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Scoping climate-ready management of Eastern Suburbs Banksia Scrub in Queens Park, Sydney

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Cover photo

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Contents

Glossary

Term	Description
BS	Bird Sanctuary ESBS site, in Centennial Park
CPMPT	Centennial Park & Moore Park Trust
EEC	Endangered Ecological Community
ESBS	Eastern Suburbs Banksia Scrub ecological community
ESBS provenances	Individuals of ESBS species sourced from ESBS sites
ESBS species	Species that occur in ESBS communities. These species also occur in other ecological communities; this term does not distinguish between the different provenances
Local provenances	Individuals (genetic material) from a specific site
Non-ESBS provenances	Individuals of ESBS species sourced from non-ESBS sites
QP	Queens Park ESBS site, in Queens Park adjacent to Centennial Park
vrk	Values, rules and knowledge, as key components of the societal context shaping the choices available to decision makers
YR	York Road ESBS site which is adjacent to Moriah College, across the road from Centennial Park

Abstract

This report describes an analysis, conducted using the *Climate-ready biodiversity management* tool, of an endangered ecological community in an urban setting that is vulnerable to climate change. It then presents a case for a new style of project that specifically seeks to drive learning across different groups in society, to evolve preferences, stimulate changes in rules and create new understanding, that in turn enables new options for managing the site, the ecological community more generally, and indeed other threatened ecological communities in the face of climate change.

Eastern Suburbs Banksia Scrub (ESBS) is a very restricted endangered ecological community (EEC), occurring in several remnants in Sydney's east, including in Queens Park, adjacent to Centennial Park. The ESBS community only occurs on a highly restricted soil type, although most of the species typical of ESBS are much more widespread. Conservation concern for ESBS, like many restoration projects Australia-wide, revolves around maintaining the local provenances (varieties) that occur on, and are presumably adapted to, the local soil type. As well as being a remnant of an EEC, the site is valued by the community in a wide range of ways connected to different aspects of its naturalness.

Climate change in combination with existing site factors may make the current restoration objective hard to achieve and maintain in the long term. However, the analysis revealed that it may be quite feasible to maintain most of the other societal values for the site even in the face of significant climate-driven ecological changes. This potentially includes maintaining a community of ESBS species, if not of local provenances. However, achieving all of these objectives, including the non-local provenances of ESBS species, would require a series of changes in management of the site. The analysis identified multiple potential barriers to change, spanning values, rules and knowledge. These include, for example, key questions such as what would or should the legal status of the site be if it were no longer dominated by *naturally occurring local provenances* of ESBS species? What if it became dominated by other native species? Importantly, the analysis identified that the potential barriers arise from many different sources, including the land management agencies, State government, management contractors, the professional bush regeneration community, local conservation volunteers, residents, and the ecological research community.

The analysis then scoped a series of small scale experimental interventions that could readily be trialled by the current managers with targeted partners, selected due to their connection to potential barriers. These interventions were designed to stimulate specific learning to address key barriers that stakeholders and managers might experience in the future as they decide how to manage ESBS at this and other sites. Furthermore, addressing these barriers for ESBS will help stimulate changes in values, rules and knowledge needed to create options for other EECs across NSW and Australia in the face of significant climate change.

Summary

Eastern Suburbs Banksia Scrub (ESBS) is a very restricted Endangered Ecological Community (EEC), occurring in several remnants between North Head and Botany Bay in eastern Sydney. The species typically occurring in ESBS are widespread, but the ESBS community is defined by a very restricted and particularly nutrient poor soil type. Conservation concern for ESBS revolves around the remaining remnants and maintaining the provenances (varieties) of those species that occur on, and are presumably adapted to, that soil type.

Maintaining local provenances of species is a high conservation priority and a core principle of bush regeneration and ecological restoration across the country. The issue of maintaining provenances is founded on a desire to maintain genetic distinctiveness, but also avoid loss of vigour that might result from local provenances breeding with provenances from elsewhere that may not be compatible or adapted to local conditions. As well as these technical considerations, there are strong values and norms around using local provenances.

This study focuses on the ESBS site in Queens Park (QP), adjacent to Centennial Park, Sydney, which is managed by Centennial Park & Moore Park Trust (CPMPT). The site is valued by the community in many other ways, well beyond being a remnant of ESBS, in fact most people are completely unaware of the current management focus. The study used CSIRO's *Climate-ready biodiversity management* tool through two one-day workshops hosted by Waverley Council and including a range of partners who are involved in managing the site.

The ESBS community is regarded as particularly vulnerable to climate change due to its very limited north–south range, challenging the concept of a conservation objective seeking to preserve the site at a historic baseline. Other values are much less vulnerable, most of which could be obtained to some extent through accommodating climate-driven ecological change.

If ESBS provenances cease being viable at ESBS sites as a result of climate change, there would be significant challenges for current conservation principles. There are no clear alternatives that would be readily available to managers: any potentially effective alternative conservation approaches have barriers associated with values, rules and/or knowledge. The pathway towards overcoming these barriers and developing alternative conservation approaches will need to balance multiple perspectives to maintain support from experts and the local community; for example, the strict view of the ESBS vegetation type compared with the broader view of native bushland and open space.

The QP site is in much poorer condition than two neighbouring ESBS sites and the two larger sites elsewhere in Sydney. There are only a small number of remnant species present, a large number of plants are becoming senescent and there is a high density of weed species. In 2016 land managers created a buffer of non-ESBS native vegetation to protect the site. The site receives a moderate amount of weed control and removal of leaf litter in order to stimulate natural regeneration.

Given the QP site is in relatively poor condition, there may be an opportunity, in the medium term, to use the site to experiment with alternative approaches to managing ESBS

before changes might be needed at other sites. Proposed experiments could be specifically designed to start addressing barriers associated with values (the preferences of various stakeholders) and rules (multiple polices, guidelines and norms), as well as knowledge. However, before experimenting with alternative management at QP, managers and stakeholders would need to be more confident that the site does not have the capacity to naturally regenerate to a 'good condition' ESBS. So near-term management priorities are likely to focus on testing the extent to which more intensive application of best practice management (including weeding, litter removal and fire) might lead to significant natural regeneration. If this is not evident, and there is support for experimentation, then a sequence of options might be available including:

- Plant non-local ESBS provenances (from other ESBS sites)
- Non-ESBS provenances (ESBS species sourced from non-ESBS sites)
- Other native species (not ESBS species)
- Increasing the area of the site.

These options could be refined in the near term through experimentation at ex-ESBS sites, that is, locations with suitable ESBS soils but with no remnant ESBS vegetation.

These new approaches to managing ESBS sites would raise a series of challenging values, rules and knowledge questions, such as:

- How do these options change the values of the site for different stakeholders?
- What are the various regulatory consequences? How do these options change the status of the site, once it is no longer 'remnant EEC'? Could it lose legal protection, despite remaining just as valued by the broader community? How might the definition of 'protected ecological community' need to change to accommodate ecological transformation, whether natural or augmented by management intervention?
- What management approaches (which species, how managed, when) might be most effective at maintaining community values for the site with least management intervention? Or what sequence of interventions, with what triggers to change might be needed?

Experimentation at the QP site might help address these questions in a proactive and controlled manner, leading changes in preferences and policies that create conservation management options that can be implemented readily when needed at the other, higher conservation value, ESBS sites. Furthermore, addressing these questions for ESBS will help stimulate the changes needed to create options for other EECs across NSW and Australia.

Part B of the report provides a rationale and outline for a project designed to progress the evolution of the social, institutional and technical dimensions of managing ESBS or any other EEC facing transformation. It does so through a series of strategically designed small-scale interventions to probe anticipated barriers to managing EEC differently. Doing this with selected partners will provide targeted learning experiences to inform future legal and policy reforms, shape preferences and stimulate research necessary to create the opportunity for new management of current EEC sites that is viable in the long term.

PART A: CLIMATE-READY ANALYSIS – SCOPING A PATHWAY TOWARDS LONG-TERM MANAGEMENT OF THE QUEENS PARK EASTERN SUBURBS BANKSIA SCRUB SITE

1. Introduction

This report focuses on options for the future management of the Queens Park remnant of Eastern Suburbs Banksia Scrub (ESBS). It is a degraded remnant of a highly restricted and endangered ecological community[1] (EEC) in a popular park. It currently faces significant management challenges. Climate change could make management of this site even more challenging, and will also affect other less degraded ESBS sites. Many of the challenges of managing ESBS under climate change are shared by other EECs.

The project used a 'climate-ready' process to explore options, and in particular how current management can be adapted to create future management options for this and other sites. This took place over two one-day workshops conducted with the site managers and using the *Climate-ready biodiversity management* tool (Dunlop & Ryan 2016), which was developed by CSIRO with Sydney Coastal Councils Group. The climate-ready analysis (Part A) was conducted during the workshop and augmented afterwards. This information was then used to develop a 'business case' for a potential project to reduce barriers and underpin future management (Part B). The business case is supported by the analysis but can be read on its own. Together these provide a case study of using the climate-ready tool and provide an illustration of how it can be used to scope a novel type of climate adaptation project.

