Gnangara Sustainability Strategy

An across-government initiative

Groundwater – Biodiversity – Land use

LAKE PINJAR VEGETATION ASSESSMENT AND ECOLOGICAL LINKAGES

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Department of Environment and Conservation

November 2009

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Report for the Department of Environment and Conservation and Gnangara Sustainability Strategy

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This document has been commissioned/produced as part of the Gnangara Sustainability Strategy (GSS). The GSS is a State Government initiative which aims to provide a framework for a whole of government approach to address land use and water planning issues associated with the Gnangara groundwater system. For more information go to www.gnangara.water.wa.gov.au

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Lake Pinjar Vegetation Assessment and Ecological Linkages

Introduction

Lake Pinjar is primarily a conservation category wetland, located approximately 35 km north of Perth, on the Swan Coastal Plain. The lake and surrounding vegetation (henceforth described in combination as 'Lake Pinjar') are situated on the Gnangara groundwater system, between the Gnangara and Pinjar pine plantations. Almost 70% of Lake Pinjar has been identified as regionally significant bushland by Bush Forever (Site No 382 and a nominated site, now included in Bush Forever) which prompted the Western Australian Planning Commission (WAPC) to purchase parcels of land, ultimately for inclusion in the conservation reserve system. Whilst once entirely privately owned, at present over 50% of the Bush Forever sites within Lake Pinjar have been purchased by the State (Figure 1).

Lake Pinjar is a shallow surface expression of an unconfined aquifer, the Gnangara Mound, and consequently its hydrological cycle is strongly seasonal. In 1993 the basin of Lake Pinjar was recorded at 9 kilometres long and 1-2 ½ kilometres wide with an area of about 19.25 km^2 (1993). This represented more than twice the total area of remaining wetlands in the region and consequently it was recorded as being the largest wetland in the Perth Metropolitan Region (Environmental Protection Authority 1993). Lake Pinjar was classified as a sumpland in 1999 using Semeniuk and Semeniuk's (1995) classification system for geomorphic wetlands. As this classification is based on water permanency and the cross-sectional shape of wetlands, it can change over time. Lake Pinjar's classification may no longer be accurate as it has been observed that Lake Pinjar is no longer seasonally inundated, but rather remains dry all year round (Horwitz *et al.* 2009).

A study by Bowman, Bishaw Gorham (1994) revealed that the remnant vegetation of Lake Pinjar was of high conservation value. This study, commissioned by the then Department of Planning and Urban Development (now Department of Planning), found that Lake Pinjar had significantly different vegetation to other wetlands surveyed, and suggested that the vegetation of the floor of Lake Pinjar may be unique, or at least very unusual. The dissimilarity between the vegetation of Lake Pinjar's basin and margins, and that of other wetlands indicated to the Environmental Protection Authority (EPA) that Lake Pinjar

represented a special case and warranted protection. Furthermore, the majority of the vegetation falls within the Pinjar vegetation complex (Heddle *et al.* 1980) which only occurs within the Gnangara Sustainability Strategy (GSS) study area and is poorly represented and reserved (i.e. <30% retained, and <30% protected) on the Swan Coastal Plain (Kinloch *et al.* 2009).

Despite these high conservation values, the EPA recognised that not all of Lake Pinjar incorporated land that contains vegetation of high conservation value, as over half of the area had been cleared of native vegetation to provide pasture for grazing stock. Additionally, when Lake Pinjar was entirely privately owned, major modifications occurred to the shoreline and littoral zone through grazing. These disturbances have resulted in even greater emphasis being placed on the importance of conserving the remaining remnant native vegetation. It was therefore suggested that specific areas of Lake Pinjar with high recreation and conservation value be considered by planning agencies for inclusion in a Parks and Recreation reservation.

Land planning for Lake Pinjar is currently governed by the recommendations contained with the System Six report, specifically recommendation M8.2 (part 11) where Lake Pinjar is identified for reservation as Parks and Recreation under the MRS (Environmental Protection Authority 1983), and the Environmental Protection (Swan Coastal Plain Lakes) Policy (1992). The recognition of Lake Pinjar as a Bush Forever site also guides land use planning through the Draft State Planning Policy 2.8 (2004). Lake Pinjar is also mentioned in the Gnangara Park Concept Plan – Zone 3 where it is proposed that the remnant vegetation be retained and conserved through corridors or linkages to other conservation areas (CALM 1999). Finally, the majority of the study area is within the priority 1 public drinking water source area. This is the most stringent priority classification for drinking water source protection as it prevents the development of potentially harmful within the area (Government of Western Australia 2009).

In line with these recommendations this report details the assessment undertaken for the remnant vegetation of Lake Pinjar and proposes ecological linkages for the area. These linkages will complement those already proposed for both the pine plantations (post-clearing) and the GSS study area as a whole.

