

Approved Conservation Advice for Shrublands and Woodlands of the eastern Swan Coastal Plain

(s266B of the *Environment Protection and Biodiversity Conservation Act 1999*)

This Conservation Advice has been developed based on the best available information at the time this Conservation Advice was approved; this includes existing plans, records or management prescriptions for this ecological community.

1 CONSERVATION OBJECTIVE

The objective of this conservation advice is to mitigate the risk of extinction (or collapse) of the **Shrublands and Woodlands of the eastern Swan Coastal Plain** ecological community, and help recover its biodiversity and function, through: protecting it as a matter of national environmental significance under national environment law, particularly to avoid further loss; and by guiding implementation of management and recovery through the recommended priority conservation and research actions set out in this advice.

2 DESCRIPTION OF THE ECOLOGICAL COMMUNITY

The **Shrublands and Woodlands of the eastern Swan Coastal Plain** ecological community is a woodland mainly on the transitional soils of the Ridge Hill Shelf, on the Swan Coastal Plain adjacent to the Darling Scarp, and extends onto the alluvial clays deposited on the eastern fringe of the Swan Coastal Plain, and also into adjacent aeolian deposits. The community mainly occurs as a shrubland, or a woodland of *Banksia attenuata* and *Banksia menziesii*, or *Corymbia calophylla*, sometimes with *Allocasuarina fraseriana*, over a shrub layer that can include the species *Adenanthos cygnorum*, *Hibbertia huegelii*, *Scaevola repens* var. *repens*, *Allocasuarina humilis*, *Bossiaea eriocarpa*, *Hibbertia hypericoides* and *Stirlingia latifolia*. A suite of herbs including *Conostylis aurea*, *Trachymene pilosa*, *Lomandra hermaphrodita*, *Burchardia umbellata* and *Patersonia occidentalis*, and the sedges *Mesomelaena pseudostygia*, *Mesomelaena tetragona*, and *Lyginia barbata* often occur in the community. The weeds *Gladiolus caryophyllaceus* and *Ursinia anthemoides* are also common (Gibson et al 1994; WA DEC 2006; WA DPaW pers comm 2017).

3 CONSERVATION STATUS

The **Shrublands and Woodlands of the eastern Swan Coastal Plain** ecological community is listed as Endangered under the EPBC Act. At the time of its assessment, it was listed because of its restricted distribution and extent, and the highly fragmented remaining patches being threatened by weed invasion, hydrological changes due to clearing and draining, too frequent fire and dieback resulting from infection by *Phytophthora cinnamomi* (Endangered Species Scientific Subcommittee 2000). The listing is based on data collected prior to the EPBC Act commencing in July 2000. In Western Australia it is listed as critically endangered, under the name Shrublands and woodlands of the eastern side of the Swan Coastal Plain.

A flora species listed as threatened under the EPBC Act that occurs within or in close proximity to the community is *Conospermum undulatum*. Threatened fauna such as *Calyptorhynchus latirostris* (Carnaby's black cockatoo) and *Calyptorhynchus banksii naso* (forest red-tailed black cockatoo) may utilise remnants, particularly as feeding habitat.

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4 DISTRIBUTION AND HABITAT

The **Shrublands and Woodlands of the eastern Swan Coastal Plain** ecological community occurs on the eastern side of the Swan Coastal Plain in the foothills of the Darling Scarp and reflects this transitional landform and soil zone between the Scarp and the Swan Coastal Plain. Many of the plant species present in the community are more common on the Scarp. The assemblage also contains species commonly associated with marri - wandoo woodlands on heavy soils.

As at April 2017, there are approximately 130 ha of the ecological community remaining. Occurrences 1 and 2, as identified in WA DEC (2006), are found at Talbot Road Bushland in Stratton (Occurrence 1), and at Bushmead Rifle Range in Helena Valley (Occurrence 2). Additional patches were recently verified at other locations including the following; further north within Talbot Rd Bushland; at the intersection of the Great Eastern Highway bypass and Roe Highway; on Farrall Rd in Midvale; and at the junction of Clifford St and Tonkin Hwy Maddington (WA DPaW pers comm 2017). Other occurrences may be present in the region and be identified through further surveys and mapping, but overall extent will remain small.

