dynamics or climatic variation.
2. **Ecological values:** These are the biological and physical environmental characteristics contained within ACT nature reserves that the ACT Government identifies as core values for conservation and key for healthy ecosystem function. In the CEMP reporting, ecological values are used to derive the ecosystem condition indicators and metrics. Ecological values typically include native flora and fauna, habitat and connectivity of the landscape.
3. **Ecosystem stressors:** These are the threatening processes in ecosystems that are suspected to elicit change in the condition of the ecological values of the ecosystem. Protection and conservation of ecological values requires the identification and management of threat agents and processes that may impact and stress ecological values. Most management actions aim at reducing the level of stress posed by threatening processes. Specific ecosystem stressors may include pressures such as weeds, pest animals, inappropriate fire regimes, grazing, urban development, recreation, disease, and climate change.
4. **Reserve management programs:** These are the land management actions that aim to eliminate or reduce the impact of ecosystem stressors on ecological values. They can be reactive, such as pest management, or proactive, such as land use planning and community education programs.

Figure 3. A cyclic model showing the interactions between primary drivers, ecological values, ecosystem stressors and reserve management programs in a CEMP ecosystem unit.



3. MONITORING ECOSYSTEM CONDITION

3.1 SELECTING INDICATORS TO MONITOR ECOSYSTEM CONDITION

Indicators are being increasingly used by management agencies to provide information about changes in condition of protected areas. Measurement and monitoring of all ecosystem components is impossible, therefore indicators are often used as "measurable surrogates", providing a low cost and time efficient method for monitoring ecosystem health and the influence of disturbance over time (Carignan and Villard 2002; Fancy et al. 2009; Lindenmayer 1999; Niemi and McDonald 2004; Noss 1990; Noss 1999). Given the limited resources available for a detailed monitoring program in the ACT, the use of indicators is a resource efficient method of monitoring ecosystem condition over the longer term.

Within CEMP ecosystem monitoring plans, indicators are used to capture current knowledge about the relevant ecosystem and to provide a measurement of ecosystem condition. In biodiversity assessment, indicators may take many forms, and include entities such as species, ecosystems or processes. Two types of indicators are used in the CEMP monitoring plans; ecosystem condition indicators and ecosystem stressors. Ecosystem condition indicators report on the state of ecological values within an ecosystem, while ecosystem stressor indicators identify threats and effectiveness of management programs at reducing these threats. The combined use of these two types of indicators enables assessment of effectiveness of management actions aimed at reducing threatening processes and maintaining or enhancing reserve condition.

Ensuring indicators used in monitoring programs are representative of ecosystem condition is challenging (Dale and Beyeler 2001; Fancy et al. 2009; Noss 1999). In selecting indicators, the ecological values, threatening processes and what ecosystem functions play a key role in ecosystem health need to be identified for each ecosystem unit (see section 2.1). Indicator selection can then be informed and validated by expert opinion, peer-review literature or management experience. The indicators used in the CEMP monitoring plans are selected by members of an expert reference group associated with each ecosystem. Expert reference groups comprise of researchers, ecologists, land managers and community group representatives.

During a workshop, the expert reference group for each ecosystem unit propose a list of indicators which are then assessed for suitability against the following criteria:

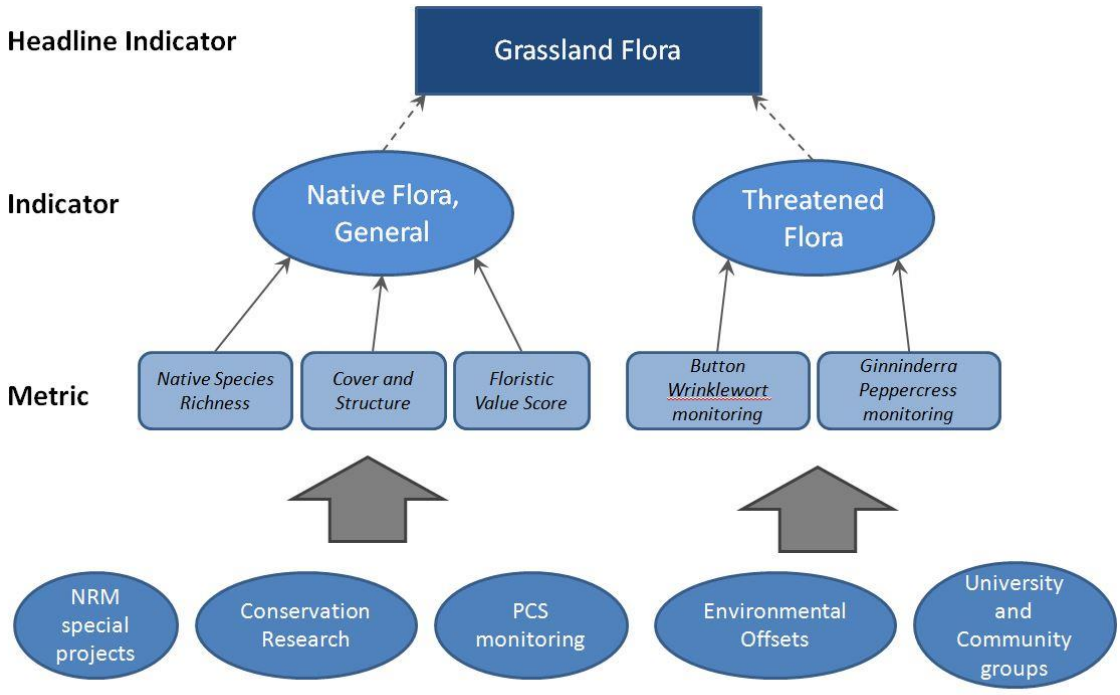
1. Can the indicator be accurately measured quantitatively?
2. Is the indicator ecologically responsive and sensitive to change?
3. Can the influence of natural processes on the indicator be separated from that of management actions (i.e. Can we determine the mechanism of change)?
4. Is the indicator informative to land managers, so that changes to management actions may affect desired conservation outcomes?
5. Is measuring the indicator logistically feasible, cost effective and within current resource availability?
6. Does the indicator meet a management need to capture current knowledge and/or fulfil statutory monitoring requirements?