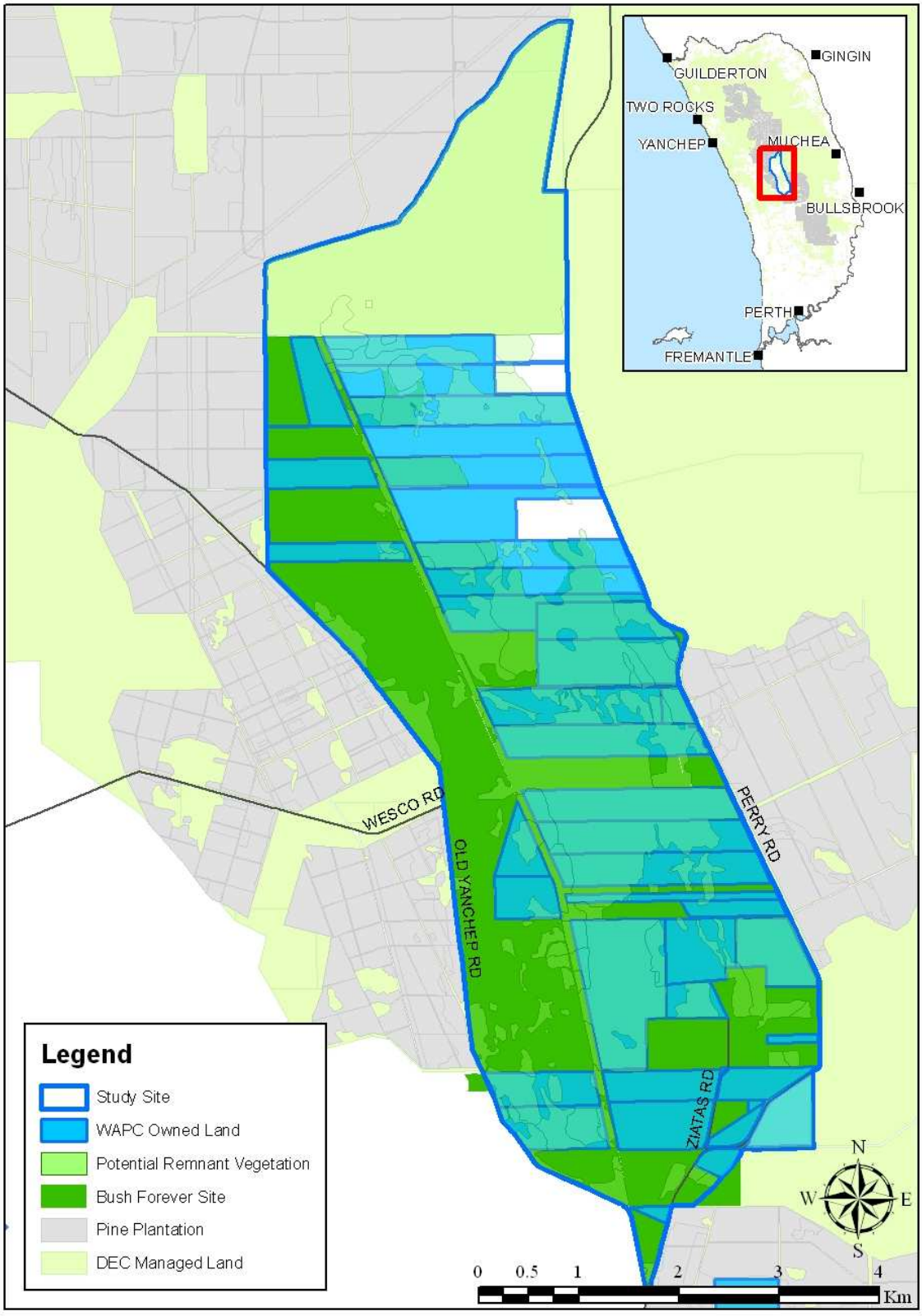


Figure 1: Location of the Lake Pinjar study site illustrating Bush Forever sites, WAPC owned land and the remnant vegetation surveyed.

Methods

Study site

The study site consisted of 3200 ha of land associated with Lake Pinjar, which forms part of a chain of wetlands, approximately 24km long. These occur east of Wanneroo road, running in a roughly north-south line at the intersection of the Spearwood and Bassendean dune landforms. Lake Pinjar is predominantly a conservation category wetland with smaller areas classified as multiple use wetlands. At present, approximately half the study site is owned by the State (WAPC) and the other half is privately owned, with the exception of a small block of State forest in the north.

Desktop assessment of potential bushland extent

Using a shapefile of remnant vegetation on the Swan Coastal Plain from the Department of Agriculture and Food WA (DAFWA), areas of potential remnant vegetation, within the study area, were identified. As this mapping (1:20 000) is based on December 2005/January 2006 orthophotos (geometrically corrected aerial photographs), a desktop survey was undertaken to refine the boundaries of these potential patches where possible. This involved the use of orthophotos (flown in 2008) to either add additional potential patches or to alter the boundaries of potential patches from the existing DAFWA shapefile.

Field vegetation and condition survey

The potential remnant patches were then field surveyed between August 2008 and January 2009. Each patch was examined using a rapid assessment (5 – 15 minutes) by the author to determine:

- whether the landform and vegetation was upland or wetland;
- if the patch was burnt during the past four years;
- if it represented either bushland or cleared areas;
- the visual condition of the vegetation [broadly following the Keighery (1994) bushland condition rating scale (Table 1)]; and
- any additional comments about the site.

Phytophthora dieback was not visually assessed during these field visits and thus was not used in the vegetation condition rating.

Table 1: Keighery condition scale from Keighery (1994)

Pristine Pristine or nearly so, no obvious signs of disturbance
Excellent Vegetation structure intact; disturbance affecting individual species; weeds are nonaggressive species
Very Good Vegetation structure altered; obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires; the presence of some more aggressive weeds; dieback; logging; grazing.
Good Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires; the presence of some very aggressive weeds at high density; partial clearing; dieback; grazing.
Degraded Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires; the presence of very aggressive weeds; partial clearing; dieback; grazing.
Completely Degraded The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Bush Forever (Government of Western Australia 2000a) and (2000b) defined 'bushland' as native vegetation in good or better condition based on the Keighery (1994) condition scale. Therefore, areas completely cleared of native vegetation and those with 'degraded' native vegetation were excluded from the analysis of 'bushland' patches.

As 50% of the study site had already been purchased by WAPC, most patches were accessible once approval was obtained from the WAPC. However, there were 'tenants' associated with some of the WAPC owned land, which prevented access to some sites. Of the 27 patches which could not be accessed directly, 19 were assessed from a short distance (i.e. from a neighbouring property or road, from a distance between 5 and 360 m (average of 50m)) and 8 were assessed by desktop (i.e. they did not receive a vegetation condition rating but were classified as bushland, native vegetation or cleared). Only 10 of

the patches which could not be accessed were on WAPC land (with tenants) while the remaining 17 were privately owned.