The climate-ready process uses the *adaptation pathways* approach to climate adaptation, which places emphasis on decision making in the face of climate and societal uncertainty, rather than focusing on impacts (Wise et al. 2004; Gorddard et al. 2016; Wyborn et al. 2016). Similar approaches have recently been applied to conservation decision making in a number of settings in Australia (Dunlop et al. 2013, 2016; Bosomworth et al. 2015), including with the Sydney Coastal Councils Group.

The first part of this report summarise the analysis of the Queens Park ESBS site. The structure follows the steps of the *Climate-ready biodiversity management* tool: section 2 describes the context including multiple values, and current objectives and management; section 3 describes possible long-term ecological changes driven by climate change; section 4 explores possible future climate-ready objectives and associated management; section 5 describes key uncertainties; and section 6 outlines possible barriers to adopting the climate-ready objectives and management. The content that is described in sections 2 to 6 was primarily derived from the two one-day workshops that were conducted in February and March 2017 with staff from Waverley Council, Centennial Park Moore Park Trust (CPMPT) and the bush regeneration contractors who help manage the site. Some additions and corrections to the content were subsequently made by the project team and participants.

[1] On 1 December 2017 ESBS was reclassified as a Critically Endangered Ecological Community. We retain the designation EEC in this report as that reflects its status at the time of the analysis.

More complete reporting of the workshop deliberations is included in the tables in the Appendix.

A box is included, at the end of each section, with the relevant part of the workshop agenda and some facilitation guidance for people wishing to run their own climate-ready workshops. In addition, as the process uses concepts that are likely to be new to some participants, facilitators should summarise the progression of ideas before moving to the next stage, and periodically ask participants to reflect on the extent to which they are thinking differently about the issue and about how they feel about it.

Key questions that arose during the course of the climate-ready analysis of ESBS in the workshops are noted as follows:

- *Q: If land managers recognise that conserving vegetation to a pre-climate-change baseline becomes unviable, how can they revise their conservation objectives and management practices to become more 'climate ready'?*

These questions reflect many of the issues that managers and other stakeholders may need to address before they can adapt the management of ESBS sites as they experience significant ecological change resulting from climate change. The project outlined in Part B is specifically designed to help start addressing a range of these issues.

2. Queens Park ESBS: current state and context

This analysis focuses on the Queens Park ESBS site (QP), but it does so in the context of the neighbouring Bird Sanctuary (BS) and York Road (YR) sites, which are in much better condition, and other ESBS sites in the region. The analysis was also conducted recognising that many other EECs and other ecological communities will share similar future management issues to those being identified for ESBS.

Context

Eastern Suburbs Banksia Scrub (ESBS) is a very restricted Endangered Ecological Community (EEC), occurring in several remnants in eastern Sydney (NSW Scientific Committee 2017). The ESBS community has a characteristic relative abundance of species, however the species occurring in ESBS typically also occur in other coast heath vegetation types, which are widespread along the east coast. ESBS specifically occurs on a very restricted soil type made up of aeolian sands (ancient wind-blown sand) that are particularly nutrient poor. Between 3% and 9% of the original extent of ESBS currently exists (NSW Scientific Committee 2017). It occurs in a number of very small and often degraded remnants in the highly developed eastern suburbs of Sydney, with larger patches at North Head, Botany Bay and La Perouse, which are managed by the NSW National Park and Wildlife Service.

Within the Centennial Parklands, Sydney, there are six patches of ESBS, the most significant being the YR, BS and QP remnants. Over the past 15 years the YR remnant has been completely regenerated from soil seedbank after having been planted to Radiata pine in 1945. The BS remnant has similarly been regenerated from soil seedbank after previously being highly degraded, planted to exotics and colonised by weeds. Both of these sites have restricted access and have received intense 'best practice' bush regeneration by contractors and a group of dedicated volunteers.

This analysis focuses on a small, degraded, highly used, remnant of ESBS on the corner of Queens Park, adjacent to Centennial Park. The site is owned by CPMPT under state legislation and is within the Waverley Local Government Area. It is managed cooperatively, and contributes to Waverley Council's 'improve the condition of native remnants' target. The YR and QP ESBS sites are the only EEC remnants in the Waverley Council area. Unlike the YR and BS ESBS sites, the QP site is not fenced and has numerous informal pathways.

Conservation concern for the ESBS ecological community revolves around protecting the remaining remnants and maintaining the provenances (varieties) of those species that occur on, and presumably are adapted to, its characteristic soil type.

Maintaining local provenances of species is a high conservation priority and a core principle of bush regeneration and ecological restoration across the country (see Box 1). The issue of maintaining provenances is founded on a desire to maintain genetic distinctiveness, but also to avoid loss of vigour that might result from local provenances breeding with provenances from elsewhere that may not be compatible or adapted to local conditions. As well as these technical considerations, there are strong values and norms around using local provenances in bush regeneration practice.

The site is small and isolated, and has been classified as being in 'very poor' condition (Sydney Bush Regeneration Company 2015). It is currently characterised by a small number of ESBS species (five), aging and senescing trees, no recruitment of new ESBS species from the soil seedbank, no dispersal from nearby ESBS sites, little to no establishment of seedlings from existing plants, and a high density of weed species. The site has not experienced the extent of managed burning that has encouraged recruitment at other sites. It is affected by exotic grass and other weed colonisation, which is periodically controlled by spraying or hand weeding. It is disturbed by rabbits, dogs and people. Phytophthora is present in Centennial Parklands and is a risk in the ESBS sites.

The QP and BS sites are within Centennial Parklands which is a very well used multi-use open space, popular with walkers, for dog exercise, personal trainers, and organised sport. The Parklands have heritage significance including extensive Victorian gardens and ponds. They were protected in 1850 to protect Sydney's water supply (Busby's Bore) after the Tank Stream became polluted. This included construction of a fence to restrict access, which is reputed to have caused a riot!

The ESBS community is one of many EEC in the country. The social and institutional challenges associated with managing ESBS sites in the face of transformational climate change will be very similar to those for other EEC, other matters of environmental significance covered by State and Commonwealth legislation, and other ecological communities more generally. This project provides an opportunity to reveal and explore those issues. Further, the experiences gained through implementation of the adaptation pathways developed in this project, particularly in relation to shifting values and changing rules, should help drive changes in the decision-making context necessary to enable new approaches to managing other EEC and conservation issues effectively in the face of significant climate change.

Box 1. Consideration of provenance in ecological restoration

'Provenance' in ecological restoration refers to the population from which an individual derives. For many people it has become synonymous with local adaptation, that is, the belief that plants from local populations will always outperform plants from distant populations when planted together.

Provenance can be important for conservation for a variety of reasons including avoiding outbreeding depression (which can occur when two divergent populations are brought together and their offspring are less fit than either parent), disruptions to local adaptation (through introduction of genes that are less suited to local conditions), and introduction of weedy genotypes (Broadhurst et al. 2008).

Maintaining the integrity of local provenances has been a strong focus of bush regeneration and threatened species management, and in many situations there remains considerable resistance to planting non-local provenance plants. Some bush regeneration prescriptions recommend relying entirely on local seedbanks, discouraging any deliberate introduction of seed or plants derived from other populations. Other strategies do include deliberately using a mix of seed sources (Broadhurst et al. 2012).

However, in small and isolated populations, there is also the risk of inbreeding depression, that is, the accumulation of deleterious mutations and loss of genetic diversity that leads to lower seed production and reduced seedling vigour. Reduced genetic diversity may also result in less scope to cope with environmental change and limited genetic material for natural selection to act on. Generally, inbreeding is now regarded as more of a risk in fragmented landscapes than outbreeding depression. Indeed 'genetic rescue' is now a priority strategy for many isolated small populations. Further, to account for climate change, recent advice proposes using a mix of local provenances and seed from additional populations including ones that may be better adapted to future climates (Prober et al. 2015; Broadhurst et al. *In press*).

For this analysis we used the following definitions:

- *ESBS species* = Species that occur in ESBS communities, regardless of whether the individual plants in question derive from an ESBS population or another community where the species also occurs naturally
- *Local provenances* = Individuals (genetic material) from a specific site
- *ESBS provenances* = Individuals sourced from ESBS sites
- *Non-ESBS provenances* = Individuals of species found in ESBS but sourced from non-ESBS sites.

Values

The native vegetation on Queens Park is highly valued for a range of different reasons that are important to different groups.

It is a remnant of ESBS, a highly restricted EEC. The value of it as ESBS is intimately connected to the local provenances on site, and the fact that, despite being highly modified

and in very poor condition, it has the integrity of being a natural remnant rather than a reconstructed or planted community.

- *Q: Is it a 'remnant' if plants are actively planted in it? Does it make a difference if the planted individuals are from already present species or absent species?*

The QP site is also valued by the community for multiple other reasons. In fact it is likely that most people are completely unaware that ESBS exists as a community, that the site is a remnant of an EEC or of the current management focus.