The sensitivity of an indicator is not always known prior to monitoring; knowledge of how well an indicator detects change in ecosystem condition often emerges over time. In light of this, CEMP evaluates and reviews the contribution of both indicators and metrics each reporting cycle.

Following the expert reference group workshop and choice of indicators for each ecosystem, a four-tiered structure is used to help further define selected indicators and determine how they can be measured to assess ecosystem condition. The four components of the indicator structure developed (Figure 4) are:

1. **Indicator type**: Two types of indicators are used – ecosystem condition indicators and ecosystem stressor indicators.
2. **Headline Indicator**: Each indicator belongs to a headline indicator, which enables the grouping of indicators into broad categories. Examples of a headline indicator may be flora or fauna.
3. **Indicators:** Indicators are monitored and assessed in each ecosystem to provide an indication of change in condition. Examples of indicators might be a threatened ecological community or introduced predators.
4. **Metrics**: Metrics are used as the data sources to measure the condition of each indicator. There may be more than one metric contributing to each indicator.

Figure 4. A diagram showing the upwards flow of information from monitoring and research programs that contribute data to metrics, which in turn inform indicators for ecosystem condition assessment. The example shown is for two ecosystem condition indicators in the Lowland Native Grassland Ecosystem unit; Native Flora (General) and Threatened Flora, which are grouped together under the Grassland Flora headline indicator.



3.2 CLASSIFICATION OF METRIC ATTRIBUTES

Metrics are the 'measurable entities' that are used to provide data to inform indicator condition in CEMP. For example, the condition of the indicator 'Native Flora (general)' in the Lowland Native Grassland Ecosystem Monitoring Plan may be measured in various ways, such as by assessing native species richness, cover and structure of major functional groups or the floristic value score of grasslands. These are just some of the ways to 'measure' grassland flora health. Similarly, the indicator of 'Threatened Flora' may be measured by choosing some representative species and assessing changes in abundance and distribution in response to management actions (Figure 4).

For each ecosystem unit, CEMP initially used information from pre-existing monitoring programs that had data on metrics which could be aligned with chosen indicators. The use of existing monitoring programs enabled an assessment of the amount and quality of pre-existing quantitative data, in addition to a preliminary assessment as to where current knowledge gaps and data deficiencies were. For each ecosystem unit plan, additional, new metrics were suggested where data gaps were strongly apparent.

Once indicators and associated metrics were decided upon for each ecosystem unit, CEMP conducted an analysis of available data for each metric to determine its' condition within the ecosystem. In order to provide accurate information with repeatable measurements so that metric condition (and therefore indicator and ecosystem condition) could be tracked over time and compared between reporting cycles, metrics were required to have a clear, concise and repeatable method for measurement and analysis of data. To ensure this, metrics were defined using a number of different attributes (Table 1).

The first step was to define in detail what data populated each metric and how they would be assessed. This was termed the 'metric assessment' (Table 1) and examples included changes in abundance, richness or area or distribution.

To capture how important each metric was to informing the relevant indicator and thus ecosystem condition, metrics were ranked against five criteria and given a rating or "class" associated with its ranking; either "core", "mandate" or "minor" (Table 1). To determine the metric rating we considered whether:

1. There is a large risk to the ecological value represented by the metric, indicator and/or ecosystem function associated with incorrect /absent management strategies;
2. The cost of managing and monitoring the metric is acceptable and achievable;
3. There exists a long term data set that forms solid baseline data from which future research questions can be effectively derived;
4. There is uncertainty surrounding the best management practice for the ecological value represented by the metric;
5. The species or community impacted is threatened (therefore must be monitored under statutory obligations) or is little known.

Table 1. Metric attributes and associated definitions.

