Government of **Western Australia**
Public Transport Authority

Forrestfield Airport Link Project

Survey of Floristic Community Types East of Dundas Road – Addendum Report

Prepared by

RPS

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SURVEY OF

FLORISTIC COMMUNITY TYPES

EAST OF DUNDAS RD,

FOR THE

FORRESTFIELD AIRPORT LINK

PROJECT

ADDENDUM REPORT:

ADDITIONAL ANALYSIS

Prepared for
Public Transport Authority of Western Australia

by

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May 2015

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1.0 INTRODUCTION

1.1 Background

The Forrestfield-Airport Link project aims to construct a spur rail line from the Bayswater Station/Midland line through to the eastern suburb of Forrestfield and includes a station servicing the Perth airport.

In 2014 a study that included 10 quadrats in two areas in the High Wycombe locality (Areas 3 and 4, Figure 1), was undertaken for the Public Transport Authority (PTA) to confirm the vegetation Floristic Community Types (FCTs) and hence the presence of Threatened Community Types (TECs) in those areas.

However, the statistical results of the study were not definitive and were not consistent with mapped TECs east of the study area and in the same locality. In addition, a review of the results suggested that the higher number of weed species present in the study area sites than in Gibson *et al*. (1994) FCT sites suggested that weed species may be biasing the results. It was also considered that the inclusion of DPaW data collected on the SCP after the Gibson *et al*. (1994) SCP study and subsequently analysed with the Gibson *et al*. (1994) dataset ('supplementary data') and which included additional sites on the eastern SCP, could improve the accuracy and clarity of the results.

1.2 Scope of the study

The PTA directed that further analysis be undertaken on the data collected during the 2014 survey and that the additional analysis should include re-running PATN analysis of field data against the Gibson *et al*. (1994) SCP dataset following:

- The removal of weed taxa from both data sets.
- Inclusion of DPaWs 'supplementary data' and the removal of weed taxa from all datasets.

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LEGEND

Survey Area

AREA 3

AREA 4

DUNDAS ROAD

MAIDA VALE ROAD

KEWDALE FREIGHT TERMINAL

Job Number: 11323907
Doc Number: 004
Date: 20.04.15
Scale: 1:5,000 @ A3
Created by: RA
Source: Orthophoto - Landgate, Nov 2014

GDA 1994 MGA Zone 50

0 50 100 200 m

Figure 1

Site Location

2.0 METHODS AND LIMITATIONS

2.1 PATN analyses of vegetation units and Floristic Community Types (FCTs)

2.1.1 Introduction

The PATN analyses (numerical classification techniques) compared the similarity of species presence data collected at the 10 survey quadrats with the 509 site SCP dataset (Gibson *et al*., 1994). The methodology for the two analyses undertaken for this report was the same as that outlined in detail in the main report (Morgan, 2015), with the exception that in the first analysis weed species were removed from the combined datasets, while in the second analysis the dataset included an additional 590 DPaW supplementary sites in the SCP dataset (total of 1098 sites) and weed species were removed from all datasets (Keighery, 2012). Mr Ted Griffin undertook the analyses and has outlined and detailed the methods used in his reports (Appendices 1 and 2).

2.1.2 Data compatibility

The survey data was reasonably compatible with the SCP dataset, in that both datasets were based on data collected from quadrats of the same size (10 metres by 10 metres) from two visits per site including one in optimal season (Spring). Most of the survey quadrats were also recorded in vegetation that was in 'Very Good' condition and had high species counts. The exceptions to this were three quadrats in Area 3 (ARQ7, ARQ8 and ARQ11) on the Poison Gully creek banks and adjacent slopes. Overall, the differences in quadrat sampling with the DPaW datasets were kept to a minimum, with the exceptions noted above (particularly quadrat ARQ7).

2.1.3 Data preparation

Plant taxa names were reconciled between the survey data, the Gibson *et al*. (1994) data and the Keighery *et al*. (2012) dataset. This process was outlined in Morgan (2015).