The habitat that is critical for survival of the ecological community is the area of occupancy of known occurrences; and the sandy to gravelly soils on the eastern Swan Coastal Plain and foothills of the Darling Scarp on which the community occurs, areas of similar habitat within 200 metres of known occurrences, (i.e. sandy to gravelly soils on the eastern Swan Coastal Plain and foothills of the Darling Scarp); and remnant vegetation that surrounds or links several occurrences (this is to provide habitat for pollinators or to allow them to move between occurrences). Because the ecological community has a very restricted distribution and is listed as Critically Endangered in Western Australia, no condition thresholds have been applied to the nationally-listed ecological community and hence it is considered that all areas meeting the description of the ecological community are critical to its survival.

As at April 2017, it is known to occur in the following Local Government Areas: Gosnells and Swan; within the Perth Natural Resource Management (NRM) catchment; and within the Swan Coastal Plain bioregion (Interim Biogeographic Regionalisation for Australia (IBRA) Version 7).

5 THREATS

Clearing

Clearing for agriculture and urbanisation has been extensive on the Ridge Hill Shelf on the eastern side of the Swan Coastal Plain, where the ecological community occurs. The community type is also likely to have been regionally rare prior to any clearing (Gibson et al 1994). Hence, there are few remaining areas of this community.

Talbot Road Bushland and adjacent lands are encompassed in a variety of tenures including reserves for the purpose of conservation, cemeteries, and freehold land originally intended for housing.

The Bushmead Rifle Range is privately owned, and currently protected under a conservation covenant with Parks and Wildlife. The ecological community at that site will ultimately become a reserve managed for conservation.

Further widening of Roe Highway and a possible road upgrade at Stirling Crescent Bushland, and at the Clifford Rd on Tonkin Hwy junction have the potential to impact on the ecological community.

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The largest of the occurrences in Stratton is planned for conservation management; however, the smaller areas of the ecological community at that location may be planned for development.

Altered fire regimes

Fires are likely to have a significant effect on the vegetation composition in Mediterranean ecosystems such as those in the south-west of Western Australia (Abbott and Burrows 2003). If an appropriate frequency of fires is exceeded however, species that are obligate seeders may not have sufficient time to flower and produce seed. If the time between fires is too long, obligate seeders may become senescent and be unable to regenerate. Therefore, fires must occur at appropriate intervals and possibly the appropriate season and intensity to sustain the integrity of plant communities. As this ecological community is not well studied, little is known of its requirements in terms of fire regime to maintain species composition. However, it is likely that the fire regimes in Occurrences 1 and 2 have been modified to more frequent fires, especially hot burns, since European settlement. The recent high frequency of fires in the Talbot Road Bushland is likely to have favoured weeds and plants that propagate by resprouting.

All disturbance in remnants results in increasing weed invasion, particularly where remnants are small. Therefore, fire frequency should be minimised unless future studies indicate that fire is not occurring frequently enough. In addition, the risk of fire is increased by the presence of grassy weeds in the understorey, as they are likely to be more flammable than the original native species in the herb layer. The fire frequency in Talbot Road Bushland has been very high recently. The increased number of fires may well be impacting the community in terms of structure, composition and level of weed invasion. The floristics of the site require monitoring so that the community's response to fire can be determined.

Fire within Occurrence 2 at Bushmead Rifle Range would increase weed levels but also may induce germination of seed stored within the soil. The area does not appear to have been burnt for many years and grazing by sheep may have caused the loss of some species from the site that now only occur as propagules in the soil.

Weed invasion

Weed invasion is usually enhanced by disturbances such as fires and grazing if weed propagules are present. The occurrences of this community are close to agricultural or urban areas that act as weed sources, and so would be vulnerable to weed invasion following any disturbance. Current levels of weeds in most occurrences are still quite low; however, those in Stratton have been subject to high levels of historical disturbance and subsequent weed invasion.

There are tracks through occurrences of the ecological community. Weeds have invaded to varying extents along these tracks and such areas should be considered priority areas for weed control. In particular, piles of soil scraped from tracks generally contain high concentrations of weeds and act as a source of weed invasion. Such piles should be avoided when tracks are cleared, or be removed where they already exist.

A weed control program would be necessary to maintain or improve the condition of occurrences of the community in the long term. Brown & Brooks (2002) state that the aims of weed control are to maintain the pre-invasion condition of the habitat (prevention); control or arrest ongoing weed invasion (intervention); and reverse the degraded condition of the habitat where applicable (rehabilitation). A weed control program would involve (adapted from Brown & Brooks 2002):

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1. accurately mapping the boundaries of weed populations;
2. selecting an appropriate herbicide or other method of weed control after determining which weeds are present;
3. controlling weeds that pose the greatest threat to the community in the early stages of invasion where possible eg; invasive perennial grasses; and
4. rehabilitation through reintroduction of local native species where areas are no longer capable of regenerating following weed control.