Metric Attribute	Definition
Metric name and associated indicator or stressor	The metric name and number. The metric number indicates whether the metric contributes data towards a condition (C) indicator or a stressor (S).
Summary and condition report	A summary of the findings for the condition, trend and data confidence for the metric applicable to the current CEMP report.
Metric Assessment	The method by which the metric is assessed, such as increase in area, richness, abundance or diversity over time.
Class	The three classes include core (usually long-term monitoring programs or key ecosystem function), mandate (usually a threatened species monitored through statutory requirements) or a minor metric.
Category	The ACT monitoring category; whether the indicator or stressor is monitored under a statutory obligations under the *Nature Conservation Act 2014* or the *Environment Protection and Biodiversity Conservation Act 1999* or is a non-statutory monitoring program.
Primary Drivers	Primary natural drivers such as climate and land use history, which are identified as interacting with the indicator as shown in the conceptual model relevant to the ecosystem.
Associated condition indicators	Related ecosystem condition indicators identified as interacting with the metric as shown in the conceptual model relevant to the ecosystem.
Associated stressors	Related ecosystem stressors identified as interacting with the metric as found by the conceptual model relevant to the ecosystem.
Rationale	An explanation of the rationale behind the inclusion of the metric e.g. statutory monitoring, high priority for management.
Projects contributing to metric	Which projects and/or organisations (within ACT government or otherwise) have monitoring programs that contribute data to inform the metric.
Periodicity	How often the data will contribute to CEMP reporting.
Baseline	The data used as the reference or baseline condition of the indicator or stressor e.g. the first survey or control plots.
Reference Condition	The original (modelled or data-derived) condition of the indicator prior to large scale modern anthropogenic disturbance. A detailed description is given section 3.3 of this document.
Target Condition	When maintenance or restoration of reference condition cannot be feasibly achieved, the target condition is used to provide a meaningful goal for management actions to aim towards over the medium term (10+ years).
Trigger point(s) for management	A pre-defined point for management intervention. For example, if population decline of a threatened species is found to be greater than 30% over two years, then a particular response may be triggered.
Qualitative input	Identified any expert opinion, observational data or other qualitative input that informs the metric. Source of expertise is identified.
Future research questions, management directions, knowledge gaps and recommendations:	A practical outcome of the assessment including data gaps, priorities for management or information/data needs relating to the indicator or stressor.

Metrics meeting three or more of the first four criteria are classed as “core” metrics. Most metrics that are placed in the “core” category included those with consistent methods and long-term datasets. Metrics that meet condition five are classed as “mandate” while all others are placed in the “minor” category.

Each metric was assigned an ACT monitoring category to indicate whether it was monitored under statutory requirements. The primary drivers associated with each metric were identified, as were other condition indicators and stressors that would interact with each metric and associated indicator. The rationale behind the inclusion of the metric was explained, contributing projects (including the use of expert advice) were identified and how often the metric would be assessed (periodicity) was listed (Table 1). Four important metric attributes were the baseline, reference condition, target condition and trigger points, and these are explained in more detail in section 3.3 below. The final attribute for each metric was the recommendations on future research priorities and management directions as an outcome of the metric condition assessment (see section 4).

3.3 WHO PROVIDES DATA TO INFORM CEMP METRICS?

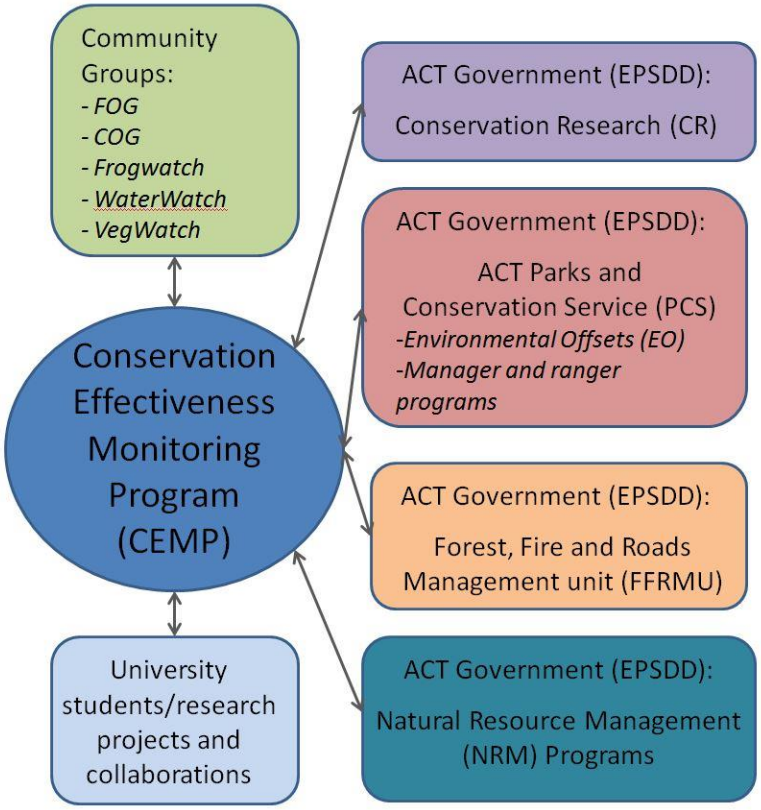
As metrics may be informed by a number of different monitoring programs or research projects, for the purpose of assessing the quality and relevance of data, monitoring and research programs contributing to each metric are defined by different attributes (Table 2). These include location of study sites, duration of program, methods used and sampling design as well as information including the program name, primary contact position, data storage, reporting schedules and specific research questions to inform users of CEMP reports of the origins of data informing the metrics. These data appear in the appendix of each ecosystem monitoring plan.