Weed species were removed from the datasets.

2.1.4 PATN analyses and determination of FCT

Two analyses were undertaken with the following characteristics:

- Dataset of 10 survey quadrats with the 509 site Gibson *et al*. (1994) SCP dataset, with weed species removed from the combined dataset.
- Dataset of 10 survey quadrats with the 1098 Keighery *et al*. (2012) SCP dataset (comprised of 508 Gibson *et al*. (1994) SCP dataset and 590 supplementary sites, reconciled to 2005 taxonomy).

The PATN analyses used dendrogram classification (with both an 'all site' classification and a single site insertion (SSI) classification) and a nearest neighbour (NNB) analysis as methods to determine site FCTs.

The SSI classification analysis involved running the cluster analysis for each survey site, one at a time, with the respective SCP datasets. SSI is considered a more powerful and reliable means of deriving a dendrogram classification for each survey site as it causes less 'disruption' of the clustering of the SCP datasets. When all survey sites are included together in a clustering analysis with the SCP dataset sites 'all site analysis', it can cause disruption and some reorganisation of the SCP sites. The SSI classification analysis is closely analogous to the Gibson *et al*. (1994) analysis that determined the FCTs because it uses the same algorithm for the classification used by Gibson *et al*. (1994), with only the one additional site considered.

The NNB analysis isn't a classification process, but is an indirect process for assigning a SCP FCT to a survey site by determining which SCP dataset sites are most floristically similar to it (measured by an index of dissimilarity). Each of the survey sites could, in turn, be assigned to the same FCT as that of the most similar SCP dataset sites.

DPaW undertook their study of the SCP supplementary sites with the Gibson *et al*. (1994) sites, using the PATN module ALOC, which 'fixed' the groupings of Gibson *et al*. (1994) sites (FCTs) and allocated the supplementary sites to those FCTs or, where site groups were too dissimilar, to new FCTs (see descriptions in Appendices 1 and 2). For this study, Griffin did not use the ALOC module.

2.1.5 Limitations of the floristic analysis

It has been found in other floristic analyses that the addition of new sites to the Gibson *et al*. (1994) SCP dataset to produce a combined classification, may disrupt

the original Gibson *et al*. (1994) classification of sites (Griffin and Trudgen, 2004). The more data that is added, the higher the level of disruption. If this occurs it can make it difficult to assign the new sites to a Gibson *et al*. (1994) FCT (Griffin and Trudgen, 2004). The application of a SSI classification largely overcame this limitation.

Another limitation in conducting a PATN floristic analysis using the above methods may arise depending on the degree of success in reconciling the data sets. A further limitation may arise from any significant differences in data collection methods between the two surveys. However, the data sets were considered reasonably compatible for this data analysis. Finally, the success of the PATN analysis to assign a SCP FCT to survey sites can be limited to the extent that the type of vegetation in the study area was sampled in the Gibson *et al*. (1994) SCP survey, allowing comparison with the outcomes of the SCP dataset analysis. The inclusion of the supplementary data significantly moderated this limitation since it included numerous sites from the eastern SCP and more particularly, from the study area locality.

3.0 FLORISTIC COMMUNITY TYPES, THREATENED ECOLOGICAL COMMUNITIES AND PRIORITY ECOLOGICAL COMMUNITIES

This section outlines the results of additional floristic analysis conducted by Mr Ted Griffin on the survey data and the SCP datasets. It is based on two reports prepared by Ted Griffin, which are included in Appendices 1 and 2.

3.1 Floristic analysis

3.1.1 PATN analysis and FCTs

The results for the Area 3 and Area 4 sites from the PATN 'all sites' and SSI classifications and NNB analysis of all survey sites (10 in Areas 3 and 4 and 6 in adjacent areas (not covered in this report)) for the 'no weeds' and 'supplementary & no weeds' analyses, are presented in Table 1. Results from the initial study (Morgan 2015) are also included in Table 1 for comparison.