Following disturbances such as fires, the above actions need to be followed up with a post-disturbance weed control program that responds to weed establishment, particularly in the following 1–2 years after disturbance. Subsequent control of weeds is very important to prevent their re-establishment.

A disused gravel pit occurs in the south-east portion of Reserve 23953. This area contains some significant infestations of weeds.

Grazing

The Bushmead Rifle Range has been grazed by sizeable flocks of sheep over the years and this may have altered the structure and composition of the plant community by trampling, selective grazing and facilitated weed invasion.

Rabbits have impacted parts of Talbot Road Bushland in the past, particularly where recent fires have decreased the density of understorey vegetation. They selectively graze more palatable species and spread weeds in their droppings. A rabbit control program has been undertaken using fumigation and ripping of the burrows in the area of the community managed by the Metropolitan Cemeteries Board (Reserve 6955).

Introduction of Disease

The community type appears to be quite susceptible to dieback caused by *Phytophthora* species and the pathogen is common in Talbot Road Bushland (Safstrom & Taman 1999). Further spread or amplification of the disease should therefore be minimised wherever the community occurs by ensuring good hygiene procedures. This would involve wash-down of any equipment used adjacent to the community. The drainage waters flowing through Occurrence 1 may be carrying the pathogen and, as discussed below, this may require specific management.

The community in Bushmead Rifle Range may also have been impacted by dieback historically. This may have been introduced and/or spread by vehicles, sheep or walkers.

Dieback causes loss of susceptible species and may result in altered composition and structure of vegetation. The areas of infection will need to be mapped in Bushmead Rifle Range to help guide future management such as rehabilitation, treatment of priority areas with phosphite that is used to control dieback, and closure of specific tracks where vehicle or foot access may spread or amplify dieback impact.

The presence of dieback was assessed and found on the western side of the Roe Highway in Stirling Crescent Bushland but a negative result for dieback presence was obtained for the eastern side of Roe Highway in the Stirling Crescent area.

Hydrological changes

Water from urban areas to the east of Talbot Road Bushland is channeled into Reserve 23953. This may be implicated in introducing and/or amplifying dieback in the reserve and alternative strategies for drainage need to be investigated.

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Pollution

The pollution of the surface waters with animal droppings or fertilisers would increase nutrient levels and hence, favor weed invasion because introduced species are generally adapted to higher nutrient levels than native Australian plants. Surface runoff of other pollutants into the community from surrounding lands is also possible.

Erosion by wind and water

The unconfined drain through the Talbot Road Bushland is resulting in noticeable levels of erosion and redeposition of topsoil. This drain flows through the southern end of this community and other means of channeling water should be considered.

6 PRIORITY CONSERVATION AND RESEARCH ACTIONS

6.1 Principles and standards

To undertake priority actions to meet the conservation objective, the overarching principle is that it is essential to maintain existing areas of the ecological community. This ecological community has been heavily cleared and very few remnants remain. In addition, it is more cost-effective to retain an intact remnant than to allow degradation and then attempt to restore it or another area. Remnants are likely to retain a fuller suite of native plant and animal species, and ecological functions, noting the more disturbed and modified a patch of the ecological community, the greater the recovery effort that is required. Certain species may not be easy to recover in practice, if lost from a site. Retention of intact patches is particularly important for systems characterised by high richness and/or local endemism of native species.

This principle is highlighted in the National Standards for the Practice of Ecological Restoration in Australia (Standards Reference Group, SERA, 2016):

“Ecological restoration is not a substitute for sustainably managing and protecting ecosystems in the first instance.

The promise of restoration cannot be invoked as a justification for destroying or damaging existing ecosystems because functional natural ecosystems are not transportable or easily rebuilt once damaged and the success of ecological restoration cannot be assured. Many projects that aspire to restoration fall short of reinstating reference ecosystem attributes for a range of reasons including scale and degree of damage and technical, ecological and resource limitations.”

Standards Reference Group SERA (2016) – Appendix 2.

The principle serves to dissuade ‘offsets’ or ‘trade-offs’ where intact remnants are removed with an undertaking to set aside and/or restore other sites. The destruction of intact sites always represents a net loss of the functional ecological community because there is no guarantee all the species and ecological functions of the intact site can be replicated elsewhere (*also see section 6.3 – Offsets*).