Information to inform CEMP metrics and associated indicators is collected from Government and non-Government monitoring programs, research projects and surveys. CEMP draws on data collected during monitoring and research programs conducted by ACT Government as well as relevant external research and monitoring conducted by universities and community groups (Figure 5). This provides an opportunity to coordinate and integrate monitoring efforts across government, research institutions and community groups, and to capture the best information available to support adaptive, evidence-based decision making.

Table 2: Attributes of contributing programs and corresponding definitions.

Program Attribute	Definition
Program name and affiliated projects	The name of the monitoring program/research project and the organisation or group from which it is run, in addition to any affiliated projects.
Sites	Locations from which data is collected.
Measured attributes	The variables within the metric that are measured representing numerical or categorical data that could be used in analyses.
Monitors action or asset	Whether or not the monitoring is focused on recording only changes in the entity that is directly managed (action) and/or monitors the ecological asset or value to be conserved.
Management/research questions (project specific)	Specified management questions that the research project or monitoring is aimed at answering.
Type of monitoring:	Defined as one or more of four types of monitoring: opportunistic/ad-hoc, qualitative surveys, mandate monitoring or research project.
Temporal scale:	The length of time the monitoring or research program has run, or is intended to run, defined as one of three categories: long (> 10 years), medium (5-10 years) or short (<5 years) term.
Monitoring period:	The period of time over which the monitoring has taken place (for example from 2008-current day), with any missed sampling periods identified.
Sampling intervals	How often the monitoring takes place, for example, annually during October, or biannually during summer and spring.
Sampling methods:	What sampling methods are used, and if sampling methods have changed over the monitoring period. For example transects, spotlighting, trapping, point observation.
Data type	The data that is collected, for example presence/absence, number of individuals, qualitative.
Spatial data available	Spatial locations of research and monitoring plots should be available on ArcGIS Online "Research and Monitoring plots" file (CR administration), where applicable.
Confidence in data	A three-tiered system (Low, Moderate or High; see section 4.1 of this document) measuring the rigour of data collected by the monitoring program or research project.
Data storage and availability	The location that the data is stored in (either ACT Government or external), when data becomes available (if cyclic) and any prior agreements with external parties to access the data.
Reporting schedule	When reports/up-to-date data are to be available from the project or monitoring program, including if not immediately available or if cyclic.
Contact	The primary contact for the monitoring program or project, including ACT Government department, external organisation and position.

Figure 5: Framework to show contributors to data sources collated by CEMP. Information from programs feed into CEMP, which in turn provides feedback on management actions and future research priorities.



3.4 BASELINES, REFERENCE CONDITION, TARGET CONDITION AND TRIGGER POINTS

Key attributes of metrics are the **baseline, reference condition** and where applicable, **target condition** and associated **trigger points**.

The **baseline** refers to the initial condition from which any change in condition, including an increasing, stable or declining trend, can be measured. For many metrics the results from the first survey are used as a baseline, or alternatively the first data contributing to CEMP are used. This is particularly the case where large changes in methods used have taken place that compromised the ability to use historical data to compare changes over time. For research projects with a robust experimental design, data from control plots were are as a baseline.

The **reference condition** is defined as the ideal condition of the metric reflecting a relatively intact ecosystem. Reference conditions are sometimes called 'benchmarks' and relate to the natural range of variability of an ecosystem. Depending on the scale at which data was collected for the metric, reference condition is defined in one of three ways. The three data scales identified in CEMP are:

1) **Spatial data collected at the landscape scale (e.g. extent, connectivity):** To establish the reference condition for spatial metrics assessed at a landscape scale CEMP used the known or estimated (modelled) distribution prior to recent modern anthropogenic changes to the landscape. For example, the reference condition for Natural Temperate Grassland (NTG) extent would be the distribution of NTG prior to clearing and development of the area associated with European settlement. The connectivity of the metric at a landscape scale could also be assessed and compared to the level of connectivity in the intact or pre-modified condition.

2) **Data collected at the plot or site scale (e.g. species assemblage or structural attributes): F**or metrics sampled at the plot or site scale, such as species assemblages, richness, or biodiversity surrogates such as habitat and vegetation structural attributes. For these metrics we selected local sites which were most representative of an "intact" community (i.e. minimal disturbance by recent modern anthropogenic changes) and measured the metric at those sites (Gibbons & Freudenberger 2006). We then took either the average measurement or create a range (typically $\pm$ 1 SE) to establish reference condition for that metric. The use of a range rather than an absolute value for the reference condition allowed for natural variability between sites in addition to accommodating climatic and seasonal variations.

3) **Data collected on single species populations (e.g. threatened species):** The third and final way of establishing reference condition is for single species data, which usually applies to mandate monitoring of threatened species or monitoring of vertebrate pests. For native species data CEMP uses the IUCN Red List category for the species in the ACT as the current condition compared to the reference condition. IUCN ratings take into account abundance, geographic extent and number of populations of the species. (IUCN 2008). For vertebrate pests and introduced species, the reference condition is zero.