The site is clearly wanted and valued by the community, but it is not clear what aspects of the site they value or what it is about the site they might want preserved in the long term. Specifically, it is unclear the extent to which people view and value the site as remnant native vegetation. People do show an appreciation for the 'natural' feel of the area, and ask questions when weed control or other management is occurring on the site. Safety and aesthetics are issues for the community; they probably prefer open vegetation, as opposed to closed scrub, and may desire lighting for safe evening use, for example dog walking.

The ecological health of the site is valued. Managers seek to improve the condition of the site from its current 'very poor' condition, rated against benchmark for ESBS. The community too are believed to care about the ecological health of the site, showing interest in the management being undertaken.

The setting of the site, very close to the CBD of the largest city in Australia, contributes significantly to how it is seen and valued. It is a patch of native vegetation within a larger complex of grassed open space, surrounded by high-density residential and commercial development. This setting emphasises the contrast between the natural aspects of the site and the extensive transformation of the rest of the landscape, and contributes to the very heavy use and visitation of the broader site by a large range of people. Uses on the immediate site include passive recreation, walking, off-leash dog exercise, and even the production of music videos. The surrounding parklands have a large number of playing fields, paths, fitness stations and cliffs. These are used for walking, running, dog walking, bike riding, by personal trainers and for bouldering (rock climbing). The area is extremely popular on weekends.

Current management objective

Workshop participants formulated the following objective for the site: *Good quality, stable remnant of native vegetation that is owned by the community.*
Where:

- good quality: species diversity (greater than 15 species characteristic of ESBS); regeneration is occurring (due to a good seedbank); low weed cover (<20%); showing immediate positive response management (e.g. fire, raking)
- stable: requiring less management inputs over time, as it increases in quality
- remnant native vegetation: specifically, Eastern Suburbs Banksia Scrub
- owned: locals and visitors like the vegetation on site and have a strong connection in part due to the ESBS community.

This objective represents the combined intent of numerous existing ESBS plans (Australian and NSW Government, CPMPT), Waverley Council targets for remnant vegetation, the Centennial Parklands and York Road Eastern Suburbs Banksia Scrub Vegetation Management Plan and best practice bush regeneration. It represents the aspiration of the staff responsible for QP ESBS from Waverley Council and CPMPT. It had not previously been documented explicitly in this way.

Current management

The current approach to managing QP and neighbouring BS and YR ESBS sites is to use 'best practice' bush regeneration that involves works to actively encourage natural germination and growth from the existing seedbank. This includes weeding, removal of leaf litter (ESBS naturally has areas of exposed sand), fire and control of public access. In the recent past the BS and YR sites have received intensive management including planned fire, and responded very well to these treatments.

The QP site has been a lower priority than the other sites as it is more degraded, has a very low number of ESBS species, and has a more challenging physical layout, being less naturally contained and experiencing higher usage. It is currently maintained with a low to medium level of restoration activity conducted on an opportunistic basis, including grass mowing, some weed control, occasional litter removal and a planted buffer of non-ESBS native plants. It has experienced a very small arson fire, after which there was very limited seedling emergence. With this low level management and regular human use the site is showing no signs of recovery. Given its condition, it is uncertain how it may respond to more intensive management.

Proposed (near-term) management

Actions that are planned or proposed to achieve the objective include weeding as the highest priority, litter removal (raking) and controlled fire. Ideally disturbance would be controlled by fencing, but this is unlikely at this site. Managers hope that this management would be sufficient to stimulate natural regeneration, as has been experienced at YR.

- *Q: Will more intensive best practice stimulate regeneration?*

If this is not successful, current management could be adapted to include more direct methods to increase the richness and cover of ESBS species and add genetic diversity. This could include seeding or planting ESBS provenances of species not currently on the site; starting with flowering herbs may increase the aesthetic appeal of the site. The number of individuals and genetic diversity of existing species could also be augmented with stock from ESBS provenances from nearby sites.

- *Q: Is it still a 'native remnant' if planted with non-local stock?*
- *Q: Which stakeholders would know or care about the difference? Would it have the same legal status for protection and funding priority?*
- *Q: For how long might this supplementation be effective?*

Current barriers to management

Barriers to impending *new* approaches to managing a site are a key part of the climate-ready process. The *Climate-ready biodiversity management* tool does not explicitly elicit barriers that managers are *currently* experiencing, however many of these barriers were raised in the workshop and a range of them are reported here. These include:

- QP is likely to be below the ecological threshold to recover with best practice, although this has not been tested.
- Sufficient funding for increased management may not be received, as the QP site is a lower priority than other sites and likely to require relatively more effort to regenerate.
- Limited existing climate change planning for the site or the community which has a particularly small north–south range (22 km).

A1. Agenda extract and notes

Time (mins)	Session	Description
10	Welcome	• Introductions & Overview of day • Ethics (how the information participants provide will be used)
10	Overview of climate-ready thinking	• Presentation introducing the core climate-ready concepts: o Overall ('wedges' diagram, pathway) o Futures: Large change, uncertainty, multiple values: 'climate-ready objectives' o Adapting: Making different decisions, barriers, 'values-rules-knowledge' (vrk), learning now to enable change later
60	Queens Park Eastern Suburbs Banksia Scrub	Presentation by land manager and wide ranging discussion about the current context of the site, covering ecological, governance and societal dimensions, including multiple reasons the site is valued by different communities and what aspects they specifically value. ❖ Fill in ***Table A1*** (or take notes and fill in table later) ❖ Synthesise as an ***Initial problem statement***

Current barriers

In general we expect barriers to future changes in management to be more substantial but possibly easier to eventually overcome (e.g., changes in stakeholder preference; new techniques) than barriers to current management which may be more fundamental, deeply entrenched or involve harder trade-offs (e.g., ecological limits, limited budgets). Current barriers are listed to acknowledge them, however (for the climate adaptation analysis) the later activities should focus on anticipated barriers to changing management in the future.

Uncertainty

Uncertainty pervades consideration of ecosystem management and climate impacts and adaptation. The climate-ready process is specifically designed to cut through most of the uncertainty. Throughout the analysis participants will raise important uncertainties, these can be captured on a designated sheet (***Table A2***) and checked at various times.

3. Long-term ecological changes facing the QP site and ESBS in the region

The site potentially faces two main causes of ecological change, the current decline spiral and climate change.

Continuation of current 'decline spiral'

- There is very limited scope to increase the extent of ESBS in the landscape due to development for roads, buildings, facilities and conversion to other forms of open space.
- Seedbanks at QP are likely to be poor and declining in quality and diversity. Mature shrubs are senescing, and less able to contribute to seedbanks, and there is little to no emergence of seedlings that will contribute to seed quantity or diversity in the future.
- Lack of fire and other recruitment triggers, combined with simplification and loss of seedbank, is reducing any limited potential there may be for recruitment of existing or new ESBS species.
- Declining native vegetation enables weed establishment.
- Weed establishment, canopy closure (due to shrub maturity and lack of disturbance) and litter accumulation further restricts recruitment opportunities from any latent seedbank.

Future climate-driven ecological change

Workshop participants were not aware of any detailed information about how ESBS species might be affected by climate change. However, there was much discussion drawing on their observations of the responses of ESBS to past climatic events. It was anticipated that:

- hotter temperatures may initially favour native species, as weeds suffer more in summer
- drying and a change in seasonality (more summer rain) could significantly affect species on the site. The current native vegetation did suffer in the last drought, with grasses more affected than shrubs. Young plants often die off if the soil dries out.

In addition, there is a general expectation that the majority of ecosystems across Australia will experience increasing turnover in species compositing (loss of resident species and gain of new ones) and change in the ecological community type (Dunlop et al. 2012), and there is no reason to expect ESBS species to be less sensitive. The complexity of anticipating species turnover at this site is amplified by uncertainty about the detail of future species changes, the association of ESBS with a very specific soil type and uncertainty about local adaptation of provenances to that soil type. It is unclear whether ESBS provenances and species might be able to successfully establish (naturally or assisted) in different locations that become more climatically suitable. Similarly, it is unclear whether lack of specific adaptation to the soil type, or lack of mycorrhizal fungi, will limit the ability of other native species to establish successfully in the site as it becomes more climatically suitable for them.

Impact on valued aspects of QP

The biodiversity of the QP site can be considered in a range of different ways, each corresponding to different values associated with the site, as noted above. The 'change-persistence table' (Table 1) explores how different aspects of the site (rows) might be affected by climate change (second column), and what attributes might persist despite those changes (third column). Annotations on the table indicate how community connection to the site might be affected by climate change.

This analysis highlights that the anticipated ecological change is in conflict with the traditional conservation objective of seeking to maintain a historical baseline (be that composition at 1750 or any more recent benchmark). In contrast, most of the other aspects of the site that contribute to it being valued by the community may be much less affected by climate change. Some changes in management may be needed to accommodate or even facilitate ecological change in such a way to ensure those aspects can persist.

This analysis shows that significant ecological change should not be equated with total loss of ecological value of the site; in the face of change there is a very real prospect that *some if not most of the biodiversity values of the site could be retained with suitable management.* Interestingly, however, the analysis elicited some degree of dissonance or regret in some participants by revealing that much of the community value for the site may not be intimately connected to its current designated ecological type, ESBS, its rarity and designation as EEC.