6.2 Priority actions

Priority actions are recommended for the abatement of threats and supporting recovery of the ecological community. Actions inconsistent with these recommendations that are likely to significantly affect the ecological community should not be undertaken. In assessment of activities that may have a significant impact on the ecological community, incorporate relevant actions listed below when determining recommendations including conditions of

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approval. Applications to Australian Government or other funding programs should also consider prioritising the recommended research and restoration activities below.

The four key approaches to achieve the conservation objective are:

PROTECT the ecological community to prevent further loss of extent and condition;

RESTORE the ecological community within its original range by active abatement of threats, regeneration and revegetation, and other conservation initiatives;

COMMUNICATION – ENGAGE WITH AND SUPPORT people to increase understanding of the value and function of the ecological community and encourage their efforts in its protection and recovery; and

RESEARCH AND MONITORING to improve our understanding of the ecological community and methods for restoration and protection over the long-term.

These approaches are overlapping in practice and form part of an iterative approach to management that should include research, planning, management, monitoring and review. Key groups to engage with include: landholders, land managers, land use planners, researchers, community members, and the Indigenous community.

Specific management, research and other conservation priorities for Shrublands and Woodlands of the eastern Swan Coastal Plain are described below.

6.2.1 PROTECT

Preventing vegetation clearance and direct habitat damage

Highest priorities

- Map the boundaries, condition, and risk level to occurrences of the ecological community. This will identify the areas in most urgent need of protection and restoration.
 - Enter mapped information into a GIS-enabled database to enable identification of occurrences during environmental impact assessment and to facilitate protection and management.
 - Notify land managers of the occurrences on land that they manage to encourage compliance with legislation and management of occurrences.
- Minimise further clearance, fragmentation or detrimental modification of remnants of the ecological community and of surrounding native vegetation, for example, through land use zoning and during residential development, basic raw materials extraction, and associated infrastructure development.
 - Given that this ecological community is highly restricted in spatial extent, with very few patches remaining, any further losses to any patches of the ecological community should be avoided where possible and to any other adjacent vegetation.
 - High conservation value, least modified and older growth areas are particularly important for retention and management.
 - Overall, efforts should be made to increase the remaining extent, condition and landscape scale connectivity (including with other surrounding native vegetation types).
 - Identify high quality remnants in advance of zoning and development planning decisions and avoid clearing or damaging the remnants.

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- Recognise the landscape position of remnants of the ecological community and ensure that planning supports increased resilience within the landscape (by retaining appropriate connectivity between remnants of all naturally occurring ecological communities in the area).
- Prevent impacts to native vegetation, native fauna, hydrology or soil structure from developments and activities adjacent to or near patches of the ecological community by planning for and appropriately avoiding or mitigating off-site effects. For instance, apply recommended buffers of at least 20–50 m (native vegetation buffers are preferred) around patches of the ecological community and avoid activities that could cause significant hydrological change or eutrophication. Wider buffers may be required where there is larger scale landscape change, for example hydrological modifications.
- Prevent further drainage or alterations in or near patches of the ecological community that disrupt the natural hydrology of the patch.
- Remove redundant or disused drains in or near patches, particularly if this restores natural hydrology of the patch.
- Protect mature trees, particularly with hollows, even if they are dead. Large and old trees may have numerous fissures that provide shelter; support diverse insects and their predators; and act as ‘stepping stones’ for fauna moving between remnants in an otherwise cleared landscape.
- Retain other native vegetation remnants and mature isolated trees near patches of the ecological community where they are important for connectivity or as buffers.
- Prevent firewood collection that leads to loss and damage of trees and logs.
- Manage access to remnants to prevent, for example, disturbance and spread of plant pathogens and weeds.
- New walking or bike tracks should be near, rather than through patches of the ecological community. They should use existing management access tracks, rather than creating new tracks.
- Ensure that areas that form important landscape connections, such as wildlife corridors or other patches of particularly high quality or regional importance are considered for inclusion in formal reserve tenure or other conservation related tenure for protection and management in perpetuity.
- Liaise with local councils and State authorities to ensure that cumulative impacts, from activities undertaken as part of broader or related projects (e.g. road works, developments), are reduced when planning individual activities.
- Avoid the requirement for offsetting, by avoiding and mitigating impacts to the ecological community first. Consistent with ‘like-for-like’ principles, match offsets to the same ecological community, as it is not appropriate to offset losses of one ecological community with another ecological community, given the high local endemism and β -diversity in the region. Further information is in *Section 6.4 – Offsets*.

Other priorities

- Protect the native soil seed bank by minimising soil disturbance and removal.

