

Appendix G Biological Survey Adequacy and Limitations

FLORA AND VEGETATION SURVEYS

Flora and vegetation survey (Ecological 2019, Woodman 2019, 2020)

The table below displays the evaluation of the flora, vegetation and fauna assessment against a range of potential limitations that may have had an effect on that assessment. Based on this evaluation, the assessment has not been subject to constraints that would affect the thoroughness of the assessment and the conclusions reached.

Flora, vegetation and fauna survey – limitations and constraints

Potential limitation	Impact on assessment	Comment
Sources of information and availability of contextual information (i.e. pre-existing background versus new material).	Not a constraint.	<p>Woodman (2019): Reasonable contextual information for the Study Area was available prior to the survey. Sources of information used included government databases (DBCA), which are known to have been extensively populated with data from numerous surveys conducted in the general vicinity of the Study Area, as well as numerous general sources pertaining to the climate, geomorphology, flora and vegetation of the Swan Coastal Plain, and several surveys conducted in the local area, including some that overlapped the Study Area.</p> <p>Woodman (2020): Good contextual information for the Study Area was available prior to the survey. Sources of information used included government databases (DBCA, DAWE), previous unpublished reports and data from the vicinity of the Study Area (Eco Logical 2019; Spectrum 2018; 360 Environmental 2014; GHD 2012; Woodman Environmental 2006) as well as numerous general sources pertaining to the climate, geomorphology, flora and vegetation of the Swan Coastal Plain.</p> <p>Ecological (2019): Broad-scale vegetation mapping at a scale of 1:250,000 was available (Beard 1979, Shepherd et al 2002). Geology, landform and soils mapping at a scale of 1:250,000 was also available (Geological Survey of WA and Geoscience Australia 2008). The information which was available was sufficient and as such sources of information were not considered a major limitation.</p>
Scope (i.e. what life forms, etc., were sampled).	Not a constraint.	<p>The survey requirement of a Detailed and Targeted flora and vegetation survey in accordance with the EPA Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016) was adequately met.</p> <p>Due to the degraded nature and uniform distribution of vegetation within the survey area</p>

Potential limitation	Impact on assessment	Comment
		and timing of the survey (i.e. spring); most life forms are likely to have been sampled adequately during the time of the survey.
Proportion of flora/fauna collected and identified (based on sampling, timing and intensity).	Not a constraint.	<p>The proportion of flora surveyed was adequate. The entire survey area was traversed, and flora species were recorded systematically.</p> <p>Woodman (2019): Only dominant species were recorded. Data suitable to describe vegetation units and identify where the potential exists for conservation significant vegetation and/or flora to be present.</p> <p>Woodman (2020): All vascular groups that were present in the Study Area were sampled. A high proportion of perennial vascular taxa were recorded based on the intensity and method of survey, and almost all could be positively identified. A high proportion of annual vascular taxa were recorded based on the intensity and method of survey; however, detection and identification of some annual taxa may have been limited by below average rainfall recorded prior to the survey (during July – October 2019; see timing/weather/season/cycle below). Unknown vascular taxa were collected, with specimens identified at the WA Herbarium.</p> <p>Ecological (2019): The survey effort was adequately met. The area was surveyed for conservation significant flora species and vegetation communities by field staff undertaking transects across the survey area spaced 5-20 m apart on average. This method provided an accurate assessment of habitat characteristics and likelihood of conservation significant species. The number of quadrats established was sufficient to determine the vegetation communities present and to identify any vegetation of conservation significance. Adequacy of sampling effort was tested via a species accumulation curve; approximately 69% of the flora potentially present within the survey area was recorded.</p>
Completeness and further work which might be needed (i.e. was the relevant survey area fully surveyed).	Not a constraint	<p>The information collected during the survey was sufficient to assess the vegetation that was present during the time of the survey.</p> <p>Ecological (2019): The survey area was surveyed to the satisfaction of the scope and a Detailed and Targeted flora and vegetation survey as per relevant guidelines. Two taxa were not identified to genus level and nine taxa were not identified to species level. It is unlikely that any of the taxa are conservation significant.</p>