Ranking of bushland patches

Based on the site visits and the use of aerial photography, a shapefile was created for the remnant patches within and surrounding Lake Pinjar. This was attributed with the data collected in the field, as well as other spatial information, to assist with ranking.

In order to rank the individual bushland patches, a series of scores based on several attributes of the bushland remnants (condition, area, perimeter to area ratio and proximity to remnant vegetation), were allocated to each bushland patch. The scores were totalled for each individual patch, with a higher score indicating a greater ecological value. Each attribute is outlined below, with details on how each score was allocated.

Condition score

The condition rating attributed to each bushland patch during the field vegetation and condition survey (following Keighery (1994)) was assigned a score (Table 2), with 'Excellent' being given the highest score of 6, and 'Good-Degraded' the lowest of 1.

Table 2: Condition Score

Condition Rating Score	**Score**
Excellent	6
Excellent – Very Good	5
Very Good	4
Very Good – Good	3
Good	2
Good - Degraded	1

Area score

The area was calculated for each discrete bushland patch and these were then divided into five classes. The classes and their associated scores are listed in Table 3 below, with the

highest score attributed to the largest patches. If a bushland patch consisted of more than one polygon (i.e. there was a division due to vegetation condition or landform) then both polygons were given the same area score, from the composite or discrete patch, as they contribute to this patch.

Table 3: Area classes and score

Patch Size (hectares)	**Score**
>250	5
100.1 – 250	4
50.1 – 100	3
10.1 – 50	2
0 - 10	1

Perimeter to area ratio score

The perimeter to area ratio was calculated for each discrete bushland patch; however, as with the area score the same value was attributed to all polygons which contributed to that discrete patch, if multiple polygons existed. The ratios were then divided into classes, and assigned a score (Table 4). Those with a smaller ratio were given a higher score as they had a greater internal area and therefore would be less impacted by edge effects.

Table 4: Perimeter to area ratio classes and scores

Perimeter to area ratio	**Score**
0 – 0.005	5
0.0051 – 0.01	4
0.011 – 0.02	3
0.021 – 0.06	2
0.061 - 1	1

Proximity to remnant vegetation score

The proximity of each bushland patch to another patch of remnant vegetation, either within or outside the study area, was determined by buffering the remnant vegetation shapefile at a distance of 50 m. This allowed the proximity of any patch to its closest remnant

vegetation patch to be determined to within 50 m. The distances were divided into classes and scored (Table 5). Those patches in close proximity to remnant vegetation were given a higher score so as to give weighting to connectivity of patches.

Table 5: Proximity classes and scores

Proximity to nearest remnant vegetation (within 50m)	**Score**
0 – 49	3
50 – 100	2
101 - 150	1

Delineating ecological linkages

Within the last 10 years, bushland corridors have been identified by two regional studies – Bush Forever (Government of Western Australia 2000b) and the Perth Biodiversity Project (PBP) (Del Marco *et al.* 2004) and draft corridors have also been identified by the City of Wanneroo (City of Wanneroo 2008). Lake Pinjar has been involved in each of these proposals as shown in Figure 2a. Bush Forever (Government of Western Australia 2000a) designated three regionally significant corridors which traverse Lake Pinjar and the Perth Biodiversity Project (Del Marco *et al.* 2004) built on this by further defining the linkages and adding an additional linkage in the north. Finally, the City of Wanneroo proposed one corridor which intersects Lake Pinjar.

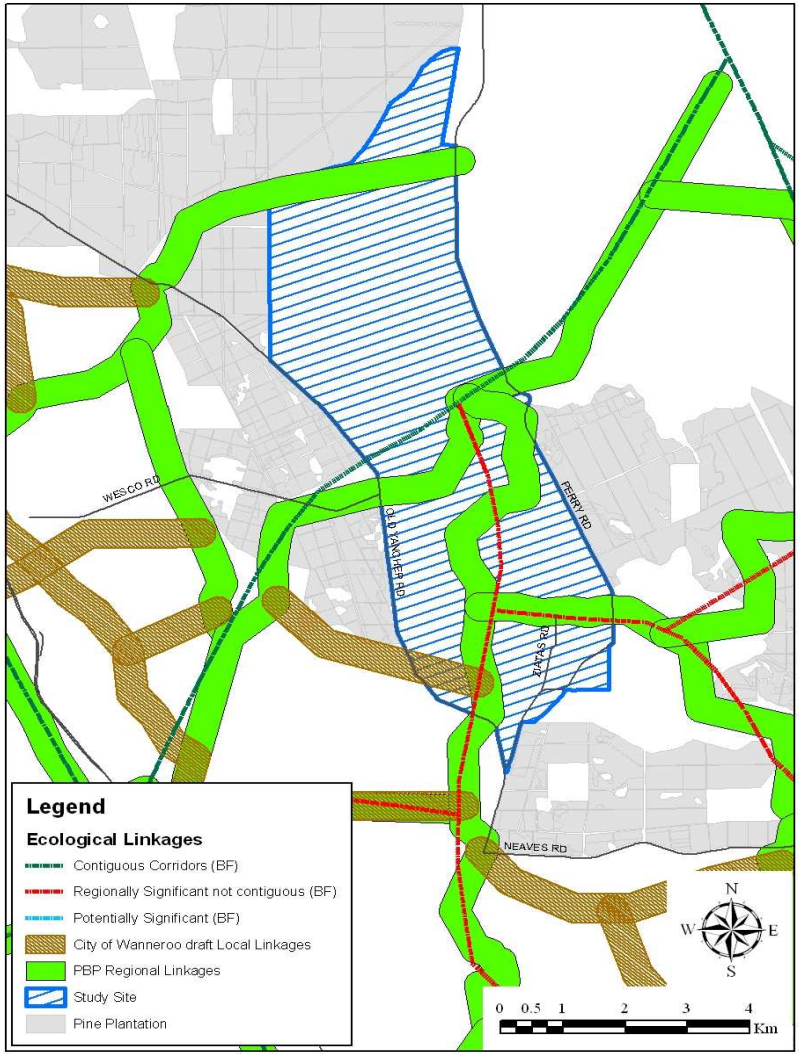
Recently these linkages were reviewed and conceptual ecological linkages proposed for both the pine plantations (post-harvesting) (Brown *et al.* 2009b) and the GSS study area as a whole (Brown *et al.* 2009a). These conceptual linkages utilised previous studies (including those mentioned above) in combination with community consultation and newly sourced information to build on the proposals of previous work (Figure 2b). Along with the ranking of each individual bushland patch, these reports and previous studies have guided the placement of ecological linkages throughout, and adjoining Lake Pinjar.