It can be seen from Table 1 that the analysis with the weeds removed ('no weeds analysis') resulted in some, mostly small, changes in the FCT results, with a small shift towards FCT20a observed in some cases (sites ARQ5, ARQ10 and ARQ13). The detailed results for the 'no weeds analysis' are shown in Table 2 in Appendix 1.

The inclusion of the supplementary data ('supplementary & no weeds analysis') caused a very significant change in the results. In Area 3, the creek and gully vegetation sites (ARQ7 and ARQ8) firmed towards FCT3c, while the sites on the plain adjacent to Poison Gully moved towards FCT20a (ARQ5, ARQ6 and ARQ11). In Area 4 there was a significant change with four of five sites found to be FCT20a and the other site, ARQ14, found to be FCT20a/21a. The significant shift in the results towards FCT20a is due to vegetation floristics in survey area sites being similar to that in numerous FCT20a supplementary sites recorded in vegetation in the survey area locality and adjacent areas. For example, four of the five nearest neighbours to site ARQ5 were all FCT20a supplementary sites and seven of the ten nearest neighbours to ARQ5 were FCT20a supplementary sites (Table 1 in Appendix 2).

The FCTs mapped in Areas 3 and 4 were: FCT3c, FCT20a, FCT20b and FCT21c (Figures 2 and 3). Two of the quadrat FCTs presented problems for mapping FCTs. These problems and the resolution of the mapped FCTs were as follows.

i) Area 3, sites ARQ5 and ARQ6. The vegetation in these sites and on the surrounding plains areas on the north side of Poison Gully in Area 3 was interpreted as being floristically very similar. However, the FCT determined for ARQ6 varied from ARQ5 in including an affinity to FCT20c. It was decided to use the FCT determination for FCT5 (FCT20a/21c) for the broader vegetation unit because:

- Site ARQ5 was in an area of slightly better vegetation condition and vegetation at ARQ5 was interpreted as more representative of the plains unit;
- Site ARQ6 soils appeared slightly different in having more yellow sand present than other areas;
- There were no FCT20c SCP dataset sites in ARQ6's ten most similar NNBs (Table 1, Appendix 2).

ii) Area 4, ARQ14. Four of the five quadrats in Area 4 were determined as FCT20a. ARQ14 was found to be FCT20a/21a. It was decided to map all of Area 4 as FCT20a because:

- The majority of sites in Area 4 (four of the five quadrats) were FCT20a;
- Most of the western part of Area 4 vegetation floristically seemed similar to ARQ10 (rather than ARQ14, which was sited around a few small remnant Marri trees).
- The most similar SCP dataset NNB to ARQ14 was a FCT21a site, but the next two most similar SCP dataset NNB sites were FCT20a sites, with dis-similarity coefficients very close to the FCT21a site.

Descriptions for the mapped FCTs are (Gibson *et al*., 1994):

FCT3c: '*Eucalyptus calophylla – Xanthorrhoea preissii* woodlands and shrublands' (Pinjarra Plain).
FCT 20a: '*Banksia attenuata* woodlands over species rich shrublands' (Spearwood/Pinjarra).
FCT20b: 'Eastern *Banksia attenuata* and/or *E. marginata* woodlands' (Ridge Hill/Pinjarra).
FCT21c: 'Low lying *Banksia attenuata* woodlands or shrublands' (Bassendean).

3.1.2 Status of the FCTs in the survey area: Threatened Ecological Communities and Priority Ecological Communities

FCT3c, FCT20a and FCT20b are listed by DPaW as TECs (DPaW, 2015a) :

- SCP3c (Critically Endangered): '*Eucalyptus calophylla – Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain' (Swan Coastal Plain).
- SCP20a (Endangered): '*Banksia attenuata* woodland over species rich dense shrublands' (Swan Coastal Plain)

- SCP20b (Endangered): '*Banksia attenuata* and/or *E. marginata* woodlands of the eastern side of the Swan Coastal Plain' (Swan Coastal Plain).