The **target condition** is established for metrics where the reference condition is, in all practical terms, beyond the ability of management to achieve, and represents medium-term goals for management to work towards. For example, the return of NTG to its pre-modern anthropogenic change extent of 15,000 ha may be the reference condition for a metric measuring NTG extent, but is an unrealistic target for management. A more achievable goal may be to increase the quality of 5% of native pasture to NTG status over 10 years and avoid any net loss of extent from current levels. The target condition for metrics are established with extensive consultation with managers, and can be adjusted over time as increased knowledge of the ecosystem is available and better adaptive management outcomes are obtained.

Trigger points are used in some metrics to define recognisable points (thresholds) above or below which a change in management should be triggered. For example, when the estimated population density of a threatened species falls below a certain number (e.g. <500 animals) a pre-determined management response may be initiated. Trigger points enable adjustment to management actions prior to poor condition being reached, with an upper or lower trigger point used where appropriate. For metrics without substantial data sets or expert knowledge, the definition of a meaningful trigger point is difficult to allocate. In the first CEMP report for each ecosystem unit, the trigger points for some metrics are defined as 'To Be Advised' (TBA) until further knowledge is gained that can assist in the establishment of meaningful trigger points and associated management response.

4. ASSESSING ECOSYSTEM CONDITION

4.1 DEFINING 'CONDITION'

For the purpose of the CEMP program, monitoring ecological condition refers to the measuring of the biodiversity values within the ecosystem (Keith and Gorrod 2006). This may include metrics that measure structure, function or composition of the ecosystem at various scales (Noss 1990). To monitor ecosystem condition CEMP measures changes in select indicators and associated metrics within an ecosystem. The first step of assessing the condition of metrics (and consequently related indicators) involves the review of information from current monitoring programs as per each metric assessment definition (Table 1). The condition of each metric/indicator is a relative state; it is assessed and defined relative to the 'baseline' and against the 'reference condition' and 'target condition' over time (see section 3.3 of this document).

Three elements of condition are assessed to determine the overall condition grading for each metric. **Condition/state** is the current condition of the metric relative to the prescribed reference condition; **condition trend** is the current condition compared to the baseline condition (i.e. whether condition is improving, stable or declining over time) and **data confidence** refers to how confident we are in the accuracy of the data informing condition/state and trend. These three elements of overall condition are defined as follows:

1) **Condition/state**: In this assessment the term 'condition' refers to the health of ecological values, while the term 'state' refers to the status of ecological stressors. The condition or state of a metric is assessed relative to an identified acceptable condition or state (the reference condition or target condition).

   Specific criteria for ranking condition or state have been established for different data types. The scaling of condition for spatial metrics was adapted from McIvor and McIntyre (2002) and condition assessments for population metrics used listing categories in the IUCN Red List (IUCN 2008).

   Condition/state of a metric or indicator may be one of four levels as follows:

   a. Good condition refers to a situation where the condition of ecosystem values and processes are close to or above the reference condition and where the negative impacts of threatening processes are limited or successfully controlled by management actions. The quantitative assessment of 'good' condition in CEMP reporting is defined as equal to or above 75% of reference condition for spatial data, equal to or above reference condition for plot data, and for individual species data the population meets criteria for not being listed in the IUCN Red List and is stable.

   b. Good with some concerns indicates overall condition of the metric/indicator is good, but there are some sites or attributes that need improvement or do not meet the 'good condition' criteria and condition is therefore below reference condition. The quantitative assessment of 'good with some concerns' condition in CEMP reporting is defined as being

greater than 60% but less than 75% of reference condition for spatial data, within one statistical range of variability (e.g. standard deviation or standard error) from reference condition (defined for each metric) for plot data, and for individual species data the population meets criteria for not being listed in the IUCN Red List, but is declining and/or is uncommon and data deficient.

c. Moderate condition indicates that values within the ecosystem are showing signs of degradation and management actions need to be implemented as a priority to restore condition and to prevent further loss of condition. The quantitative assessment of 'moderate' condition in CEMP reporting is defined as being between greater than 45% but less than 60% of reference condition for spatial data, within two statistical ranges of variability from reference condition for plot data, and for individual species data the population meets criteria for being listed as Vulnerable in the IUCN Red List.

d. Poor condition indicates the indicator is not managed or management has been ineffective, placing a significant threat on the ecosystem values. Changes to management should be of high priority; in some cases data deficiency on threatening process will lead to a poor rating. The quantitative assessment of 'poor' condition in CEMP reporting is defined as being between less than 45% of reference condition for spatial data, outside of two statistical ranges of variability from reference condition for plot data, and for individual species data the population meets criteria for being listed as Endangered or Critically Endangered in the IUCN Red List.