Potential ecological linkages have been defined within this study site that visually meet the following criteria:

- Meets the regional linkage objectives for the broader GSS project;
- Links the best condition and largest bushland remnants together in a minimum 500m wide linkage

These were then finalised based on the location of ecological linkages proposed by the GSS and the location of areas with greater than 60% remnant vegetation, within 2 km^2 (utilising the guidelines in (Davis 2009).

a)



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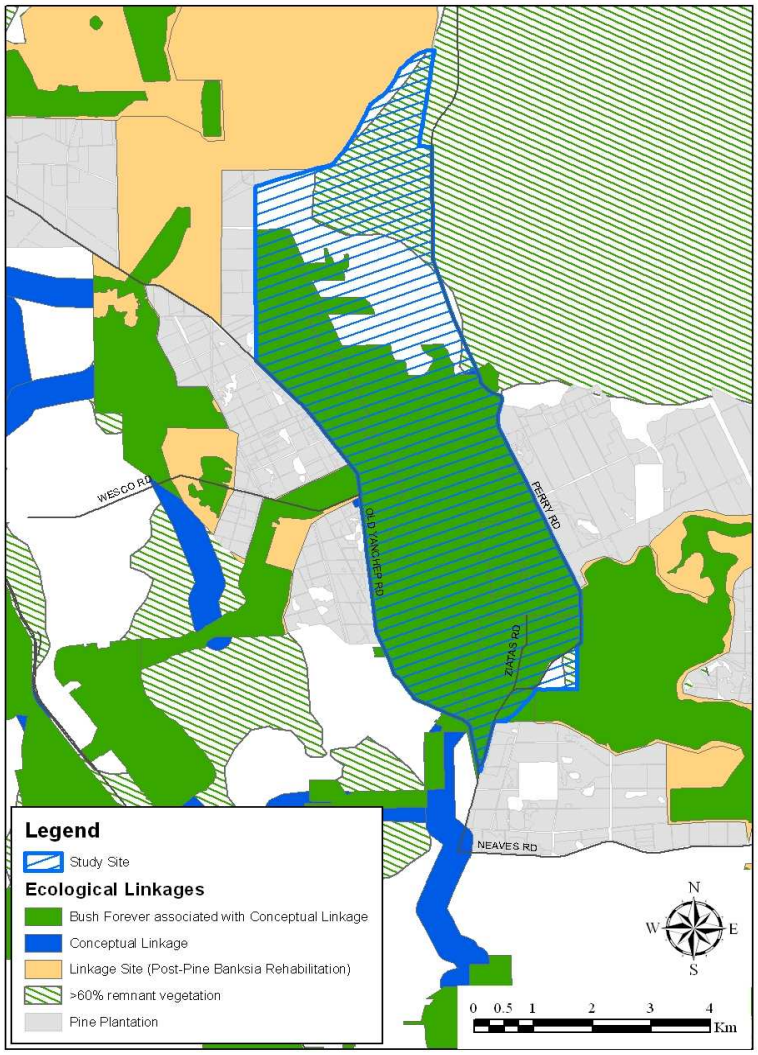

Figure 2: Previous ecological linkages from a) regional studies and local government and b) the Gnangara Sustainability Strategy

Results and Discussion

Bushland extent and condition survey

Bushland patch extent, size and distribution

A total of 1641 ha of potential remnant native vegetation were identified, visited and assessed, in 115 patches. However 16 ha (5 patches) of these were found to be completely cleared of native vegetation. In addition, as Bush Forever (Government of Western Australia 2000a) and (2000b) defined bushland as native vegetation in good or better condition based on the Keighery (1994) condition scale, a further 45 ha in 13 patches were assessed as 'Degraded', labelled as native vegetation and not included in the subsequent analysis of 'bushland' remnants (Figure 3).

The attributes of the remaining 1580 ha, in 97 bushland patches, ranged in size from 0.1 to 583 ha (Figure 4a). The majority of bushland patches were within 0 – 10 ha, or more specifically 1 – 5 ha. This range in size resulted in an average perimeter distance of 2253 m and an average perimeter to area ratio of 0.038 (Figure 4b). This average perimeter to area ratio conforms to the value used within the City of Wanneroo's Local Biodiversity Strategy (City of Wanneroo 2008) as a guideline for viability. They used a perimeter to area ratio of 0.04 as a general guideline for determining the viability of a natural area, where viability can be defined as the ability of an ecological community to be self-sustaining in supporting and maintaining the full range of living organisms it naturally contains, over a long time frame (Western Australian Local Government Association 2004).