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- Retain habitat features for fauna, noting species requirements (e.g. fallen timber, particular structure of vegetation). For example, for many bird species the quality of native vegetation as habitat can be improved by leaving fallen logs and leaf litter in situ, controlling weed species, taking care of the canopy by controlling against dieback *Phytophthora cinnamomi*, and controlling wildfires by public awareness and vigilance (Davis et al 2013).
- Prior to removal of any trees, or use of heavy machinery that may also damage the understorey, ensure comprehensive flora and fauna surveys have identified threatened species on site and their potential shelter and nesting sites, for example hollows, burrows, rocks and tree crevices, as well as visible nests. Damage to these should be avoided altogether, but if approved for removal, care should be taken to appropriately relocate fauna.

Preventing weeds and feral animals

- Prevent weed invasion by minimising soil disturbance.
- Following disturbances implement a weed control program that responds to weed establishment, particularly during the 1–2 years following disturbance. It typically is most effective and requires less resource to control weeds at this time.
- Do not plant (or spread) known, or potential, environmental weeds within or near the ecological community:
 - prevent activities such as planting potentially invasive species in gardens or other landscaping near the ecological community; or dumping garden waste in or near patches of the ecological community.
 - control runoff, e.g. urban runoff to prevent movement of weed material into natural areas, or elevating soil nutrients that encourages establishment of weeds over natives.
- Detect and control weeds early. Small infestations should be a priority for removal. For example, weeds have invaded to varying extents along these tracks and such areas should be considered a priority for weed control.
- Prevent further introduction of feral animals and contain domestic animals within new residential areas.
- Use appropriate hygiene to minimise the introduction or spread of weeds at susceptible sites. For example, keep vehicles and machinery to dedicated roads and out of remnants wherever possible. If vehicles must be taken into remnants ensure vehicles are effectively washed first to remove weed seeds.

Prevent dieback and other diseases

- Monitor for *Phytophthora cinnamomi* and other plant pathogens to minimise the risk of new infestations in areas that are not yet infested. Manage early for local containment or eradication.

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- Implement a *P. cinnamomi* management plan to ensure that the fungus is not introduced into locations of the ecological community and that the spread in areas outside of, but adjacent to patches is mitigated (DoE 2014).
- Ensure that appropriate hygiene protocols are adhered to when entering or exiting the known location of the ecological community, such as those outlined in Podger et al. (2001).
- Implement a hygiene management plan and risk assessment to protect known patches from further outbreaks of *P. cinnamomi*. This may include but is not limited to:
 - Contaminated water is not used for firefighting purposes,
 - Contaminated soil is not introduced into the area as part of restoration, translocation, infrastructure development or revegetation activities,
 - Ensure that areas where the ecological community is known to occur that are *P. cinnamomi* free, are sign posted and hygiene stations are implemented and maintained.
- Implement mitigation measures in areas that are known to be infected by *P. cinnamomi*, this may include but is not limited to;
- Application of phosphite (H_3PO_3), noting the potential deleterious effects as a fertiliser with prolonged usage.

Groundwater

- Manage groundwater extraction by monitoring changes to levels of groundwater over the long-term. Use the results of monitoring to ensure adverse impacts to native vegetation are minimised.

Fire

- Use a landscape-scale approach and available knowledge on fire histories and age of stands, to identify appropriate fire regimes. Where able, fires should be managed to ensure that prevailing fire regimes do not disrupt the life cycles of the component species of the ecological community, that they support rather than degrade the habitat necessary to the ecological community, that they do not promote invasion of exotic species, and that they do not increase impacts of other disturbances such as grazing or predation by feral predators.
- As most fires in this community are unmanaged (mainly arson or accidental/lightning), it is difficult to maintain a prescribed fire regime. A flexible approach will be required, with the impact of unmanaged fires minimised through fire response and community engagement.
- Given the cycle of fires promoting grassy weed establishment and higher fuel loads, manage the fire-weed cycle by controlling invasive weed species before and after any fire events.
- Implement appropriate fire management regimes for the ecological community taking into account results from research. These may include some of the following actions:

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- do not burn during reproductive seasons of threatened or functionally important or characteristic flora, and fauna species;
- do not burn if soil moisture is very low, or relatively dry conditions are predicted for the coming season;
- where controlled burns are deemed essential, use small scale (<1 ha) mosaic burning patterns to reduce impacts of too frequent fires on the ecological community and associated flora and fauna;
- within large patches burn different parts in rotation, rather than the whole area in any one season;
- avoid native vegetation removal as part of fire management or creation of new tracks or use of machinery through bushand. Slashing to maintain low native understorey as a fire break is preferred over a mineral earth fire break;
- consider fire regimes appropriate for other nearby ecological communities when planning burning (for example, where wetlands are adjacent);
- monitor outcomes of fire and manage consequences (e.g. weeds and feral predators); take results into account when managing future fire regimes. (For further information on monitoring priorities see *section 6.2.4*).