The scaling system used for condition assessment of metrics and associated indicators in CEMP is based on a "traffic -light" system adapted from the US State of the Parks Report (see https://www.nps.gov/stateoftheparks), and the Queensland National Parks key park values rating system (http://www.npsr.qld.gov.au). The Queensland National Parks key park values rating system identifies a four tiered colour-coded indicator system adapted from the IUCN World Heritage Outlook (2014) (see http://www.worldheritageoutlook.iucn.org). In this system, 'good' condition/state is denoted using dark green, light green denotes generally good condition with some concerns, amber denotes moderate condition while red is used to show very poor condition of metrics/indicators (Figure 6).

2) **Condition trend:** Condition trend is the direction of change in condition over time, which may be one of three states: positive, negative or stable. Current condition of an ecosystem is assessed and compared to a previously determined state ('baseline'). In the CEMP program condition trend is indicated by a directional arrow located within the colour-coded symbol. Up arrows indicate an increase in condition over time as shown by the data, while a downwards arrow indicates a decrease in condition. A sideways arrow is used to indicate that the condition of the metric/indicator is stable (Figure 6).

3) **Data confidence**: The data confidence rating evaluates the ability to draw both statistical and causal inference from the data, reflecting the robustness of sampling methods used and therefore is an indication of the accuracy of and ability to be confident in the condition/state and trend rating given to each metric. The data confidence rating may be one of four ratings:

a. High: This confidence level is given when data is sourced from monitoring and/or research that used proven field methods and robust sampling designs, such as the use of many sites (replication), randomisation of site locations and the use of control plots.

b. Medium: This rating is given where monitoring has taken place over a long period of time, but may have inconsistencies in methods over this period, a change of study sites or minimum experimental design underpinning the methods used (e.g. many mandate monitoring programs) and with some, but limited, replication and randomisation.

c. Low: This rating was given where study sites are severely limited (minimal replication), no experimental design was used, there may have been large changes to the field methods used or study sites (inconsistency of methods), no randomisation and/or unproven sampling methods were used.

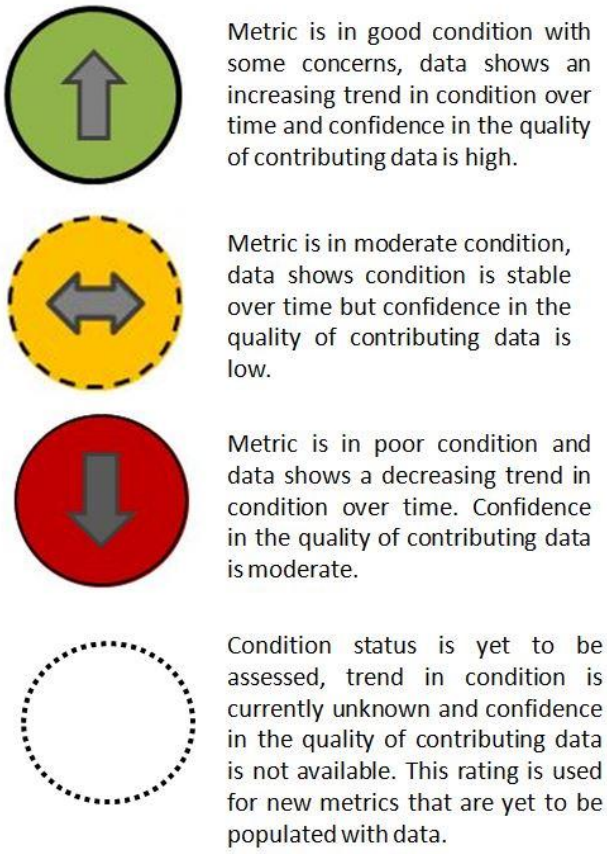
d. Unknown: Data confidence is unknown due to no information on data type. This category is often used for new metrics, where a data confidence rating will be assigned in the next reporting cycle. (Figure 6).

Figure 6. Levels and corresponding symbology for condition/state, condition trend and data confidence used in the CEMP program.

Condition/State		Condition Trend		Data Confidence	
	Indicator is in good condition		Condition of the indicator is improving		Confidence in condition assessment is high
	Indicator is in good condition with some concerns		Condition of the indicator is stable		Confidence in condition assessment is moderate
	Indicator is in moderate condition with a number of concerns		Condition of the indicator is declining		Confidence in condition assessment is low
	Indicator is in poor condition with many significant concerns		(Blank) Trend in the condition of the indicator is unknown		Confidence in condition assessment is not available

Examples of combinations of symbols used for reporting overall condition are shown in Figure 7. These represent the combined assessment of condition/state, condition trend and data confidence.

Figure 7. Examples of overall condition assessment symbology for metrics and indicators used in the CEMP reporting framework.



When each contributing metric has been assessed for condition/state, the outcomes are 'rolled-up' to inform the condition/state of the relevant indicator. The process of 'rolling-up' of metric data to get the overall condition/state grading follows an averaging process. Each condition/state is given a numeric value as follows: 'Good'=4, 'Good with some concerns'=3, 'Moderate'=2 and 'Poor'=1. As the number of metrics informing indicator condition/state varies between indicators, the total sum of all the metric conditions is calculated then averaged by the number of contributing metrics. For example, an indicator with four metrics with conditions 'Good' (4), 'Good with some concerns' (3), 'Moderate' (2) and 'Good with some concerns' (3) respectively, would lead to an indicator condition/state of 4+3+2+3=12/4=3, which gives an indicator condition assessment of 'Good with some concerns'. In a case of the final value containing a half (e.g. 2.5), a conservative approach is taken and the indicator condition/state is rounded down to the lower grading (e.g. 2.5 is lowered to 2= 'Moderate'). Examples of metric condition/state combinations and the 'rolled-up' overall indicator condition/state are shown in Figure 8.