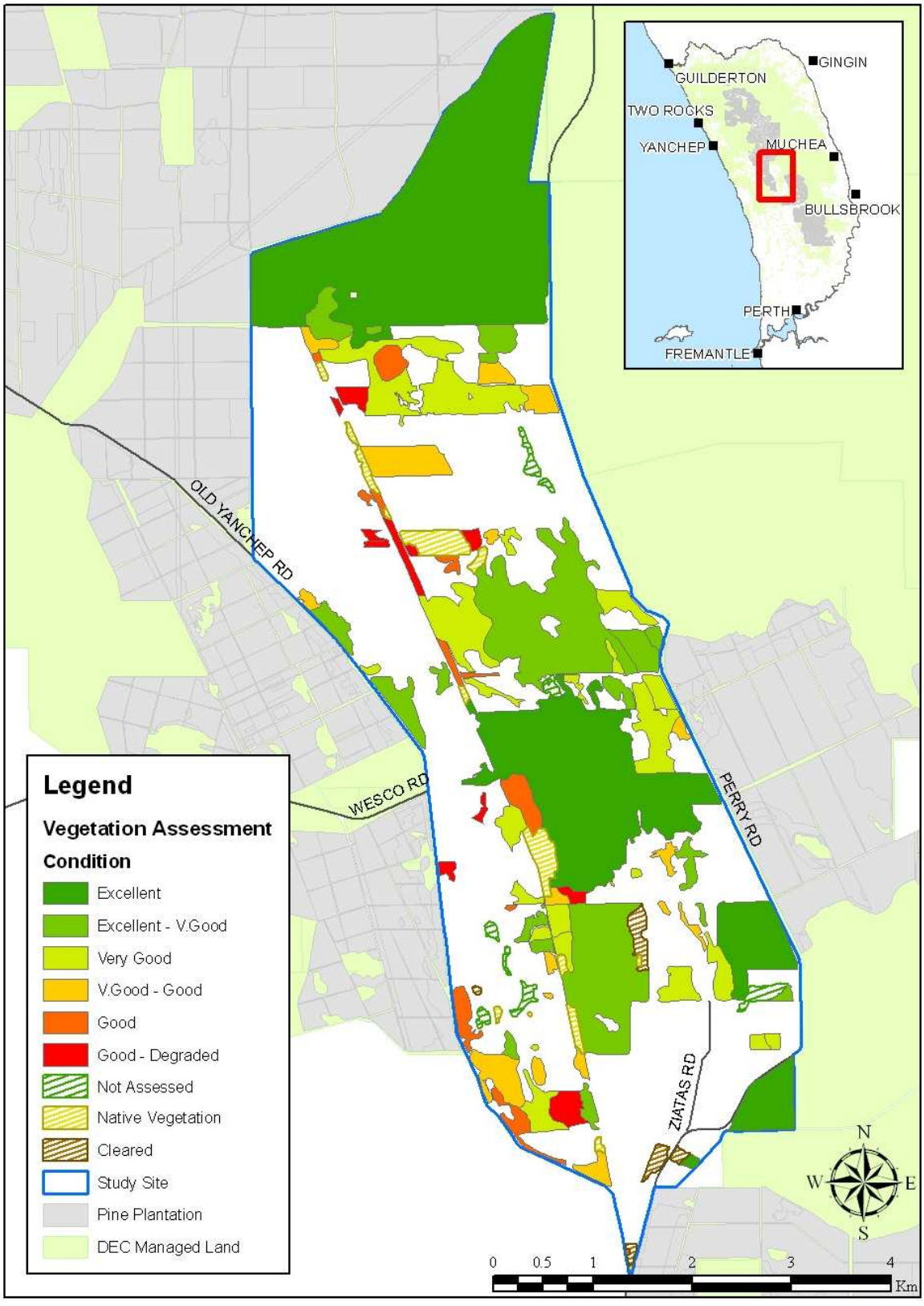

Figure 3: Bushland extent with associated vegetation condition rating. Cleared patches and degraded native vegetation are also illustrated.

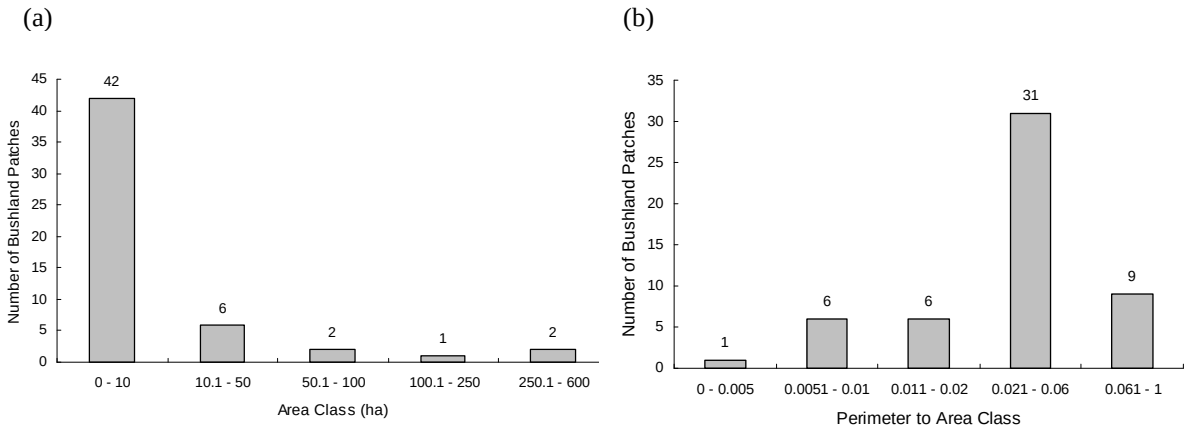

Figure 4: The distribution of patch (a) area and (b) perimeter to ratio classes within the study site.

The bushland patches were not evenly distributed within the study site. The greatest number of bushland patches occurred in the centre and along the eastern edge. However there were seven large discrete patches (composed of many smaller bushland patches due to condition rating or landform variations) which contributed to the uneven distribution of the remnant vegetation bushland patches.

Vegetation condition in bushland patches

Overall there were a greater number of bushland patches rated as Excellent (53%) than any other category. The condition rating of Excellent-Very Good had the second largest area attributed to it (21%) and the total area within each condition rating then continued to decrease as the condition declined (Figure 5).