Preventing grazing damage

- Where feral herbivores (e.g. rabbits) are present or there is an overabundance of native herbivores (e.g. kangaroos) install temporary or permanent fencing to protect regrowth, revegetation areas, or sites with threatened, regionally important or diverse understorey species.
- Manage populations of feral grazing animals that damage native vegetation.

6.2.2 RESTORE

The Standards Reference Group identifies six principles as ‘key principles of ecological restoration practice’, the details of which are provided by the Standards Reference Group SERA (2016):

1. Ecological restoration practice is based on an appropriate local indigenous reference ecosystem.
2. Restoration inputs will be dictated by level of resilience and degradation.
3. Recovery of ecosystem attributes is facilitated by identifying clear targets, goals and objectives.
4. Full recovery is the goal of ecological restoration but outcomes may take long timeframes.
5. Science is essential to good practice but the two processes are synergistic.
6. Social aspects are critical to successful ecological restoration.

These principles underpin how the priority restoration actions below should be properly implemented.

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Restoration

Highest priorities

- Implement optimal restoration strategies (including regeneration, revegetation) for the ecological community, across the landscape. In general, use locally collected seed where available to create an appropriate canopy and diverse understorey.
- Ensure restoration is site specific, as this is important to the success of restoration efforts.
- Restore wildlife corridors and linkages (where appropriate) between remnants of the ecological community and other areas of native vegetation or reconstructed habitat, to reduce fragmentation and isolation.
- Consider particularly the needs of species of conservation concern or known to be of functional importance for the ecological community.

Other priorities

- Encourage appropriate use of local native species in developments and revegetation projects through local government and industry initiatives.
- Implement effective adaptive management regimes using information from relevant research (e.g. SERA 2016).

Control invasive species and diseases

Highest priorities

- Map weed occurrence and prioritise management of weeds in highest quality patches or where threatened or regionally significant species are known to occur.
- Implement effective control and management techniques for weeds currently affecting the ecological community integrating this with alternative habitat provision and feral predator control.

Other priorities

- Control introduced pest animals through consolidated landscape-scale programs.
- Manage weeds before and after fire, and during revegetation works to maximise success of restoration.
- Manage weeds at the sides of new roads and housing and industrial developments near to the ecological community by regular monitoring, and control by targeted herbicide spraying or manual removal for several years after the works are complete.
- Ensure actions to control invasive or other pest species avoid impacts on non-target species and do not have any long-term adverse impacts upon the ecological community:
 - ensure workers are appropriately trained in the use of relevant herbicides and pesticides, best methodologies (e.g. spot-spraying, stem injection) and what to target;
 - avoid chemical spray drift and off-target damage within or near to the ecological community, having regard to minimum buffer zones.

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6.2.3 COMMUNICATION – ENGAGE WITH AND SUPPORT

Maintain a recovery team

- Support the continuation of the Swan Region Recovery Team, with broad community involvement.

Education, information and local regulation

- Develop a communication strategy, education programs, information products and signage to help local communities, planners and managers recognise:
 - when the ecological community is present and why it is important to protect it;
 - how to appropriately manage patches of the ecological community; and
 - responsibilities under state and local regulations and the EPBC Act.
- Promote knowledge about local weeds, means to control these and appropriate local native species to plant.
- Develop education programs to discourage damaging activities such as the removal of dead timber, the dumping of rubbish (particularly garden waste), creation of informal paths and the use of off-road vehicles in patches of the ecological community.
- Encourage local participation in recovery efforts, removing threats and actively restoring existing patches, as well as facilitating these. This may be achieved by setting up a recovery team(s) with appropriate expert and local participants; adoption of patches by local conservation groups; or encouraging short term involvement through field days and planting projects, with appropriate follow-up.
 - Ensure planners and participants are aware of appropriate species to plant across the range of the ecological community (taking into account local sub-communities), the best opportunities to restore landscape connectivity and encourage natural regeneration and the best known techniques for the site conditions and species being planted.
 - Ensure land managers are given information about managing fire for the benefit of threatened species and ecological communities.
 - Ensure commitment to follow-up after planting, such as care of newly planted vegetation by watering, mulching, weeding and removal of tree guards.
- Promote awareness and protection of the ecological community with relevant agencies and industries. For example with:
 - state and local government planning authorities, to ensure that planning takes the protection of remnants into account, with due regard to principles for long-term conservation;
 - land developers and construction industries, to minimise threats associated with land development;
 - local councils and state authorities, to ensure road widening and maintenance activities (or other infrastructure or development activities) involving substrate or vegetation disturbance do not adversely impact the ecological community. This includes avoiding the introduction or spread of weeds and avoiding planning new roads or paths through patches of the ecological community.