Figure 8. 'Rolling-up' the data - table showing various combinations of metric conditions and outcomes for the condition of the relevant indication they inform, following an averaging process.

	Metric 1	Metric 2	Metric 3	Metric 4	Overall Indicator Grading
1	Good	Good with some concerns	Moderate	Good with some concerns	Good with some concerns
2	Good with some concerns	Poor	Moderate	Good	Moderate
3	Moderate	Good with some concerns	Poor		Moderate
4	Poor	Moderate	Moderate	Poor	Poor
5	Good	Good with some concerns			Good with some concerns
6	Good	Good	Moderate		Good with some concerns
7	Moderate	Moderate	Good with some concerns		Moderate

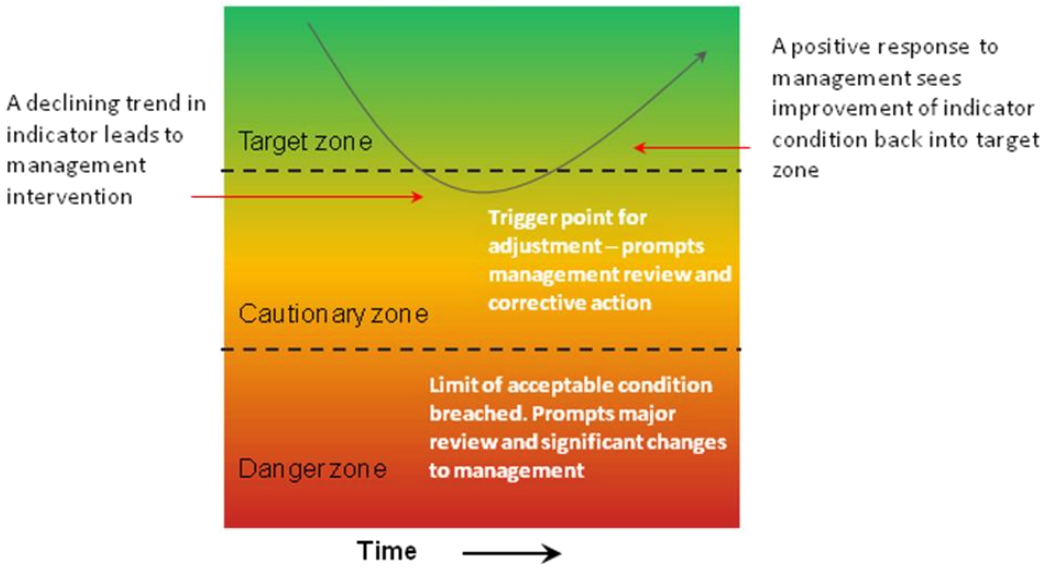
The same process of averaging used to assess indicator condition/state is repeated for condition trend ('Improving'=3, 'Stable'=2 or 'Declining'=1) and data confidence ('High'=3, 'Moderate'=2 and 'Low'=1). These two assessments are then combined with the condition/state of the indicator to inform the overall indicator condition.

4.2 COMBINING CONDITION ASSESSMENT WITH REFERENCE CONDITION AND TARGET CONDITION

CEMP modified the principles of 'Target zones', 'Cautionary zones' and unacceptable 'Danger zones' presented in Jones (2009) to tie together results of condition assessment with reference/target condition and trigger points. This method provides the ability to identify quantifiable thresholds in condition that 'trigger' a review of management actions when breached, thus enabling management to act prior to poor condition being reached (Figure 9).

For example, if indicator condition is within the target zone defined for that indicator (such as 'good' condition/state with a stable or improving trend – see section 4.1 of this document), management actions are adequate and the desired outcomes are being achieved. However, if the condition of the indicator is declining, its condition may soon pass a defined trigger point into the 'Cautionary zone'. Such an outcome would initiate changes to management actions (Figure 9) that may be reviewed in the next CEMP reporting cycle. For example, for a particular species, a trigger point may be a population that is a given amount above the minimum viable population for that species. The actual minimum viable population represents the limit of acceptable condition beyond which the indicator enters the 'Danger zone' and requires immediate review and significant changes to be made to management (Figure 9). One current issue is that trigger points for many metrics are either unknown or based on expert opinion due to lack of data. Part of the CEMP process is to highlight research and knowledge gaps so that trigger points for each metric can eventually be derived from data and sound knowledge of the ecosystem.

Figure 9. The conceptual relationship between the condition/state of an indicator, its reference condition or target condition and trigger points that lead to a change in management actions. Adapted from Jones (2009).