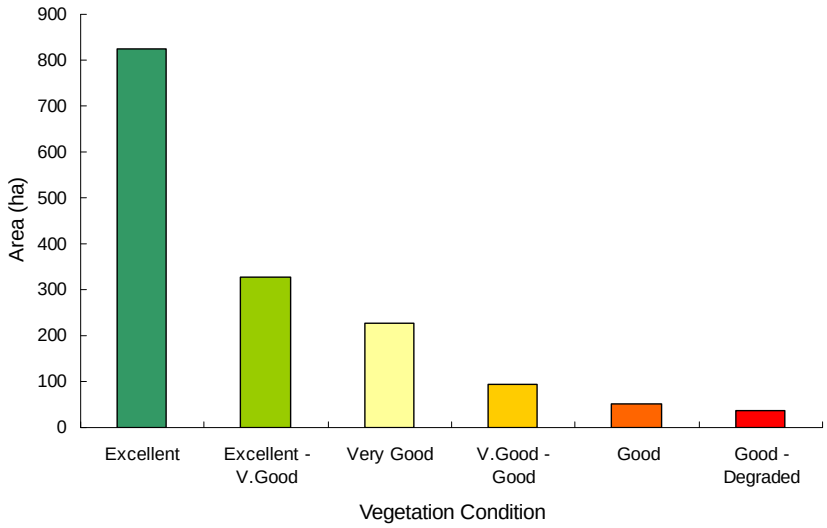

Figure 5: Total area of bushland patches within each condition rating category

The relationship between condition and landform revealed that the uplands were more frequently in Excellent condition than the wetlands. Of the uplands, 84% were rated as Excellent, however only 29% of the wetlands fell within this condition rating category. Conversely, the proportion of wetlands within the Excellent – Very Good and Very Good categories was greater than that of uplands (Figure 6a). However, if the largest patch is removed from the analysis (an upland landform), these relationships change slightly as the percentage of Excellent uplands decreases to only 44%, and thus the proportions of other condition categories, for both landforms, are more similar (Figure 6b).

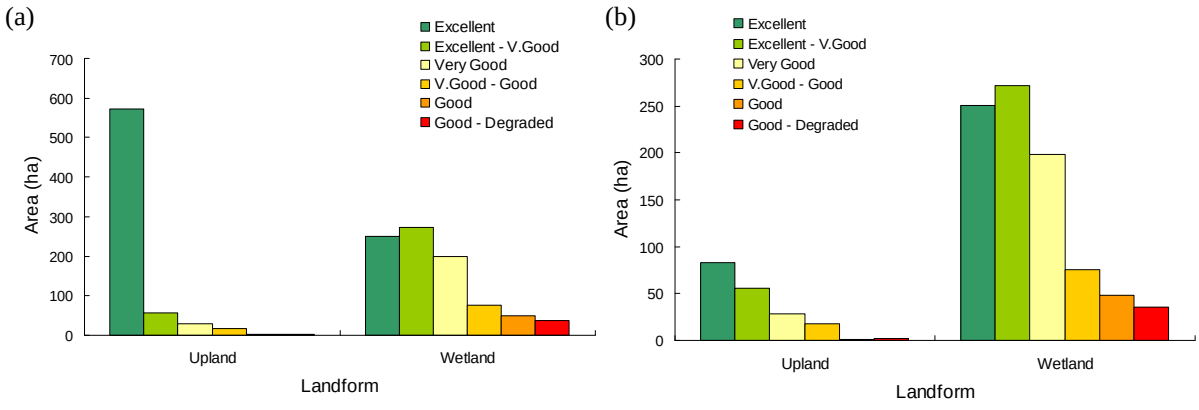

Figure 6: The proportion of each landform within the six vegetation condition categories (a) before the largest patch is removed and (b) after the patch is removed.

Figure 7 illustrates some of the wetlands found at Lake Pinjar, including examples of wetlands which are in excellent and degraded conditions. Another example of a wetland

with a different vegetation composition is illustrated in Figure 8 as well as a *Banksia* woodland upland.