Table 1 Change-persistence table for the Queens Park ESBS site. The annotations indicate the extent to which the aspects that are valued by different groups may be lost (♥) or persist (♥) through anticipated ecological change; smaller symbols represent possibly smaller change. The table was developed with participants in the first workshop, modified by the project team, then presented and confirmed at the second workshop. (This corresponds to Table 4 in the Climate-ready biodiversity management *tool.)*

1. ASPECT OF BIODIVERSITY / NATURAL FEATURE Relevant stakeholder	2. … ATTRIBUTES OF THIS ASPECT THAT MIGHT CHANGE	3. … ATTRIBUTES OF THIS ASPECT THAT COULD PERSIST
Location Residents	Appearance of vegetation, species present (including native and exotic), abundance, cover, structure.	The physical place will remain ♥
Soil type Specialists, staff.	No change.	Aeolian sands characteristic of ESBS ♥
ESBS species (QP provenances) Specialists, staff. People of NSW.	Significant reduction of local provenances of ESBS species. Potentially first replaced by other provenances, then other species. ♥	Provenances lost from site, possibly established and persist elsewhere. ♥
ESBS species (non-ESBS provenances) Bushcare, staff. People with good knowledge of native species.	Change in provenances. Eventually, gradually, change in species; replaced by other native vegetation.	ESBS species could persist on site, initially. ESBS species persist elsewhere as very widespread. ♥
Native vegetation Residents; Bushcare, staff; People with knowledge of native species	Change in species composition and vegetation structure. Loss of ESBS replaced by other native vegetation.	Native vegetation. Potentially in good condition: diverse, regenerating, low weed presence. ♥
Native-feeling vegetation Residents; visitors; staff; People with passing knowledge of native species	Dominance of native understory lost (or not established if there is none now).	Native trees and shrubs, some native understory. ♥ Complement to built-up areas and other open space in the parklands. ♥
Dog walking habitat Dog walkers (dogs)	Change in specific plant species.	Open vegetation with mix of trees and shrubs
Trees elsewhere in Queens Park Residents, visitors	Types of trees. Possible loss of some significant types e.g. figs would be missed. ♥	Suitable density, size, mix of native and exotic trees, providing shade and aesthetics. ♥
Trees on the QP ESBS site Residents, staff	Loss of local trees. ♥ Expansion of non-local/non-native trees.	Diversity, cover, abundance of trees ♥
Birds Residents, staff, visitors, birdwatchers	Types of birds resident and visiting. Richness may decrease ♥ or increase ♥; some species lost ♥, some new ones ♥.	Remains diverse, with seasonal variation, and habitat for species not common in surrounds. ♥

A2. Agenda extract and notes

Time (mins)	Session	Description
10	Future ecological change	Introduce transformational ecological change Presentation on examples emphasising the *magnitude* of future ecological change and the *types* of change species and ecosystems might experience
30	ESBS and change	Discuss future climate and ecological impacts changes the site ***(Table A2)***
10	Intro to climate-ready objectives	Introduce: Change vs loss; place vs biota; multiple values Draw change-persistence table, work through one or two examples
60	Change and persistence	Complete the change-persistence table ***(Table A4)*** Discuss the implications for how the site is valued, and how change might affect future management priorities

Future change

Use a combination of historic examples of extremes and information about ecological change due to climate change. Run several extremes together, make them more extreme and more frequent, extrapolate; ask, 'What if the ecosystem / key species did not recover in the same way?'

Can also use a prepared large change scenario with a combination of gradual change and extremes.

Change and persistence

Construct the rows of the table based on the discussion about the site and how it is valued. Add a row for each different aspect of the site that might be valued for a specific reason or by different section of the community.

Try to keep the descriptions biophysical (what thing is being valued), and note who might value each aspect.

For each row, note in the second column which characteristics of the valued thing might change with climate change (assume moderate/feasible amounts of management are applied). Then note in the third column which characteristics might persist despite the changes noted in the second column (again allowing for reasonable amounts of management).

Discuss how the changes would affect the value connected to feature corresponding to each row. Is the value retained with the aspects that persist, or would the value be lost with the ecological changes? For each row, annotate whether the value is associated with the changing aspect or the persisting one.

It may be necessary to split rows to separate aspects that might respond to climate change or be valued in different ways. Some things fit into the table easily, others may be hard to deconstruct so they fit in consistently with the columns. Where this happens it may be necessary to take time to revisit how different aspects are described, or do further splitting or lumping of rows.

It is best to consider a large magnitude of ecological change, e.g. 'end-of-century' impacts. Intermediate levels of change could be included if there were significant medium-term dynamics that might be relevant. However, moderate impacts should not be analysed simply because they are more likely or 'in the relevant planning timeframe'. The climate-ready approach is about starting the process of getting ready for large levels of ecological change. This will be a medium- to long-term process (multiple 'planning timeframes'), and requires anticipating those large changes and their social and management implications.

Note that this is an exercise fraught with uncertainty; the process accommodates that uncertainty very well. Restricting discussion to a few ecological features or types of change with higher (perceived) levels of future ecological knowledge is likely to be counterproductive.

4. Climate-ready objectives and management

This next section of the analysis describes a number of c*limate-ready objectives* that were developed in appreciation of the potential ecological changes anticipated above. These are objectives for the management of the site that could effectively conserve valued aspects of biodiversity while accommodating inevitable ecological change.

Four objectives were scoped, each focusing on biophysical outcomes that might be sought. They are expressed using the syntax: *Maintain <valued aspect of the feature> while <other aspect of the feature> changes in the face of climate change*. Each is largely consistent with the originally articulated objective of 'Good quality, stable remnant of native vegetation that is owned by the community', but each is more specific with respect to anticipated ecological change. It can be taken that the aspiration for the site to be 'owned by the community' is retained in each of the climate-ready objectives. However, there may be variation in the extent to which that ownership can be connected to the presence of ESBS provenances and species, as opposed to other more-persistent characteristics of the site.

The bold text is the core objective, the plain text adds detail or context. The first objective seeks to accommodate a moderate amount of change, but may not be viable in the longer term.

Table 2 Climate-ready objectives for the Queens Park ESBS site. (This table was not included in the original Climate-ready biodiversity management *tool.)*

1. Improve the diversity and abundance of ESBS species on the site allowing for changes in provenance to increase genetic diversity and adaptability in the face of climate change. This objective is viable for moderate levels of climate change.
2. Maintain/improve the presence of native vegetation at the site while the types of species that are present change. Vegetation that is dominated by natives (trees and shrubs), and feels native, even if it is not predominantly ESBS and has a significant exotic component, self-sustaining (low management input), and with healthy ecosystem processes.
3. Improve the diversity of bird species while the types of species change over time. Including rare and less common, nomadic, specialist species that enthusiasts will appreciate. Some species will come, others will go. Achieved through expanding areas and diversity of habitat, at whole of park scale.
4. Maintain recreational access, including off-leash dog walking, in a semi-natural setting while the species and vegetation type changes. Kids and dogs can run, dig and play with sticks.

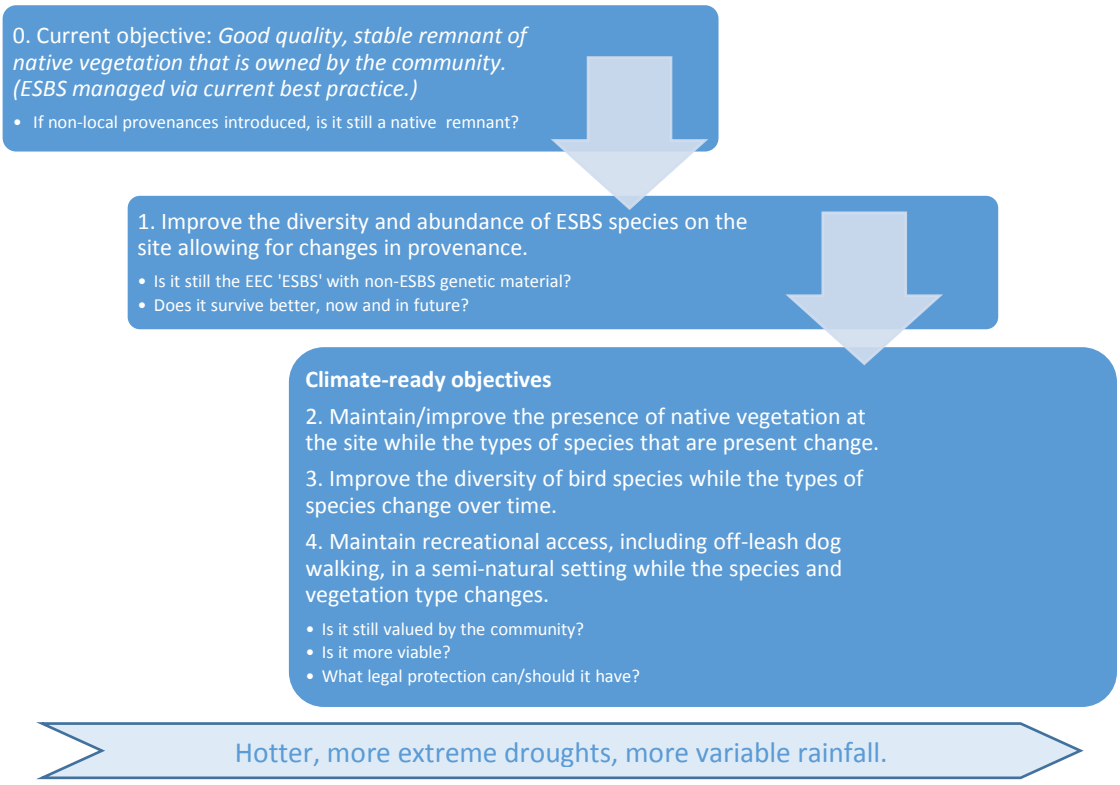

Figure 1 Sequencing of current and future objectives into a pathway

These objectives can be sequenced though time (Figure 1), leading to key questions such as: how long each objective might remain feasible as the environment changes, what changes in management might be required for each objective, what societal conditions might be necessary before the next objective can be adopted?