FCT3c is listed under the Commonwealth EPBC Act of Threatened Ecological Communities (Australian Govt, 2015):

- '*Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain', Endangered

FCT21c is listed as a Priority Ecological Community by DPaW (DPaW, 2015b):

- 'Low lying *Banksia attenuata* woodlands or shrublands ('community type 21c'), Priority 3'.

Table 1. FCTs estimated from the all-sites PATN dendrogram classification and nearest neighbours analysis (NNB) and from a single site insertion (SSI) PATN dendrogram classification (see Appendices 1 and 2).

Project Area	Site	Previous Results: Griffen Summary FCT (Table 2, Morgan 2015) *d*	Previous Results: Authors Final FCT Determination (Table 2, Morgan 2015) *d*	No weeds analysis: Griffen Summary FCT c	Supplement-ary & No weeds analysis: Dendrogram FCT e	Supplement-ary & No weeds analysis: NNB *a* FCT	Supplement-ary & No weeds analysis: SSI *b* FCT	Supplement-ary & No weeds analysis: Griffen Summary FCT e
Area 3	ARQ5	?28/21c	21c/28/20c	??21c/20a	20a	20a	21c/20a	20a/21c
Area 3	ARQ6	?28	21c/28/20c	??3b/21c	20a	20a	21c/20c	20a/20c/21c
Area 3 – creek banks	ARQ7	?11	?11	???11/21a	3c	??3c	3c	??3c
Area 3 – gully slopes	ARQ8	?3c	?3c	?3c	3c	?3c	3c	?3c
Area 3 – gully slopes	ARQ11	?3b	?3b/20c	?3b	20a	20a	20b/28/3b	20a/20b
Area 4 - west	ARQ9	21a/20b/20c	20c/21a	21a/20b	20a	20a	20a	20a
Area 4 - west	ARQ10	20a/21a	20c/21a	20a	20a	20a	20a	20a
Area 4 - west	ARQ14	20c	20c/21a	21a/3b	20a	21a/20a	21a/3b/20b	20a/21a
Area 4 - east	ARQ13	4/21c/20c	3b/20c	20c/20a	20a	20a/?20c	20a	20a
Area 4 - east	ARQ15	3b	3b/20c	3b/20c/21a	20a	20a	20a	20a

a NNB Nearest neighbour analysis

b SSI Single site insertion dendrogram classification

c From 'Recommended to Consider', Table 2, Appendix 1.

d Results from first stage of study (Morgan, 2015)

e From, Table 2, Appendix 2.

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Job Number: 11323907
Doc Number: 005
Date: 20.04.15
Scale: 1:1,250 @ A3
Created by: RA
Source: Orthophoto - Landgate, Nov 2014 RPS 2013 Threatened Flora - GDH, 2014 and DPaW, 2014

GDA 1994 MGA Zone 50

0 20 40 80 m

Figure 2

Area 3 Updated Floristic Community Type Map

RPS

Job Number: 11323907
Doc Number: 006
Date: 20.04.15
Scale: 1:2,000 @ A4
Created by: RA
Source: Landgate, Nov 2014

GDA 1994 MGA Zone 50
0 5 10 20 30 40 m

Figure 3
Area 4
Updated Floristic Community Type Map

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4.0 CONCLUSION

The analysis of the survey data combined with the Gibson *et al*. (1994) dataset with weeds removed, resulted in some small changes to determined site FCTs. However, analysis of the survey data combined with the Gibson *et al*. (1994) dataset and SCP supplementary sites (Keighery *et al*., 2012) with weeds removed resulted in very significant changes to the results. In Area 3, the creek and gully vegetation sites (ARQ7 and ARQ8) firmed towards FCT3c, while the sites on the plain adjacent to Poison Gully moved towards FCT20a (ARQ5, ARQ6 and ARQ11). In Area 4 there was a significant change with four of five sites found to be FCT20a and the other site, ARQ14, found to be FCT20a/21a. This analysis is considered to be a more complete and accurate analysis, mostly due to the inclusion of the additional 590 DPaW SCP supplementary sites.