Potential limitation	Impact on assessment	Comment
Mapping reliability.	Not a constraint.	<p>Aerial photography of a suitable scale was used to map the survey area and identify potential fauna habitat. Sites were chosen from these aerials to reflect changes in community structure. Opportunistic sites were also used if differences were observed during on ground reconnaissance. Vegetation types were assigned to each site based on topography, soil type and presence/absence and percent foliage cover of vegetation.</p> <p>Broad-scale vegetation mapping at a scale of 1:250,000 was available (Beard 1979, Shepherd et al 2002). Geology, landform and soils mapping at a scale of 1:250,000 was also available (Geological Survey of WA and Geoscience Australia 2008). The information which was available was sufficient and as such sources of information were not considered a major limitation.</p>
Timing, weather, season, cycle.	Not a constraint.	<p>Flora and vegetation surveys are normally conducted following winter rainfall in the South-West Province, ideally during spring (EPA 2004). The field assessment was conducted in November (i.e. spring), in the 2016 and 2017 survey in fine weather conditions and therefore these factors are not deemed to be constraints.</p> <p>Woodman (2019): Although the survey was not conducted within what is considered to be the usual appropriate season for survey in the Swan Coastal Plain bioregion (spring), dominant taxa were able to be identified to allow for broad vegetation type mapping.</p> <p>Woodman (2020): The majority of the survey was conducted within what is considered to be the appropriate season for survey in the SCP bioregion (Spring). However, the lower than average rainfall in July – October 2019, in combination with higher than average temperatures in July – October 2019, may potentially have resulted in the abundance of annual taxa being affected, as well as sooner than expected senescence of such taxa. It is not known if the rainfall received was insufficient for germination of any taxa. Some targeted survey was conducted in April 2020, however, this survey targeted perennial taxa that are distinct at any time of year only</p> <p>Ecological (2020: The survey area is located in the Swan Coastal Plain bioregion of Western Australia. Recommended survey timing for this region is in spring (September- ovember; EPA 2016). The field survey was undertaken in mid-November. Many flora species were flowering at</p>

Potential limitation	Impact on assessment	Comment
		<p>the time of the field survey or had sufficient material (fruit) available to identify majority of the dominant and target species. The timing was appropriate for conducting this level of survey. For two conservation significant species however, conditions were not suitable to enable detection. <i>Tetraria australiensis</i> (EPBC Act VU, BC Act T rank VU) and <i>Diuris purdiei</i> (EPBC Act EN, BC Act T rank EN) both require fire to initiate flowering and as no fire had occurred recently within the survey area, these species may not have been detectable. Additionally, many taxa in the Cyperaceae family had dried off at the time of the survey which limited the availability of sufficient material to enable positive identification.</p>
Disturbances (fire flood, accidental human intervention, etc.).	Not a constraint.	<p>The survey area and regional surrounds have been subject to disturbance over a significant period of time. Given the wide range of this disturbance, this is not considered to be a limitation within the survey area.</p> <p>Woodman (2019): The vegetation in the study area is highly disturbed due to clearing, weeds etc. This made the resolution of Vegetation Units somewhat difficult in the field in some instances.</p> <p>Woodman (2020): There was no evidence of fires having burnt the vegetation in recent years, or evidence of any other significant disturbances.</p> <p>Ecological (2020): Disturbances within the survey area included the presence of weeds, minor rubbish dumping and decline of vegetation condition due to edge effects. These disturbances did not negatively impact the ability to meet objectives outlined in the scope of works.</p>
Intensity (in retrospect, was the intensity adequate).	Not a constraint.	<p>The survey area was traversed on foot and all differences in vegetation structure were recorded appropriately.</p>
Resources (i.e. were there adequate resources to complete the survey to the required standard).	Not a constraint.	<p>For all surveys the available resources were adequate to complete the survey. The personnel that conducted the field survey are both suitably qualified to identify specimens having previously undertaken numerous flora and vegetation surveys on the Swan Coastal Plain.</p>
Access problems (i.e. ability to access survey area).	Not a constraint.	<p>Existing tracks enabled adequate access to survey the vegetation and fauna within the survey area. Where access was not available by car, the area was easily traversed by foot.</p> <p>Woodman (2019): Some landowners denied access to properties within the Study Area. However, all areas of intact vegetation could be adequately surveyed with no-access areas</p>