Management

Current best practice management for the site includes no deliberate introduction of new species or genetic material even from other ESBS sites. If no further recruitment is observed it is likely that management will be broadened to include introducing some species from other ESBS sites. This could be done on a trial basis, focusing on groups such as groundcovers and herbs that are missing for the QP site.

- *Q: Would the site still be a classified as 'remnant ESBS' if material were actively introduced from other sites?*

To facilitate objective #1 'Improve the diversity and abundance of ESBS species on the site allowing for changes in provenance', the site would continue to be managed as ESBS, with weeding, leaf litter removal, periodic fire and removal of non-ESBS native plants. However, the following changes could be adopted:

- cease activities aimed at preventing the establishment of non-ESBS-provenance plants in the site, such as planting a 'buffer' of non-ESBS native species
- actively seeding and planting seedlings, as opposed to relying on regeneration from the seedbank

- start introducing ESBS species sourced from non-ESBS sites ('non-ESBS-provenances')
- plant ESBS species beyond the current boundary of the site to expand the area of the patch and allow dispersal of additional ESBS species and genes into the original remnant.

➢ *Q: How would any increase in area of the ESBS vegetation on the site be classified: ESBS, EEC, remnant?*

➢ *Q: Which stakeholders would know or care about the difference? Would it have the same legal status for protection and funding priority? Would it have the same community support?*

➢ *Q: Would it be more viable with additional ESBS species and genetic stock? For how long?*

To facilitate objectives 2 (maintaining and improving the presence of (non-ESBS) native vegetation), 3 (the diversity of birds) and 4 (access to recreation in a semi-natural setting), the site would continue to be managed as native vegetation with removal of most exotic plants. Suitable changes in management might include:

- cease restricting the establishment of non-ESBS native species
- start active establishment of non-ESBS native species around the original site
- allow the voluntary recruitment of non-ESBS native species within the site
- actively plant non-ESBS native species within the site
- permit an exotic grass understory in higher visitation areas.

➢ *Q: How would the site be classified if it were planted with non-ESBS species?*

➢ *Q: Would establishment of non-ESBS species change its legal status as EEC?*

➢ *Q: Would the site continue to be a biodiversity conservation priority?*

➢ *Q: How would the site be valued by the community with changes in vegetation type?*

➢ *Q: would the site be more ecologically viable in the long term?*

A3. Agenda extract and notes

Time (mins)	Session	Description
20	Climate-ready objectives	Develop climate-ready objectives for selected valued aspect of the site using the syntax. List in ***Table Ax***
30	Changes in management	For each objective (***Table Ax***), or valued aspect of the site (row in ***Table A4***), identify management that might need to be stopped, maintained or started (***Table A5***)

Climate-ready objectives

Ask if the analysis in Table A4 suggests any changes in priorities. What ecological features might you seek to preserve as the change is occurring?

Formulate some 'climate-ready objectives'. These will be aspirations that are feasible as large ecological change occurs. They are intended examples of objectives that might be adopted at some time in the future; they are not intended as the singular objective that the managers will or should adopt, especially not in the near term.

One key rule: do not allow an objective that seeks to prevent the inevitable ecological change. Managers could adopt such an objective in the near term, if they wish; but it would not be climate-ready. Stress we are talking about objectives for a world with significant ecological impacts of climate change, not now.

Objectives should have the following syntax:

'*Conserve Y, (for V), while X changes (in response to Z)*'

Where X, Y are ecological descriptions; Y is what is being preserved (not changing) and X is expected (inevitable) ecological change.

V and Z are optional. V is the objective that seeks to maintain, and Z is the specific environmental (climate) change that is anticipated.

Do one objective as an example, then facilitate participants developing several more. Do one objective per aspect of biodiversity or natural feature (rows in Table A4). Depending on the table, this is likely to be relatively straightforward for most rows; some will be trivial and not worth dwelling on; some will lead to discussion and be worth word-smithing. For some rows it may be hard to formulate an objective, which may indicate the descriptions in the persistence and change cells need to be revisited.

Changed management

Ask how different these new objectives are from current ones. What changes might be needed to achieve the objectives? Focus on change that might be needed to allow the inevitable ecological change to occur, rather than trying to stop it. Broad types of management are often the same (e.g., weeding), but may differ in intent and in how they are implemented: clarify what might need to be done differently (e.g. which species, where). Elicit aspects of current management that might need to stop and those that could be maintained, and new management that might need to be started.

5. Uncertainties

A range of uncertainties were identified during the workshop, and are listed below. Some of these may be critical and could be addressed directly with future work; others may be unknown but may be less critical for management decisions.

- Uncertain rate and detail of climatic and ecological change.
- The current regeneration potential of the site is unclear: many species are senescent, there is very limited regeneration (even with some fire) and no recruitment of new ESBS species. How much regeneration might occur with more intensive regeneration effort?
- How well will ESBS provenances and species survive on site as the climate changes?
- Could more intensive management extend the ability of ESBS species to persist?
- What non-ESBS native species could grow on ESBS sites as the climate changes?
- What management regimes would support non-ESBS native species in the future?
- What do people want from the QP site, and how much might this change over time?
- What changes might occur in legislation about preserving EECs as they experience ecological change? Will the legislation seek to protect current EEC sites, future locations for EEC or both, or neither?
- How will the site be classified and managed administratively as it changes? How protected will it be? Will it be a priority and attract funding for management? What activities might be allowable?
- How will 'best practice' bush regeneration evolve as the climate changes? Will it include use of non-provenance stock and non-local species?

6. Barriers to changing objectives and management

Having considered the nature of potential climate-ready objectives, the analysis considered barriers that might be encountered in adopting these objectives and revising management practices. Barriers to change can arise from the *values* of different stakeholders, *rules* including legislation and regulation but also constraints of industry and community norms, and lack of *knowledge* about how to implement alternatives or about the likely outcomes of implementing them. These barriers to adopting new objectives in response to climate change are often different in nature and source to the barriers managers may currently experience. While new, untested and potentially daunting, they may actually be easier to overcome than current barriers that have become institutionally or socially entrenched.

Workshop participants identified a range of barriers to future management, who or where the barriers originated from, and activities managers could undertake with strategically selected partners to help overcome the barriers.

The most significant barriers to adopting the new objectives were associated with the desire to maintain the site as an ESBS remnant (values) and the bush regeneration management practices prescribed in a variety of current plans and guidelines (rules). However, it appears

there may be no regulatory prohibition on planting non-local ESBS provenances and species adjacent to the site. Planting directly into the current remnant is restricted, but it may be possible with regulatory approval and a specific scientific licence.

There is uncertainty (knowledge barrier) about whether more intensive application of best practice will stimulate significant regeneration of ESBS at the QP site. There is also a question of when it may be necessary, most effective or desirable to switch to an alternative objective. If no significant regeneration is present with increased management, then a switch in the near term may be desirable. If successful regeneration is present, then it is unclear when a future change in objectives might be desirable: after observations of serious vegetation decline due to climate change, or in anticipation of future changes to maintain cover, richness and ecological health?

It is currently anticipated that, for as long as this uncertainty remains, there will be a strong aspiration to maintain the site as an ESBS remnant (knowledge-values interaction).

There were also technical (knowledge) barriers associated with the potential risks and benefits of introducing non-local or non-provenance genes, as well as uncertainty about which non-ESBS provenances and which non-ESBS native species might do well at QP, and other ESBS sites, as the climate changes. Managers suggested visually appealing flowering herbs might be suitable groups of non-local ESBS provenance plants to introduce first, suggesting aesthetics as well as functional roles might be an important consideration (values-rules interaction).