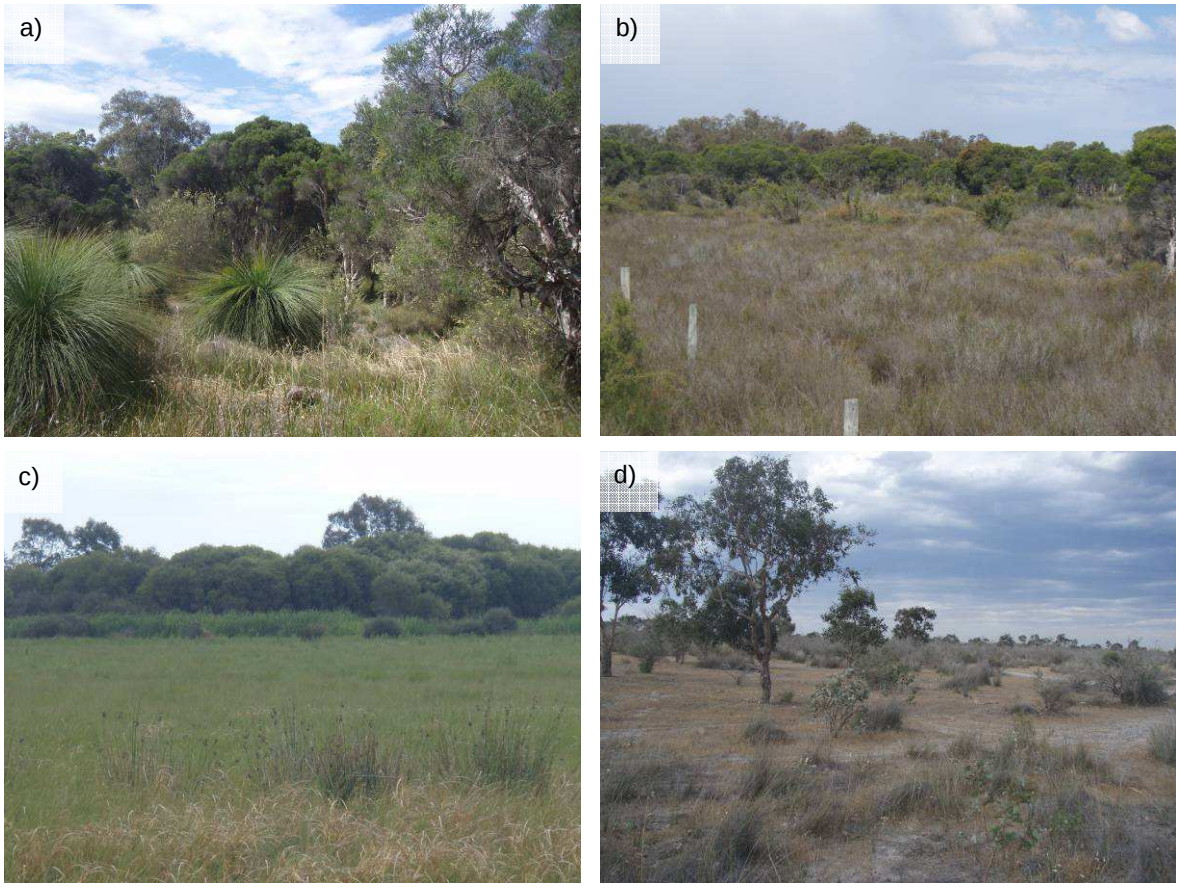

Figure 7: Wetlands of varying vegetation condition and structure within Lake Pinjar. Both a) and b) are from the same patch, categorised as excellent, c) pasture in the foreground with wetland categorised as Excellent – Very Good and d) Good - Degraded wetland.

Figure 8: a) Wetland in Very Good to Good vegetation condition and b) a *Banksia* woodland upland in Excellent condition.

Ranking of bushland patches

The total scores of the bushland patches ranged from four to 19, with 19 being the maximum score achievable. Only one patch scored 19 with the majority scoring 16. The scores were divided into classes (Table 6) to give an indication of which patches may have higher ecological values. Figure 9 shows the final ranking of the bushland patches as well as the location of the proposed ecological linkages.

Table 6: Total scores and their associated score classes used to rank the bushland patches.

Score	Polygon Count	Polygon Count (%)	Score Classes
4	1	1	Very Low
5	2	2.1	
6	6	6.2	
7	10	10.3	
8	5	5.2	Low
9	11	11.3	
10	9	9.3	
11	8	8.2	
12	4	4.1	
13	8	8.2	Moderate
14	5	5.2	
15	8	8.2	
16	12	12.4	
17	3	3.1	High
18	4	4.1	
19	1	1.0	

Of the 19 patches that ranked the lowest, 11 were not assessed directly in the field including seven which were not assigned a vegetation condition category. As no category was assigned, no condition score was attributed and the final score for the bushland patches concerned was lower than others as they had one less attribute included. This meant that they received a lower final rank and therefore possibly should have received a higher rank; however this cannot be confirmed until the sites are assessed in the field.

The rank of the vegetation complex (based on the levels of retention and protection) to which each bushland patch belonged was not used when ranking the patches. As the majority of them occur on the Pinjar complex, assigning a score based on the restriction, retention and reservation of vegetation complexes would not have helped distinguish the ecological value of each patch.

Three of the eight bushland patches within the high score class were located within an ecological linkage proposed by this study. The percentage of patches located outside of the linkages was lower for the moderate and low score classes however it then increased for the very low score class. The five highly ranked patches that were not located in an ecological linkage are components of one discrete patch. This patch, in the north of the study area, is adjacent to a proposed post-pine ecological linkage. Additionally this bushland patch is a component of an even larger patch of remnant vegetation, extending beyond the study site which has >60% remnant vegetation. These two features meant that an ecological linkage was not proposed for the northern third of the study area as it met the landscape threshold value and was already linked to the west through the post-pine linkage.

The landscape threshold value of 60% remnant vegetation was identified using information on the landscape requirements of sensitive avifauna species on the Swan Coastal Plain (Davis *et al.* 2008). This research identified a threshold of 61% total vegetation cover within a $2km^2$ area for the most sensitive species (scarlet robin). Community workshops and specialist advice clarified that areas of the landscape that had >60% remnant vegetation would provide adequate habitat for most bush birds and therefore did not need additional linkages designated within them. This was adopted as a guideline when regional ecological linkages were proposed for the GSS study area, and has also been utilised in this study.