After interpretation of the PATN analysis results for all ten quadrats, the FCTs mapped in Areas 3 and 4 were: FCT3c, FCT20a, FCT20b and FCT21c.

FCT3c (Critically Endangered), FCT20a (Endangered), FCT20b (Endangered) are TECs listed by DPaW. FCT21c is a PEC (Priority 3).

FCT3c is also listed under the Commonwealth EPBC Act as a TEC (Endangered).

5.0 ACKNOWLEDGEMENTS

Ted Griffin conducted the PATN analysis and provided a report on the analysis, included in the Appendices.

Mandy Angove (RPS) did the GIS mapping.

6.0 REFERENCES

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APPENDICES

APPENDIX ONE. PATN Analysis: survey area data and Gibson *et al*. SCP datasets, weed species removed

Report by Ted Griffin

1.1 INTRODUCTION

1.2 Purpose of this report

The current report is intended to help clarify the assignment of Floristic Community type (FCT) designation to vegetation community (site) data. FCTs were defined by Gibson et al (1994) based on site data collected from vegetation on the Swan Coastal Plain. In particular, the potential that a Threatened Ecological Community (English and Blyth 1997) is represented by the data collected needs to be clarified.

The Gibson *et al* (1994) SCP dataset included weed species. A floristic classification and FCT determination of study sites with the Gibson *et al* (1994) SCP dataset was undertaken in December 2014 (Morgan 2015a; Morgan 2015b). However, it was noted that, while the study area quadrat vegetation was considered to mostly be in 'Very Good' or 'Excellent' condition, there were much higher number of weed species in these quadrats than average numbers recorded in the Gibson *et al* (1994) SCP quadrats of comparable FCTs. This was due to the considerable disturbance and high weed cover around the study area sites, which in turn mostly had low weed cover but relatively high numbers of weed species. Since the average weed species numbers varies between the Gibson *et al*. FCTs, it was thought that the high weed species numbers in the study area sites may be biasing the PATN classification results. Therefore it was decided to run the PATN classification again, excluding weed species.

1.3 Location of Airport Rail Link Sites

The sites were from four areas adjacent to Dundas Rd in the area around the Dundas Rd-Maida vale Rd intersection, on the east side of the Kewdale rail freight yards.

1.4 Brief background to floristic analysis of vegetation on the Swan Coastal Plain

Floristic analysis (ie., analysis of variation in vegetation based on the species present, rather than description of structural variation and dominance) as a significant component of the understanding of the variation present in the native vegetation of the Swan Coastal Plain dates to Gibson *et al* (1994 – all references to the SCP survey in the current report refer to this publication), the first publication to document the floristics of the vegetation of a large part of the Swan Coastal Plain. While the SCP survey is based on a very significant amount of work, it must be viewed as a "first pass" survey, limited, in the context of the great variety of vegetation present in the very large area surveyed, by the relatively limited number (509) of sites (quadrats) it is based on. To a limited degree, this limitation has subsequently been addressed in an "update" to the work of the SCP survey (which describes additional units). However, there is no detailed publication of the results of this update available and the additional data used are not readily available in an appropriate form (ie., one that would enable ready comparison of new data to the overall data set).

The units described by the SCP survey are a series of "floristic community types", a "unit" whose rank is defined by the use within a study. The SCP survey surveyed a very large survey area and defined a relatively small number of floristic community types. Consequently, the floristic community types they have described are of a very high order (see Trudgen 1999, volume 1, for further discussion of this point). This is an extremely important point to fully grasp in interpreting the analysis presented by the SCP survey and in understanding the meaning of analysis of other data sets when they are compared to the floristic community types of the SCP survey.