The barriers discussed above are all beyond the direct control of the managers of the QP site: they originate elsewhere in the 'institutional system' that shapes the management of ESBS. For example, the *rules* come from the Department of Environment and Heritage which implements legislation and provides regulation, the community of bush regeneration professionals including practitioners and trainers who define 'best practice', recovery plans developed by state and Australian governments with technical advisors, and various strategies developed for the land managers (Waverley Council and CPMPT). The *values* that come into play include those of the individual land managers, the contractors and volunteers conducting work, the multiple different groupings of residents and visitors to the site, broader citizenry of the local area, NSW and Australia, tourists, trustees of CPMPT, and elected members of local, state and Australian governments. And the *knowledge* available to managers and those undertaking works comes from experience, experience of other bush regeneration practitioners, consultants, seed suppliers, and scientist in the local area (including the Royal Botanic Gardens Sydney) and across the country.

While managers cannot be expected to regularly engage directly with all these people in the 'system' of remnant management, the list highlights that overcoming barriers may need change or 'learning' to occur at multiple levels or places in this system. The climate-ready analysis helps identify what actions the QP managers might be able to take to facilitate that learning and, critically, with whom activities could be undertaken to give them the best opportunity to experience that learning.

Overcoming barriers to future adaptation through learning with partners

Having identified a wide range of barriers and a diversity of sources of them, the climate-ready analysis considered ways to overcome the barriers. Specifically, discussions in the workshop focused on activities that could be included within existing or near-term projects, at QP or other ESBS sites, to stimulate targeted learning by specific stakeholders that could help overcome barriers to adopting climate-ready objectives in the future. The intent was not that the new objectives that had been scoped *should* be adopted; rather, it was that if some form of climate-ready objectives do need to be adopted in the future, then addressing the identified barriers would facilitate the process of formulating and considering new objectives, and then adopting them.

The types of activities with partners that might promote learning to overcome barriers include:

- Engaging the wider bush regeneration 'community of practice' in the dilemma of attempting to use best practice management with remnants that are genetically depauperate, declining and facing further pressure from climate change.
- Engaging OEH and interested local community members in questions about the values and priorities for the site if it were to be managed more actively, and if it were to transition into another ecological community.
- Conducting experiments and monitoring focused on the genetic and phenotypic consequences of introducing genetic material from both provenance and non-provenance ESBS species. This could be conducted by the Royal Botanic Garden Sydney, with volunteers, bush regeneration professionals and the OEH so they learn about the risks and benefits of increasing genetic diversity.
- Manage ESBS sites across Sydney collectively, with QP as an experimental site used to develop and test climate-ready management that might be applied to other ESBS sites, allowing them to be managed as ESBS for as long as needed. Present this site to other ESBS managers, OEH, the conservation community and researchers as a case study of experimental management to inform the management of other EECs in the face of climate change.

A4. Agenda extract and notes

Time (mins)	Session	Description
10	Decision context	Recap on barriers and introduction to vrk framework
30	Diagnosing barriers	Identify barriers to changing management and tag as values, rules or knowledge based (***Table A6***)

Diagnosing barriers

Identify barriers then ask participants to identify the extent to which they are based on lack of knowledge (don't know how to implement or the consequences), conflicting values (stakeholders don't want the different consequences), or formal and informal rules (not allowed). Very often it transpires that the most significant barriers are around values.

Identify who 'owns' the barriers; their sources: who would need to change in order for the barrier to be overcome?

Scope what activities might give them the opportunity to learn about the issue and change.

PART B: ADDRESSING ADAPTATION BARRIERS IN EASTERN SUBURBS BANKSIA SCRUB: BUSINESS CASE

This section outlines the rationale for developing projects that are strategically designed to help create the social and institutional environment needed to formulate climate-ready objectives and management for ESBS sites, and adopt them if and when needed in the future.

7. Value proposition for a different approach

The current objective for the QP ESBS site, and probably most of the other ESBS sites, is to achieve a *good quality, stable remnant of native vegetation that is owned by the community.* At the moment that means a remnant of the ESBS community. However, the site is degraded and 'best practice' bush regeneration is unlikely to be sufficient to achieve that objective, in contrast to the neighbouring YR and BS sites that have responded well to management and other larger ESBS sites in the region that are in better condition. In addition, in the medium- to long-term climate change is likely to make the site less suitable for many ESBS species and more suitable for other non-ESBS native species. This would make the objective of maintaining the ESBS community difficult or infeasible even with supplementation of additional ESBS species and genes. The QP site is especially vulnerable, being small and in poor condition, however it is very feasible that all of the ESBS sites may experience similar changes in ecological community. The prospect of these ecological changes suggests a need to start considering how to manage native vegetation at QP and the other ESBS sites if it becomes unviable to maintain the ESBS community. The analysis in Part A suggests that the ability to adopt new objectives and management in the future will depend on the evolution of societal values and changes in the layers of rules directing management, as well as the generation of new knowledge, and that activities undertaken in the near-term can help drive these changes.

Here we outline the rationale and scope for a project aiming to *improve the diversity and abundance of ESBS species on the QP site allowing for changes in provenance to increase genetic diversity and adaptability in the face of climate change*. This objective draws on the climate-ready analysis of Part A. It departs from the current approach of focusing on local provenance, regeneration from existing seedbank, and not actively introducing additional ESBS species. It can be regarded as an intermediate step towards a longer-term objective of managing a different community if and when it is unviable to maintain ESBS. Various changes in management would be required to achieve this objective. While this is a technical component to that problem, the social and institutional challenges are possibly even greater given the 'complex social-ecological system' that shapes the management of EEC and QP in particular.

Solutions to complex problems need to be evolved, rather than designed. Evolving the social, institutional and technical dimension of managing transforming EEC could take several decades. This project proposes progressing that evolution through a series of strategically designed small-scale interventions to probe anticipated barriers to managing EEC differently. Doing this with selected partners will help promote the evolution of the

social and institutional environment by providing experiences that will help inform future legal and policy reforms, shape preferences and stimulate research necessary to create the opportunity for new management of current EEC sites that is viable in the long term.

Specifically, the project seeks to use experimental management at QP and other locations with ESBS soils as a pilot for alternative approaches to managing ESBS and EEC. This will be done to directly address a series of interacting technical, social and institutional issues that were identified in the climate-ready analysis in Part A.

8. Project outline

This project is aimed towards maintaining ESBS on the QP site as the climate changes by enabling an expansion of the current management approaches. It addresses the key barrier of using deliberate introduction of non-provenance seeds or plants in the restoration of EEC. Subsequent projects could be developed to start addressing the longer-term challenges associated with managing the site as the ecological community changes in type.

Specific issues to be addressed in this project include:

- engaging with the expectations of both the general community, and experts and professionals with a stake in the QP ESBS site and other EEC (evolving values)
- actively seeding or planting into an EEC (evolving rules)
- actively expanding the area of a remnant (evolving rules)
- uncertainty about viability of non-ESBS provenances growing in ESBS soils (evolving knowledge)
- regulatory and social dimensions of planting non-provenance plants into an EEC (evolving rules and values)
- the question of when it may be necessary to change the approach to management of QP and other sites (evolving knowledge and rules).

The project is presented as phases of more traditional and more interventionist management, however the phases could be undertaken simultaneously.

A key feature of the project is the partners each activity is conducted with and what they will learn.

Phase I

1. Intensify current best practice management on the QP site (weeding, litter removal, traffic management, controlled fire).
    - This could be conducted for several years, assessing recruitment of resident species and additional ESBS species from the seedbank.
    - This would be conducted by contractors and volunteers. Involving managers of other ESBS sites, other bush regeneration professionals, researchers from the Royal Botanic Gardens Sydney and staff from OEH would enable them to

experience the need to consider more interventionist management and begin to change their preferences, the rules they make and the research they do.

2. If there is no significant response, start seeding or planting with ESBS species that are missing from the site sourcing stock from ESBS communities (i.e. with ESBS provenances).
    - Stock could be sourced from the two largest populations at North Head or Botany Bay National Park ESBS. These populations are likely to be most genetically healthy, as well as having higher species richness, and possibly being more acceptable as collection sites.
    - Prior to this activity (during activity #1): seek permission to collect seed from other sites, collect seed and start propagation of seedlings with contractors/suppliers; seek approval from OEH to introduce material to QP.
    - As above, the trials would be conducted by current managers, but involve a wider group of experts and professionals with a stake in QP, ESBS or 'best practice' management.
    - Start engaging with the local community and wider Sydney bush regeneration community about the current activity, and options for medium- to long-term management. Pose a wide range of questions, for example about the viability of ESBS on the site (knowledge), about how managing the site differently might affect the different ways people relate to it (values), and about its classification as a remnant (rules).

Phase II

3. Trial expanding ESBS on the QP site by planting the surrounds with ESBS provenances from other ESBS sites (including species currently resident at QP as well as additional ones) along with non-ESBS species.
    - The ESBS provenance stock can voluntarily colonise into the existing remnant. Any other native species colonising into the original remnant can readily be removed if desired.
    - Monitor success of colonisation of the new ESBS species into the original remnant.
    - Partner with ecological geneticists (Royal Botanic Gardens or a university) to monitor seed set and recruitment of species that have individuals in both the original remnant and the new plantings. Assess the consequences for vigour and genetic diversity of breeding between resident and planted stock.
    - Use the site to generate dialogue with OEH, other EEC managers and the NSW Threatened Species Scientific Committee about the appropriate status of the newly planted areas. Should they be classified as EEC remnant?
4. Trial establishment and growth in ESBS soils of non-ESBS provenance (i.e. seeds of ESBS species collected from non-ESBS sites). This would be done at sites that have the appropriate aeolian sand but where no ESBS remnants are present.