Potential limitation	Impact on assessment	Comment
		<p>containing only highly degraded remnants or were observable from fence lines.</p> <p>Woodman (2020): The Study Area was accessed either via the roads, tracks or on foot and there were no access issues which hindered the survey extent.</p> <p>Ecological (2020): All relevant areas of the survey area were easily accessed and able to be surveyed.</p>
Experience levels (e.g. degree of expertise in species identification to taxon level).	Not a constraint.	<p>All survey personnel have the appropriate training in sampling and identifying the flora of the region.</p> <p>Woodman (2019, 2020): Lead Surveyor has extensive experience (>10 years) in conducting similar assessments on the Swan Coastal Plain. Personnel conducting plant identifications have had >10 years' experience in plant identification in the Swan Coastal Plain.</p>

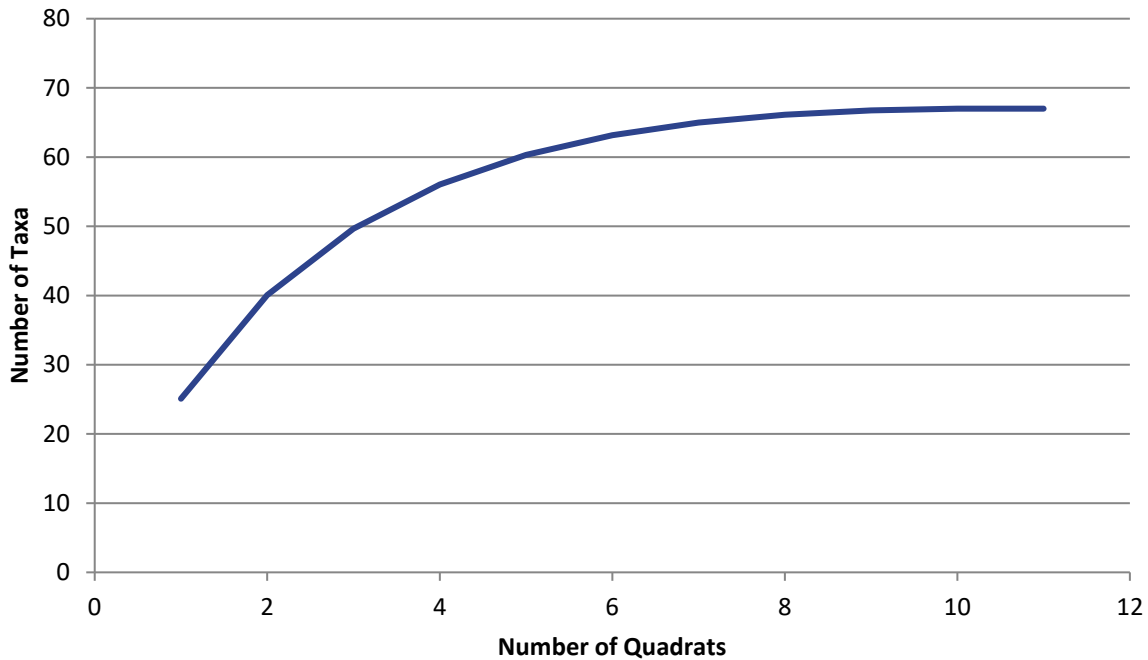
For Woodman (2020): Adequacy of Survey

The Study Area covers approximately 362 ha, the majority of which (94.8 %) is either cleared or highly modified. Within the remaining 5.2 % of the Study Area, 11 quadrats and 13 relevés were established in all preliminary vegetation patterns discernible by initial aerial photograph interpretation, both to adequately sample variation in vegetation throughout the Study Area and to ensure adequacy of sampling for vascular plant taxa. The number of quadrats and relevés established in the Study Area is considered to be an acceptable number given the limited amount of intact vegetation present.

To provide an indication of the adequacy of this survey, a taxon accumulation curve was produced using PC-Ord (McCune and Mefford 2011). Taxon accumulation curves represent a theoretical model of the relationship between sampling intensity and taxon accumulation; when sampling intensity is increased, taxon accumulation is reduced, and a taxon accumulation curve becomes asymptotic.

The taxon accumulation curve for quadrat data from the Study Area was generated using all native taxa (both annual and perennial) recorded within each quadrat. Taxon accumulation calculations for the Study Area were then undertaken utilising the Chao-2 estimator for species richness (Chao 1987) and compared to the actual number of taxa recorded in the Study Area. This provides some indication as to whether sufficient quadrats were surveyed to adequately sample the species richness in the Study Area. As the generation of species accumulation curves includes quadrat data only, and not taxa recorded during targeted searching or otherwise opportunistically recorded, the indication of adequacy of survey provided is considered to be conservative.