The important effects of the limited size data set used by the SCP survey and of the

relatively small number of floristic community types defined by them, can be summarised by the following points:

1. the definition of all but six of the Threatened Ecological Communities for vegetation on the Swan Coastal Plain (DPAW 2014) has been based on the floristic community types of the SCP survey. It therefore follows, that with six exceptions, only vegetation units from one study that are different at a very high order of floristics are treated as rare by Government. No account is taken of other important differences, such as differences in structure and dominance;

2. for the definition of floristic community types to be robust, a sufficient sized database is needed to give adequate precision in their definition. About half of the floristics community types (or sub types) of the SCP survey are based on less than 10 sites. It is likely that with a larger data set there would be significant alteration in the classification of those floristic community types from the SCP survey based on small numbers of sites.

3. as noted above, many (if not most) of the floristic community types defined by the SCP survey are very broad. They contain very significant variation in floristics, structure and dominance. Some (or in more highly cleared parts of the Swan Coastal Plain much) of this variation may be rare by any reasonable definition, but it is currently "buried" within larger groups;
4. there is likely to be significant variation not sampled by the SCP survey. This includes some variation at a high level of floristic difference (see Trudgen 1999, volume 1, for an example of this) and undoubtedly quite significant (large!) amounts of variation at "medium" and "low" levels.

5. the document, and its use by Government, has focussed attention in the environmental impact assessment process on the high level of units described, deflecting attention from the layers of variation beneath these units that also have significant conservation value.

From these points it is obvious that there is a need for a major "upgrade" to the floristic analysis of the vegetation of the Swan Coastal Plain to provide a more detailed floristic classification that considers not only more of the variation present, but explicitly recognises more of the variation present in formally described units.

Obviously, such a reworking would have some effect on what vegetation is considered rare on the Swan Coastal Plain. It needs to be stressed that it would be very unlikely to find that any of the vegetation currently considered to be rare on the basis of the SCP survey's classification was not rare. On the other hand, it is likely that such a review would very probably consider to be rare some vegetation which is not currently considered rare.

1.5 Data provided

It is very important in comparing different sets of floristic data that they are comparable in the application of names, in the intensity of the survey (ie, the effort of searching resulting in similar proportion of the flora at sites being recorded) and in the size of the site recorded. If the data from different data sets is not comparable in these ways, it reduces the clarity of the results of the analyses carried out. If the discrepancy in the comparability of the data sets is large, the results may become meaningless.

2.1 METHODS

2.2 Data Preparation

The data from the Airport Rail Link sites were provided into a standard MS Access based database designed for this type of data. One virtue of the database is that the species recorded at each site are stored against standard codes (numbers, those used by the Western Australian Herbarium) for each species. This facilitates ready comparison of data from different surveys stored in the same system.

After the data were incorporated into the database (containing the data from other projects), a process of reconciliation of flora species names with those used in the SCP survey was undertaken. This step was necessary at least because of changes in nomenclature over the last ten years and the potential of survey specific variations in the application of names. The reconciliation involved:

- reducing some infra-specific names to the relevant species name,
- combining some taxa where confusion is known to have occurred in field observations and identifications, and
- omitting some names (mostly, where a species had only been identified to genus).

The reconciliation process was relatively straight forward as most of the names had already been standardised. Most reconciliation was to conform with the methods that the SCP survey used to manage confusing taxa plus some nomenclatural changes (see Appendix).

Weed species were then removed from the combined study area sites and Gibson *et al*. (1994) dataset.

2.3 Comparability of datasets

It was not easy to make any firm conclusions about the compatibility of the data from general summaries.

2.4 Comparisons made

The data from the 16 sites plus the 509 sites from the SCP survey of the southern part of the Swan Coastal Plain (south of Gingin) were combined. This enabled various analyses to be performed.

The main purpose was intended to assign the individual sites to the Floristic Community Types (FCTs) defined in the SCP survey.

These data are provided in BM_Airport.mdb.)

2.5 Analyses carried out

The approach was the use of numerical classification techniques (PATN) based on the similarity of the floristic composition of the Airport Rail Link sites to sites in the SCP survey data set.