- This activity is (presumably) relatively uncontroversial and could be started early.
- Engage the managers of other ESBS sites who may have an interest in planting non-ESBS provenance stock and nurseries with interest in supplying 'ESBS-soil-ready' plants.
- Invite researchers to study the genetics of any tolerance in provenance and non-provenance plants to growing in nutrient poor aeolian sand.

5. Commence broad engagement with regulators and the bush regeneration community about planting non-ESBS provenance stock into ESBS.
    - Engage OEH to address any regulatory issues and special licences that might need to be obtained to trial planting non-provenance stock.
    - Use the trials above as a stimulus to engage the bush regeneration community in the issue. For example, host seminar/discussion series or form a working group to examine the issues.
    - Host field days and ensure monitoring and research results are shared widely.
6. Develop a strategy to consult the local community, visitors to Queens Park and Centennial Park, and the interested general public around future management of the site in the context of climate change.
    - Inquire about the importance of different uses and how the site is valued.
    - Canvass the possibility of managing the site differently, including as non-ESBS native vegetation.
    - Point out the opportunity to use the QP site to help develop proactive management strategies for other ESBS sites in the region.
    - Option to experimentally provide different information packages to the community to test how the framing of the information affects their understanding and preferences.
7. Develop, with other ESBS managers, a draft strategy that scopes when switches in management on the site might be required, first to active planting of ESBS provenances, then planting with non-ESBS provenances and non-ESBS species.
    - Consult with OEH and other bodies to identify changes in policy, regulations and guidelines that might be required.
    - Identify what information would ideally be available from the trials at QP and the non-ESBS sites prior to the switches.
    - Identify trigger points and indicators and that could be used identify when changes might be needed. Including indicators of changing values and institutional factors as well as ecological and physical indicators.

Phase III

An approach similar to that above, of identifying targeted activities and partners to help overcome specific barriers, could be used to explore the more challenging issue of allowing

changes in species composition on ESBS sites, potentially leading to them becoming different or novel ecological communities.

Monitoring and evaluation

As well as monitoring ecological outcomes of these trials, the project emphasises the social and institutional consequences of the proposed changes in management. This may be done more effectively by partnering with specialist social scientists to monitor and evaluate how different target communities have engaged with the project and what they have learnt; has the project led to the shifts in values, rules and knowledge that might have been expected; is that being shared beyond the immediate partners?

The impact of the project would also be enhanced through engagement with other regeneration communities across NSW, Australia and even globally, about the dilemma of long-term management of degraded endangered ecological communities.

9. Key differences with this approach

This project is different from a standard bush regeneration or community engagement project in a number of key ways:

- It includes a focus on experiential learning, being explicit about the new management being tested, but also the social and institutional questions associated with the consequences.
- It aims to create options for future management by evolving managers' decision context, rather than (just) aiming for short-term ecological outcomes.
- It involves partners because of their role in the broader 'societal system' that creates the decision-making context of ESBS managers. That is, it specifically targets partners who might influence key barriers to developing and adopting climate-ready management in the future.

For these reasons the project may require a greater level of approval and support. In addition, if a research partner is engaged to design and evaluate learning in the project, then human ethics approval will be required.

Despite these differences, there are many similarities to a more regular restoration project:

- It aims to achieve conservation outcomes at the site, and in particular maintain the integrity of ESBS at QP.
- It seeks to use the least invasive practices that can be used to achieve the objectives.
- It will require external funding and support from volunteers, and champions within Waverley Council and CPMPT.

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Appendix – Workshop outputs

Extensive notes were taken during the workshop and these were used to populate the tables after the workshops. Clarifications and further information were provided by participants before the tables were finalised. The table formats and numbering follow the templates and examples in the *Climate-ready biodiversity management* tool (Dunlop & Ryan 2016), with some modifications which are noted.

Table A1 Key characteristics of the initial project. Contextual information about the site and how it is currently managed.

PROJECT CHARACTERISTICS	INITIAL PROJECT
Threats to biodiversity	Past clearing of the region (leaving the site isolated) and the site (leaving it depleted and degraded) Very small site, low population density, low plant species richness Unknown seedbank No recruitment Aging trees Human disturbance Lack of fire Weeds, including grasses Rabbits and foxes Phytophthora is a risk, present at nearby sites Isolated. Poor dispersal from other sites
Values at stake	ESBS community (Endangered. Reclassified as Critically Endangered, 1 December 2017.) Ecological health of the native vegetation Patch of native vegetation in larger grassed open space surrounded by city Open space On site recreation: off-leash dog walking, fitness, walking, bike riding, music videos Contiguous with a large number of playing fields, cliffs (bouldering), dogs, bikes, fitness stations, personal trainers. Very popular on weekends. There would have been aboriginal occupation (especially along cliffs), but no physical evidence remains on the site. There are records of paintings in the rock shelters, but they have been covered with graffiti.

PROJECT CHARACTERISTICS	INITIAL PROJECT
Desired outcome (objective)	*Good quality, stable remnant of native vegetation that is owned by the community.* Good quality: species diversity (15 species); regeneration is occurring (due to a good seedbank, low weeds <20%); showing immediate positive response management (e.g. fire, raking) Stable: requiring less management inputs over time, as it increases in quality Remnant native vegetation: specifically, Eastern Suburbs Banksia Scrub Owned: locals and visitors like the vegetation on site and have a strong connection in part due to the ESBS community.
Source of the objective	It is a combined expression of the intent of numerous existing ESBS plans (Australian & State Governments, CPMPT), best practice regeneration, Waverley Council targets for remnant vegetation. Aspiration of the responsible Waverley and CPMPT staff.
Proposed actions	Primarily weeding, litter removal (raking) and maybe fire. Ideally fencing, but unlikely at this site. Hope those sufficient to stimulate natural regeneration, as at York Road. If not, then undertake planting.
Contextual factors	Total area of remaining ESBS is 146 ha, <3% of original. Cluster of sites around Centennial Park: Queens Park (focus of the case study), Bird Sanctuary, York Road. There are other much larger sites in good condition with significant management at North Head, Botany Bay and La Perouse managed by Sydney Harbour Federation Trust and NSW NPWS. Numerous other very small sites. All isolated, but specific management issues vary between sites (including which weeds are an issue). ESBS is very similar to widespread coastal heath vegetation of the eastern seaboard; no endemic species; it is defined by its Aeolian sands (nutrient poor, wind-blown dune sand, older). 'Good condition' sites might contain 15 spp (2 trees, 8 shrubs, 10–15 understory), ideally sites would contain 50 spp. A very small number of people (maybe only 30) actually know what ESBS is as opposed to variants of coastal heaths extending from Sydney to South-east Queensland. Simplifies after >15 years without fire; YR and BS sites have responded well to planned fires. YR and BS sites are now in relatively good condition. They are fenced to control access, have received high intensity regeneration, and have responded well. They are managed as 'best practice' sites, with funding ($88k allocated for 2016–19) and much care from volunteers and contractors.

PROJECT CHARACTERISTICS	INITIAL PROJECT
	York Road site is bounded by Moriah College which has an interest in the site; they use it for science, but without the protection afforded by EEC listing site would have been used for building/carpark.
	York Road site in good condition (30–40 spp, active regeneration, low weed cover and abundance) after 15 years of bush regeneration with no planting, after being completely cleared in 1945 and planted to Radiata Pine. It has very restricted access.
	Queens Park site is much harder to exclude people from and is in poorer condition.
	QP site receives very little management other than mowing and occasional spraying of weeds.
	QP has lost two of nine spp in recent years. [Update: The 2009 survey recorded five ESBS spp; 2017 survey recorded five ESBS spp plus another two ESBS spp suspected to not be indigenous to the site.]
	There have been planned fires in YR and BS, but it takes many months to plan, and accumulate the piles of litter to burn. Burns are managed by the fire brigade. There have been no community complaints.
	Some very small unplanned fires in QP.
	Phytophthora is in Centennial Park and is a risk in the ESBS sites.
	QP and BS are within Centennial Parklands, which is a very well used multi-use open space with heritage significance. It is noted for its Victorian gardens and ponds. It was protected in 1850 to protect water supply (Busby's Bore) after the Tank Stream became polluted; fencing off restricted public access which caused a riot!
	To most people, the QP site is probably not recognisably a remnant of a native plant community.
	QP site has strong local community interest. It is wanted by the community, but it is not clear what they want. Prefer open (vs scrubby) vegetation; safety and aesthetics are issues; may desire lighting for evening use.
	ESBS species are not planted in buffer zones (neither local ESBS provenance nor ESBS spp from elsewhere); so that voluntary dispersal from the planted individuals can be identified and removed. There is very strong resistance in the bush regeneration community to 'planting outside of an EC' (with nursery stock) due to perceived risk of undermining local provenance. Not against the law/regulations; but it is not 'best practice'.
	QP is owned by CPMPT under state legislation, and is within Waverley Council area. It is managed by CPMPT, and contributes to Waverley Council's 'improve the condition of native remnants' target.
	The more extensive North Head site has also been regenerated after extensive clearing. It is the largest site, and managed with a large number of different experimental treatments.
	There are some but not a lot of lessons shared between the managers of the different sites. Different bush regeneration contractors work across the sites with some cross-over.