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- In new residential developments include measures to limit additional impacts from domestic animals and invasive plants. These may include:
 - public education, including the use of signs to both identify good examples of the ecological community and explain beneficial and detrimental activities.
 - cat exclusion areas;
 - requirements for registering and sterilising cats;
 - requirements for dogs to remain on leash in natural areas;
 - lists of suitable species for gardens to provide habitat and complement natural areas;
 - lists of invasive plant species to avoid planting in gardens.
- Liaise with local fire management authorities and agencies and engage their support in fire management of the ecological community. Request these agencies to use suitable maps and install field markers to avoid damage to the ecological community.

Incentives and support

- Support opportunities for traditional owners or other members of the Indigenous community to manage the ecological community.
- Implement formal conservation agreements (for example, covenants) for sites on private tenure that contain the ecological community.
- Develop coordinated incentive projects to encourage conservation and stewardship on private land, and link with other programs and activities, especially those managed by regional catchment councils.

6.2.4 RESEARCH AND MONITORING

Relevant and well-targeted research and other information gathering activities are important in informing the protection and management of the ecological community. Coordination with individuals and groups with responsibilities for planning and on ground management is important to ensure that research questions and methods are well chosen, and that the information gathered can be applied to the benefit of the ecological community. Research and ongoing management activities can often be integrated to achieve the best results in the face of ongoing change. It is important that any monitoring is planned before management commences, considering data requirements to address research questions. Monitoring must also be resourced for at least the duration of the management activities, especially for those using a novel approach.

High priority research and monitoring activities to inform protection, management and restoration of the ecological community include the following:

- Review data: consolidate information over entire extent of the ecological community and improve and update maps of the ecological community across its range:
 - support field survey and interpretation of other data such as aerial photographs and satellite images to more accurately document current extent, condition, threats, function, presence and use by regionally significant or threatened species.
 - support and enhance existing programs to model the pre-European extent across the entire range of the ecological community to inform restoration; identify the most

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intact, high conservation value remnants and gain a better understanding of variation across the ecological community.

- Underake dieback mapping and risk assessment of dieback susceptible areas.
- Develop a weed management strategy that includes integrated weed management over large areas.
- Undertake or support ongoing research aimed at managing major weeds and feral animals.
- Research the effects of fire on floristics and structure of the community, and fauna in patches and across the broader landscape:
 - Keep precise records of fire history.
 - Monitor the response of the ecological community to fire, using an appropriate measure (species composition, populations of key species, etc) with a monitoring design that aims to improve understanding of the response to fire of the ecological community.
 - Identify and publish appropriate fire management regimes to conserve key species and the broader ecological community. For example, address the effects of fire intervals and timing on seedbank accumulation and seedling recruitment to inform the identification of fire regimes that maintain floristic diversity.
- Monitor changes in condition, including response to all types of management actions and use this information to increase understanding of the ecological community and inform recommendations for future management
- Long term monitoring of groundwater decline and its impacts.
- Conduct research leading to the development of effective landscape-scale rehabilitation and maintenance of vegetation condition for the ecological community. Investigate the interactions between threats (e.g. fire regimes, climate change, *Phytophthora* dieback, hydrological changes) to determine how an integrated approach to threat management can be implemented.
- Emerging weeds and relationship with disturbance (fire, physical).
- Determine priority areas for restoration to enhance connectivity and landscape resilience.
- Investigate the most cost-effective options for restoring landscape function, including:
 - revegetation or assisted regeneration of priority areas, potentially buffering, connecting and protecting existing remnants.
- Weed, and predator control options such as trapping and baiting, urban containment, exclusion fencing; re-introduction of key fauna.
- Understanding plant-fungal-hydrological relationships.
- Investigate key ecological interactions, such as the role of fauna in pollination, seed dispersal and nutrient cycling. Also investigate the mechanisms of mammal decline and understanding the ecological role of mycophagous mammals; and decline of other fauna, e.g. pollinators.
- Research cryptic biota and their role in the ecological community.
- Investigate the legacy effects of water table decline and possible management responses.