2.4.1 PATN

Several modules of the numerical classification package PATN (Belbin 1987) were used for the analyses. The parameter values were the same as used by the SCP survey used to ensure consistency of analysis with that study.

The PATN modules used were ASO (calculation of similarity matrix), FUSE (classification based on the results of ASO), DEND (representation of classification) and NNB (determination of sites most similar to each site – nearest neighbours). The results of the analyses were imported into a database (BM_airport.mdb) so that site characteristics and previous classifications (eg., Floristic Community Types derived in earlier classifications) could be associated and various analyses based on these data could be performed.

The assignment of floristic community types to the Airport Rail Link sites was made by summarising the results of two different methods:

- the classification, (all site classification and 'single site insertion' (SSI) classification) and
- the forty nearest neighbours.

Experience demonstrates that the results of these are likely to vary, but that from nearest neighbours is likely to make more sense than the 'all site' classification.

To the classification dendrogram of the combined dataset, the FCT assigned by the SCP survey was associated with the SCP survey sites. The apparent FCTs were assigned to the Airport Rail Link sites by interpreting the position of these sites in the dendrogram (particularly by the way they joined to the SCP sites. (FCTs were assigned for the 'single site insertion' classifications in the same way, and were considered more reliable than the 'all site' classification because SSI is less disruptive to the groupings of the 509 sites in the Gibson *et al.* (1994) datset.)

The 40 sites in the combined data set that were most similar to each of the Airport Rail Link sites were obtained from the nearest neighbour method (NNB). By associating those nearest neighbours from the SCP survey, the most likely FCTs for each of the Airport Rail Link sites were determined.

An attempt was then made to reconcile these different assignments of a Floristic Community Type.

3.0 LIMITATIONS

It has been found in earlier projects that the addition of new sites to the SCP survey data set to produce a combined classification disrupts the original classification. The more data added, the higher the level of the disruption. This problem can make it difficult to assign Floristic Community Types to new sites using this method.

Secondly, it is common for new data to group to their cohorts. In some cases this has proven to result from common deficiencies in the data, ie. whole groups of species missing. This absence tends to draw them together. The more sites in the added batch, the tighter they draw together.

The analyses are conducted without personal knowledge of the sites and no photographs were provided.

4.1 RESULTS

4.2 Determination of floristic community type by classification

The classifications were strongly influenced by the new sites being much more similar to each other than to the SCP sites (Figure 1). Thus, determining the FCT from this classification was impossible.