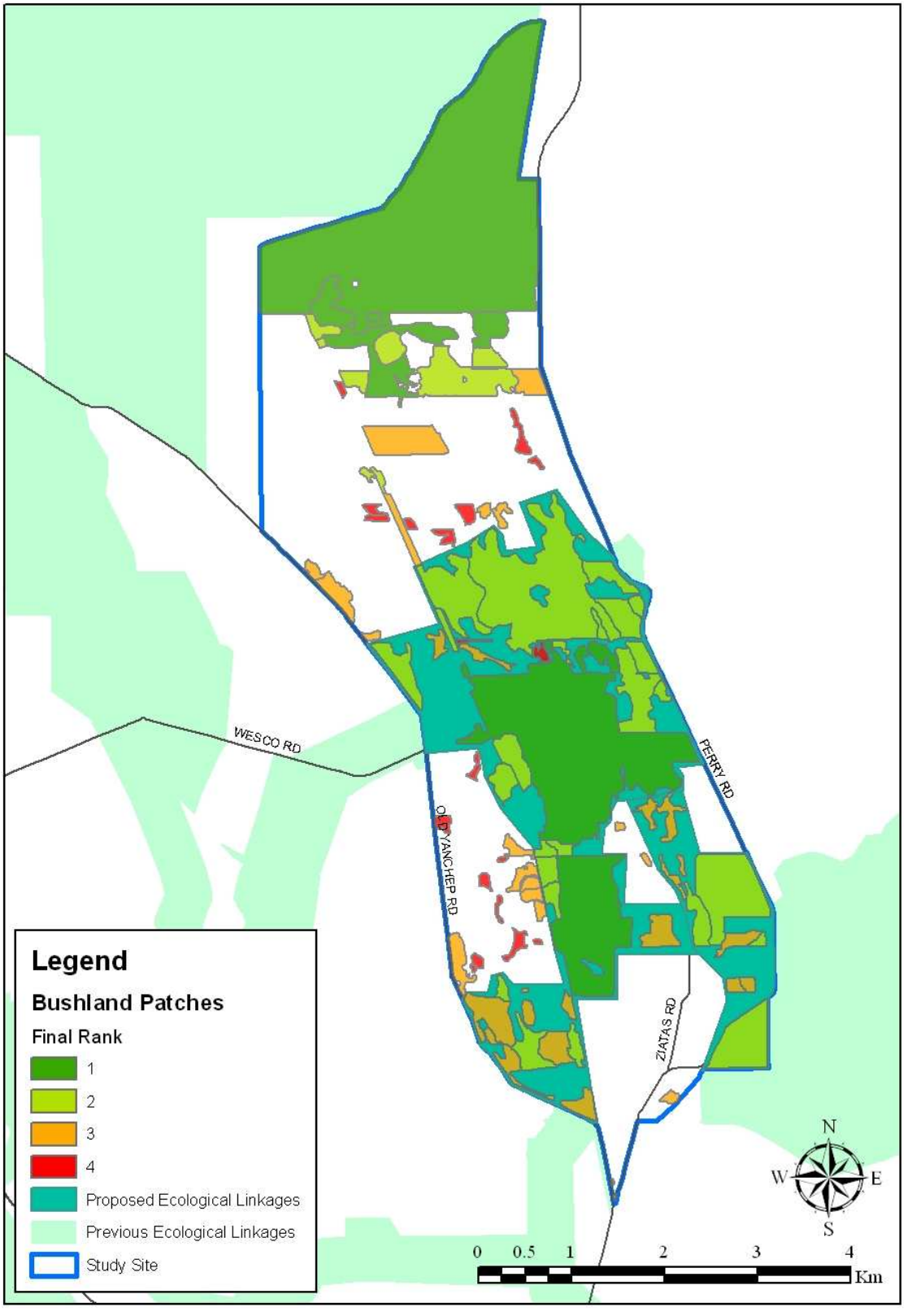

Figure 9: Bushland patches (showing final rank) and associated proposed ecological linkages.

Delineating ecological linkages

Almost 40% of the study site is proposed to be included within an ecological linkage with approximately half of the surveyed bushland patches incorporated. The two ecological linkages are generally in a north-south direction however one linkage contains two components which link the central component to bushland, within proposed linkages, in an east and west direction (Figure 9). Of the 1280 ha designated as ecological linkages, only 34% (434 ha) is not remnant vegetation, therefore requiring rehabilitation.

The two linkages aim to increase the connectivity of Lake Pinjar's vegetation by creating connectivity internally as well as utilising previously proposed linkages to connect it externally. As mentioned previously, no linkages have been proposed for the northern third of Lake Pinjar as bushland in this area is already considered to be connected to surrounding bushland, assuming previously proposed linkages are implemented, and no clearing occurs within the Unallocated Crown Land to the east. Linkages within the remainder of the study site not only connect with the conceptual linkages proposed by the GSS but also incorporate the proposals by previous studies such as Bush Forever and Perth Biodiversity Project.

Management actions

There is a need to prepare a policy document and associated prescriptions relating to the ongoing management and maintenance of ecological linkages and their incorporated bushland blocks throughout Lake Pinjar. Weed invasion and off road vehicles are two issues which were commonly noted as impacting on vegetation during the field surveys (Figure 10), however the subjects of land use planning and vesting will also need to be addressed.

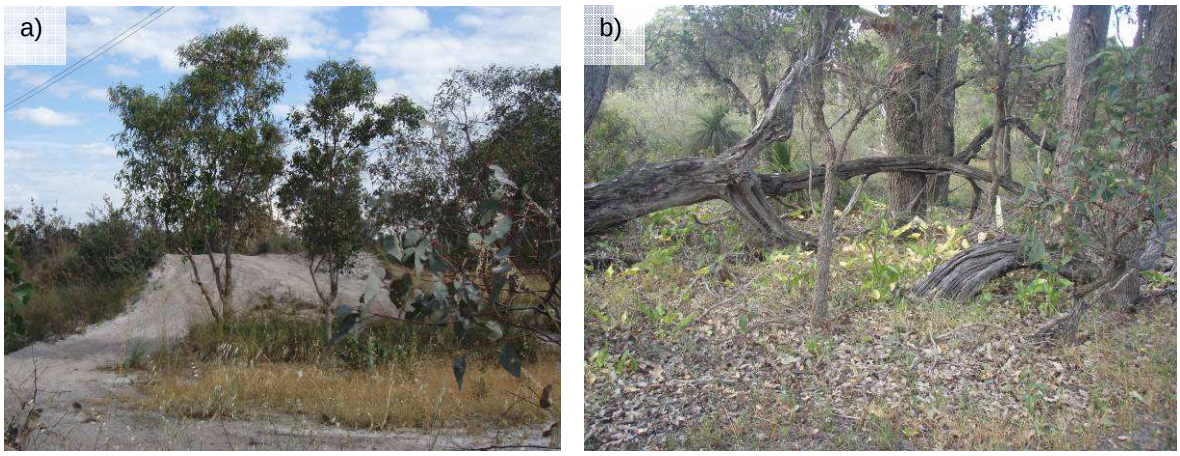

Figure 10: Impacts on vegetation include a) off road vehicles and associated tracks and b) weed infestations such as arum lilies (*Zantedeschia aethiopica*), a declared weed.

A few appropriate actions have been listed below as a start to discussions. Such management actions will need to address a whole range of threatening processes and conservation issues, including:

- acquisition of privately owned land within the linkages
- land purchased by the State to be transferred from the WAPC to the Conservation Commission to be added to the conservation estate and be managed by the DEC.
- *Phytophthora* dieback hygiene, survey and control.
- prescribed burning, fire access and wildfire response plans prepared
- removal of tracks and roads within ecological linkages
- weed control
- public access and off road vehicles, particularly in the SW corner

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