5. REPORTING OUTCOMES, EVALUATION AND OTHER CONSIDERATIONS

The CEMP's primary role is to consolidate information on ecosystem condition, thereby providing a data-rich decision support tool to inform management actions. It is important therefore, that a reporting mechanism relevant to the temporal scale of both the indicators and current management programs be established. To meet this need, the CEMP program aims to hold annual update workshops with reserve managers in addition to formal reporting cycles, with ecosystem condition reports for each ecosystem unit produced once every three years. The purpose of CEMP ecosystem reports will be primarily to help inform management actions in conserving ecological values within the ACT reserve system, however, this timeframe will also compliment other existing ACT Government commitments for reporting on biodiversity conservation outcomes that inform strategic planning and policy development such as State of the Environment reporting (SOE), Reserve Operational Plans (ROP), State of the Forests reporting (SOF), the Biodiversity Research and Monitoring Program (BRAMP) and ACT Government Nature Conservation Strategy reporting (NCS).

The structure of the CEMP reporting framework, including the use of assessment summaries and symbology to represent indicator condition (see Section 4 of this document), aims to be both informative and user-friendly. The CEMP ecosystem reports also include graphs and relevant summaries of the data behind each condition assessment for transparency of reporting and providing access to data (including links to data sets) for those readers that require more detailed information. Publishing ecosystem reports online via an intranet Hub would allow an increase in accessibility to general staff and should be considered. It is hoped that through such a reporting structure, the CEMP program will achieve higher visibility generally and encourage greater collaboration between ecologists, planners and managers through linking research prioritisation, strategic planning and management actions. The CEMP reports may also be used to recognise and promote partnerships with citizen science and external organisations that have contributed monitoring data, or may wish to contribute in the future.

A review of monitoring in ACT reserves by Stevenson and Seddon (2014) revealed that monitoring generally did not record conservation gains in response to management actions, and that consequently many current monitoring programs were "data rich but information poor" (Lindenmayer and Likens, 2010). Monitoring programs that fail to provide useful information that links management and conservation outcomes will be highlighted in the CEMP report for each ecosystem unit, with the view to re-evaluating and/or re-designing such monitoring programs through the addition of question driven monitoring with robust experimental design. In many cases this may mean adding value to current "mandate" monitoring through supplementary research projects in order to address specific management questions. By addressing such limitations, there will be a shift towards monitoring uncertainty around management efficacy and a greater focus on ensuring monitoring remains relevant to conservation goals (including overarching policy requirements) and management priorities.

A further aim of CEMP is to identify gaps in our current knowledge pertaining to the management of ecosystem units, therefore it is important that the CEMP reporting framework contains a section

that highlights these gaps and prioritises future research that addresses them. In addition to providing a mechanism for feeding in new projects to address knowledge gaps, a future research section within each ecosystem report aids in adjusting priority questions as new information emerges (adaptive management) and incorporating new conservation ideas that may have strong community and political support. This includes the ability to accommodate short term research projects, often associated with opportunistic funding, into the reporting framework.

Another issue with current monitoring programs, as identified by Stevenson and Seddon (2014), is that data is not always collected in a consistent manner over time or across organisations. Changes to study sites, field methods or the scale of data collection poses difficulties for latter data analysis and undermines confidence in results. Turnover in personnel responsible for monitoring programs and rapid changes in technology may result in inconsistent sampling methods over time, threatening data quality and consistency. The systematic approach of the CEMP framework enables the standardisation of protocols that are important for maintaining data integrity. CEMP project officers have liaised extensively to assist with achieving consistency between projects in monitoring of metrics, field methods used for data collection and to ensure management implications are considered in new programs.

CEMP also requires an ability to adapt as our knowledge base increases and new technologies become available (e.g. LIDAR, remote sensing, Collector app.). The ability of the CEMP program to incorporate multiple research projects into metrics provides a mechanism for bringing in new data collection techniques. Additional methods can be incorporated into the CEMP program to compliment standardised data whilst ensuring consistency between reporting cycles. The need to ensure data integrity across the CEMP program, in addition to promoting increased accessibility of information across agencies, has led to the idea of a centralised database for maintaining integrity of data for contributing metrics.

Other protected area management agencies in Australia have found a key element to ensure the long-term accessibility and participation in monitoring programs is the involvement of rangers and field staff (Parks and Wildlife Service, 2013). It is critically important that staff managing reserves feel involved, are able to contribute knowledge to the CEMP program (e.g. suggest areas of management uncertainty or future monitoring sites), understand its value in assisting management and consequently maintain a vested interest in collecting accurate monitoring records. Funding and logistical requirements for the CEMP program need to consider existing time demands on field staff, in addition to establishing robust protocols for the transfer of relevant skills in order to manage the high turnover of field personnel and to ensure information flow is retained on monitoring programs.

Finally, the efficacy of management actions, in terms of both achieving management goals and cost effectiveness, needs to be established. The CEMP assessment of ecosystem condition may be combined with budgeting to generate an assessment of the cost-effectiveness of management actions. A cost/benefit analysis (CBA) could consider the ecological risk vs. management cost when there is uncertainty of best practice and to assist in the prioritisation of management actions. Where monitoring data shows no measurable improvement in the ecosystem values and/or a CBA indicates management is not cost effective at achieving conservation goals, alternate management options should be considered.

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