The species accumulation curve generated from quadrat data from the Study Area is provided. As the curve is asymptotic in this case, the recorded number of taxa within quadrats equals the estimated taxon richness in the Study Area. It is therefore considered that the Study Area was relatively well-sampled with regard to this estimation measure; it should be noted, however, that this analysis is potentially not appropriate given the very small area of vegetation sampled via quadrats.



Study Area Quadrat Data Species Accumulation Curve

Another adequacy of survey measure is that developed by Mueller-Dombois and Ellenberg (1974), who suggest that an adequacy cut-off point might be when a 10 % increase in quadrats surveyed results in a 5 % (or less) increase in taxa recorded. This measure was also calculated using all native taxa recorded within each quadrat. The number of quadrats established in the Study Area satisfies this adequacy measure suggested by Mueller-Dombois and Ellenberg (1974), with the final taxon increase value of 0 % recorded following the final 10 % increase in quadrats.

FAUNA SURVEYS

Black Cockatoo Surveys (Kirkby 2020; Strategen-JBS&G 2020)

The table below provides an evaluation of the Black Cockatoo hollow assessment (Kirkby 2020) and Black Cockatoo habitat assessment (Strategen-JBS&G 2020) against a range of potential limitations that may have an effect on that assessment. Based on this evaluation, the assessment has not been subject to constraints that would affect the thoroughness and conclusions reached.

Black Cockatoo survey(s) limitations and constraints (Kirkby 2020; Strategen-JBS&G 2020)

Potential limitation	Impact on assessment	Comment
Competency/ experience of the consultant carrying out the survey.	Not a constraint.	All survey personnel have the appropriate training and experience in surveying for the target species.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	Not a constraint.	Three species of Black Cockatoo, specifically Carnaby’s Cockatoo, Baudin’s Cockatoo and Forest Red-tailed Cockatoo were targeted by this survey, and methodology was designed appropriately (e.g. hollow assessment with camera-mounted pole, photographic evidence of suitable breeding hollows, records of foraging evidence).
Proportion of fauna identified, recorded and/ or collected.	Not a constraint.	Foraging evidence from Baudin’s Cockatoo and Forest Red-tailed Cockatoo was recorded. No evidence of foraging by Carnaby’s Cockatoo was

Potential limitation	Impact on assessment	Comment
		observed. No sightings of Carnaby's Cockatoo, Baudin's Cockatoo or Forest Red-tailed Cockatoo were recorded during the surveys. No fauna were collected.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Not a constraint.	The survey was conducted of the three species of Black Cockatoo, all of which have been well-studied and documented with ample literature available.
The proportion of the task achieved and further work which might be needed.	Not a constraint.	The entire task was achieved. All trees of suitable DBH ≥ 500 mm were inspected. All remnant vegetation within the Proposed Action area was assessed for foraging quality. No additional work is anticipated to be needed.
Timing, weather, season, cycle.	Not a constraint.	The survey was conducted in Spring, during the known breeding periods for all three species of Black Cockatoo.
Disturbances (e.g. fire, flood, accidental human intervention etc) which affected the results of the survey.	Not a constraint.	The Proposed Action area has not been subject to fire or other significant disturbance in the recent past.
Intensity (in retrospect, was the intensity adequate).	Not a constraint.	The Proposed Action area was traversed on foot utilising pre-existing survey data. Every tree containing hollows was assessed. All remnant vegetation was assessed.
Completeness (e.g. was relevant area fully surveyed).	Not a constraint.	The entire Proposed Action area was traversed during the survey. All trees with a DBH ≥ 500 mm were inspected and all remnant vegetation within the Proposed Action area was assessed.
Resources (e.g. degree of expertise available in animal identification to taxon level).	Not a constraint.	The available resources were adequate to complete the survey.
Remoteness and/or access problems.	Not a constraint.	Local roads and internal access was adequate.
Availability of contextual (biogeographic) information on the region.	Not a constraint	The survey was undertaken in the Swan Coastal Plain bioregion, which has been well studied and documented with ample literature available.