PROJECT CHARACTERISTICS	INITIAL PROJECT
	There have been 'good wins' managing the other sites using 'best practice' bush regeneration (e.g. no planting). Current managers are definitely not ready to give up on regenerating ESBS at QP, as there has not yet been enough concerted effort at that site with best practice to know it won't work.

Table A2 Future ecological changes affecting the issue

FUTURE ECOLOGICAL CHANGES
Lack of fire, leading to senescence, simplification, loss of seedbank, weed establishment
Weed establishment, smothering, canopy closure and litter from non-ESBS and exotic spp
Loss of habitat for ESBS, establishment of other native vegetation
Loss of native vegetation
Hotter: may initially favour natives as weeds suffer more in summer. But native vegetation on site suffered in the drought, grasses more so than shrubs
Dryer/ change in seasonality, more summer rain, would have significant consequences.

Table A3 Uncertainties

UNCERTAINTIES
Don't know what will happen climatically, or ecologically
What do people want?
How will legislation change with respect to preserving EEC as habitat changes?
How will best practice change regarding provenances and species as climate changes?
Regeneration potential now is unclear, species are being lost, no new species established after unplanned fire
Ability for species to persist over time
Ability to maintain species through intensive management

Table A4 Valued aspects of biodiversity and the attributes of them that can be expected to change and might feasibly persist

See Table 1 in Part A above.

*Table Ax. Climate-ready objectives**

Hypothetical, long-term, objectives for Queens Park ESBS site that seek to meet climate-ready criteria. Developed in the workshop and slightly edited after.
Syntax: *Maintain <valued aspect of the feature> while <other aspect of the feature> changes in the face of climate change*.
Bold text is core objective, plain text adds detail/context.

1. Improve the diversity and abundance of ESBS species at the site allowing for changes in provenance to increase genetic diversity and adaptability in the face of climate change. This objective is viable for moderate levels of climate change.
2. Maintain/improve the presence of native vegetation at the site while the types of species that are present change. Vegetation that is dominated by natives (trees and shrubs), and feels native, even if it is not predominantly ESBS and has a significant exotic component, self-sustaining (low management input), and with healthy ecosystem processes.
3. Improve the diversity of bird species while the types of species change over time. Including rare and less common, nomadic, specialist species that enthusiasts will appreciate. Some species will come, others will go. Achieved through expanding areas and diversity of habitat, at whole of park scale.
4. Maintain recreational access, including off-leash dog walking, in a semi-natural setting while the species and vegetation type changes. Kids and dogs can run, dig and play with sticks.

*This table was added. A table of climate-ready objectives was not included in the original set of templates.

Table A5 Possible long-term changes in management actions and strategies

OBJECTIVE*	1. CURRENT ACTIONS AND STRATEGIES TO POSSIBLY PHASE OUT OR CHANGE	2. CURRENT ACTIONS TO MAINTAIN IN THE LONG TERM	3. NEW ACTIONS AND STRATEGIES TO CONSIDER IN THE LONG TERM
(0) Current objective	Restriction on introducing seed from other ESBS sites	Active best practice regeneration	Trial introducing some species from other ESBS sites
(1) Improve the diversity and abundance of ESBS species at the site, allowing for changes in provenance	Planting buffer with non-ESBS species	Manage as ESBS. Plant and protect buffer	Planting buffer with ESBS species (+/– ESBS provenance). Allowing colonisation into the site
	Containing the area of remnant vegetation	Manage as ESBS	Expand the area of native vegetation

OBJECTIVE*	1. CURRENT ACTIONS AND STRATEGIES TO POSSIBLY PHASE OUT OR CHANGE	2. CURRENT ACTIONS TO MAINTAIN IN THE LONG TERM	3. NEW ACTIONS AND STRATEGIES TO CONSIDER IN THE LONG TERM
	Managing as best practice site: maintaining local provenances	Manage as ESBS Weeding, fire, removing litter (vegetation), managing disturbance	Planting with non-local ESBS provenances to increase genetic diversity
(2) Maintain/improve the presence of native vegetation, (3) diversity of birds, (4) access to recreation in semi-natural setting	Managing as ESBS site: maintaining ESBS species; weeding out non-local natives	Manage as native vegetation. Weeding, fire, removing litter (vegetation), managing disturbance	Planting with non-ESBS provenances and non-ESBS species

*Table modified: 'Objective' column added.

Table A6 Barriers to adopting the new objectives, management and actions or strategies in the long term – examples

1. BARRIER	2. V, R, K OR LINKAGE	3. WHO 'OWNS' THE BARRIER?	4. INFORMATION OR EXPERIENCE TO HELP THEM UNDERSTAND/CHANGE	5. POTENTIAL PROJECT ACTIVITIES
Best practice. (Pressure to conform to local provenance, no direct planting, natural expansion only)	R (norm)	Regeneration community	Understand the extent to which the current practice is inhibiting a successful conservation outcome in this context.	Exchange of knowledge through a community of practice. Field days and direct involvement with climate-ready projects.
DEC recovery plan and endangered ecological community (EEC) status	R	Office of Environment and Heritage and the Scientific Community	Understand the extent to which the current practice is inhibiting a successful conservation outcome in this context.	Government involvement with climate-ready projects.
Resourcing for seedstock, weeding, consultation/ negotiation (current and future barrier)	V	Council, State Government, CPMPT, Community	Understanding the need to experiment with new practices and the advantage of using QP site for this.	Engagement with the context of the QP site. Seek to partner with target agencies in development of climate-ready projects.
Opposition to changing the goal	V	Local community; regeneration community	Demonstration current practice is not sufficient in this context, and that the outcomes of more interventionist management are in fact desirable.	Create a dialogue between government and stakeholders. Community involvement in monitoring of current practice.
Follow through (Lack of will, resources)	V, R?	Council, CPMPT		
Knowledge about provenances and outcrossing risk (benefit)	K	ANBG, researchers	Experimental evidence about the consequences of introducing new stock.	Engagement in the design, monitoring and analysis of the consequences of the project. Concern about the risk could be ameliorated by the project being framed as an experiment, rather than a deviation from best practice.

1. BARRIER	2. V, R, K OR LINKAGE	3. WHO 'OWNS' THE BARRIER?	4. INFORMATION OR EXPERIENCE TO HELP THEM UNDERSTAND/CHANGE	5. POTENTIAL PROJECT ACTIVITIES
Balance between recreation and conservation. (current and future barrier)	V, R?	Park users, State Government, CPMPT	Better understanding of community values attached to the site, and the nature of their support. Information to the local community that this is endangered bushland.	Surveys and town hall meetings about the site, its uses and values, and future management. Media releases, blog posts, signage.
Knowing when to change	K, V	CPMPT, Council	Understanding of rates of ecological and social change, and any thresholds. Understanding how long it will take to develop a knowledge base to manage other ESBS sites as they experience climate impacts.	Experiments, modelling, monitoring. Engagement with the social and institutional complexities of changing management.

Table A7 Components of a climate-ready problem statement

COMPONENTS	*RE-FRAMED PROJECT*
A. Desired ecological outcome (thing to conserve)	Good quality, stable remnant of native vegetation that is owned by the community.
B. Inevitable ecological change	Gradual establishment of non-ESBS species and continual loss of ESBS species, leading to a change in the ecological community type to possibly a novel community.
C. Long-term management actions or planning approach	Seeding or planting with a wide variety of non-ESBS species seeking to find plants tolerant to the aeolian sands and changing climate. Expansion of area of native vegetation on the site.
D. Near-term management actions	Continue seeking to maintain ESBS on site. Use QP as a trial of different approaches that can be used at other ESBS sites.
E. Enabling actions	Trials of growing non-ESBS native plants on ESBS soils. Engagement with community about what they value about the site and how that might be affected by change in management and ecological community given the inevitability of change. Engage with regulators and bush regeneration community about the need to change approach. Partner with researchers to study genetic consequences of mixing provenances, and of genetic basis for tolerance of aeolian sands. Debate in the conservation community, among academics and regulators about the legal status of changing communities and how to provide protection and determine conservation priority in the face of large ecological change.
F. Learning and changing decision context (who and what)	Local and wider community supportive of changed management when needed. Policy and guidelines change to support change in management. Policy (and maybe legislation) changed to provide legal protection to the site as a biodiversity priority, possible with new categories to replace the notion of remnants of past EEC. Knowledge available from technical experts about what provenances and species to plant and when into ESBS sites.

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