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- Further assess the vulnerability of the ecological community to climate change and investigate ways to improve resilience through other threat abatement and management actions.

6.3 Offsets

Offsets are defined as measures that compensate for the residual adverse impacts of an action on the environment. Further clearance and damage to this ecological community should not occur. Therefore, offsetting is a last resort. It should only be proposed as an attempt to compensate for damage to the ecological community that is deemed unavoidable. The ecological outcomes of offsetting activities are generally uncertain: offsetting with replanted areas is insufficient as there is no guarantee that reconstruction of the ecological community will be successful and, given the long ecological lags in the potential recreation of a resilient and functioning patch of the ecological community, the loss of mature trees, for example, severely compromises the viability of the ecological community. Replication of all species and function has yet to be demonstrated in any Australian system over decadal time scales (Maron et al 2012, 2016). Areas that already meet the condition thresholds are protected by this listing, so are not be used as an offset unless there is a substantial net conservation benefit such as a perpetual change in land tenure for conservation purposes, with ongoing threat abatement measures and monitoring put in place. With regard to any proposals involving offsets for this ecological community, which has been greatly reduced in spatial extent and condition, the aims are to:

- enable options to avoid the need to offset;
- retain remaining patches rather than offset;
- ensure that offsets are consistent with the wording and intent of the EPBC Act Environmental Offsets Policy (Commonwealth of Australia 2012), including:
 - ‘like-for-like’ principles based on meeting the overall definition of the ecological community and considering the particular species composition, maturity of trees, vegetation structure and other habitat and landscape features at a particular site (e.g. do not use offsets distant from the site of impact, as there is local variation of the ecological community);
 - how proposed offsets will address key priority actions outlined in this Conservation Advice and any other relevant recovery plans, threat abatement plans and any other Commonwealth management plans;
- demonstrate that offsets are feasible (i.e. by reference to successful applications elsewhere) with outcomes expected within reasonable time frames to offset development impacts.;
- match any offsets to the same ecological community, as it is not appropriate to offset losses of one ecological community with another ecological community, given the high local endemism and β -diversity in the region;
- maintain (or increase) the overall area, quality and ecological function of the remaining extent of the ecological community and improve the formal protection of high quality areas through a combination of the following measures:
 - protecting and managing offset sites in perpetuity in areas dedicated under legislation for conservation purposes; that is, do not allow reduction in their size, condition and ecological function in the future through ongoing threat abatement measures and adaptive management based on monitoring; and/or

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- increase the area and improve ecological function of the woodlands, for example by enhancing landscape connectivity (e.g. protecting and linking smaller remnants), habitat diversity and condition; and/or
- restoring patches to improve their condition, particularly to ensure that any offset sites add additional value to the remaining extent.

The above list does not necessarily encompass all actions that may benefit the **Shrublands and Woodlands of the eastern Swan Coastal Plain** ecological community, but highlights those that are considered to be of highest priority at the time of preparing this Conservation Advice.

6.4 Criteria for success

- An increase in the number of occurrences of this community managed for conservation and/or with conservation included in the management purpose over the next 10 years.
- Representative areas of the community across its geographical range with condition rank maintained, or with improved condition rank (Bush Forever, Government of Western Australia (2000) scales) over the next 10 years.

6.5 Criteria for failure

- Decline in condition rank of 10% or more of the area of the community over the next 10 years, excluding effects of drying climate that are outside the scope of this conservation advice.
- Failure to achieve an increase in the area managed for conservation over the next 10 years.

Summary of Recovery Actions identified in Western Australia's Interim Recovery Plan (WA DEC 2006)

There is an interim state recovery plan that has the following actions:

- Coordinate Recovery Actions
- Liaise with current land managers to implement this IRP
- Monitor the extent and boundaries of the community
- Map habitat critical to survival
- Establish quadrats in Stirling Crescent Bushland (completed)
- Disseminate information about the community
- Install markers
- Design and implement flora monitoring program
- Develop and implement fire management strategy
- Monitor dieback and determine priority areas for dieback treatment
- Implement dieback treatments
- Assess and monitor weed populations
- Implement weed control, replanting and rehabilitation where necessary

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- Ensure fences are constructed and maintained (where necessary)
- Design and conduct research
- Report on success of management strategies
- Implement weed control and rehabilitation in relevant areas
- Continue negotiations with regard to future management of Occurrence 1
- Implement drainage strategy
- Seek to transfer management of Occurrence 2 to Conservation Commission

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