Figure 1. Relevant portions of Dendrogram

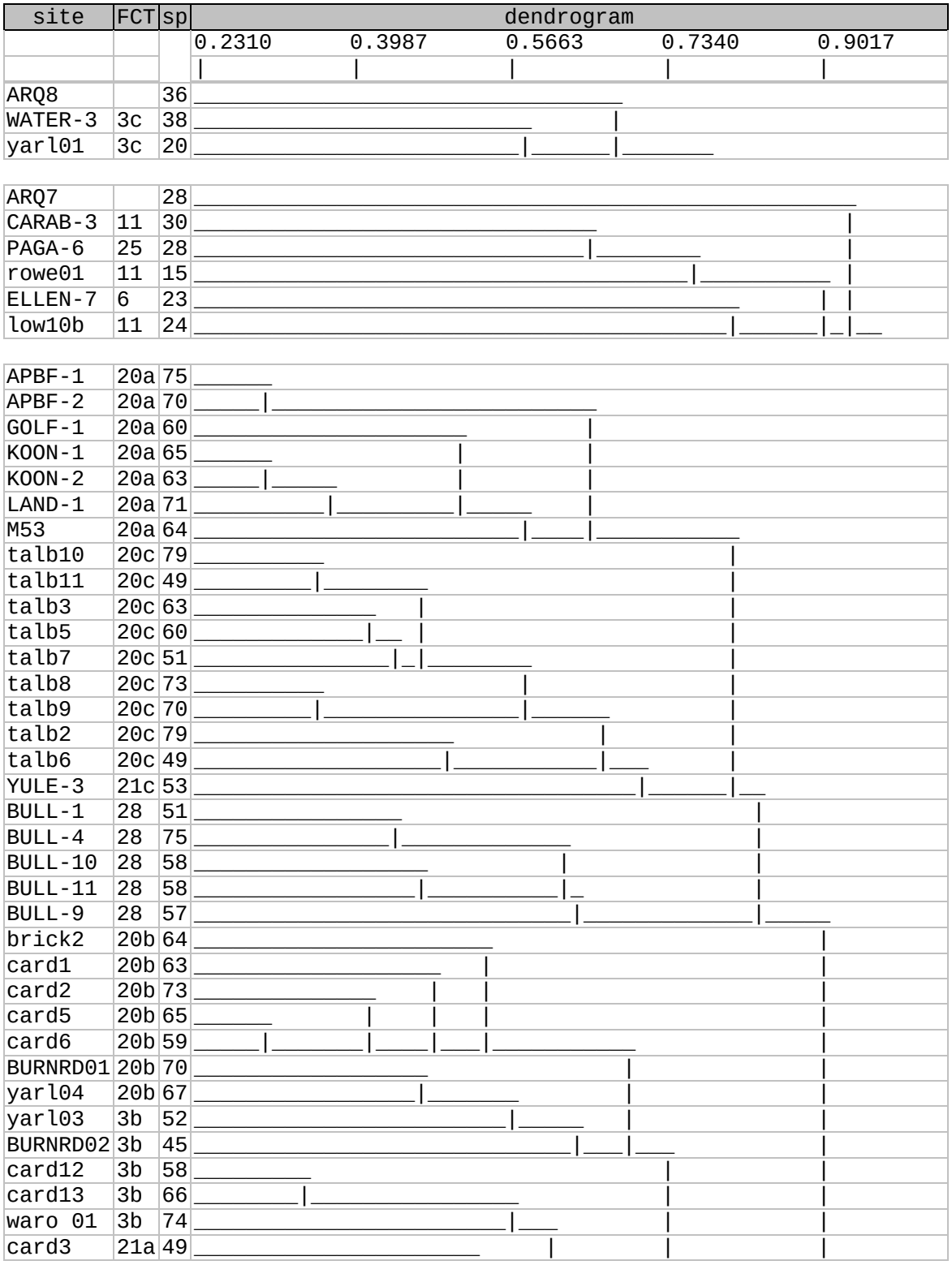

Figure 1. Relevant portions of Dendrogram (continued)

site	FCT	sp	dendrogram
waro 02	3b	77	
card8	20b	46	
card9	20b	54	
ARQ1		80	
ARQ4		80	
ARQ12		78	
ARQ16		82	
ARQ2		87	
ARQ10		64	
ARQ9		63	
ARQ3		64	
ARQ13		98	
ARQ15		88	
ARQ14		67	
ARQ11		49	
ARQ5		67	
ARQ6		71	

(Airport Rail Link quadrats ARQ*)

Inserting one new site at a time is an alternate way of assessing the possible FCT. The relevant segments of these are compiled into Figure 2 and inferences in Table 2.

Figure 2. Relevant portions of Single Site insertion Dendrogram

site	FCT	sp	dendrogram
			0.2310 0.3987 0.5663 0.7340 0.9017
APBF-1	20a	75	
APBF-2	20a	70	
ARQ1		80	
M53	20a	64	
ARQ2		87	
talb8	20c	73	
talb9	20c	70	
talb2	20c	79	
talb6	20c	49	
ARQ3		64	
YULE-3	21c	53	
talb10	20c	79	
talb11	20c	49	
talb3	20c	63	
talb5	20c	60	
talb7	20c	51	
talb8	20c	73	
talb9	20c	70	
talb2	20c	79	
talb6	20c	49	

Figure 2 (cont). Relevant portions of Single Site insertion Dendrogram

site	FCT	sp	dendrogram
ARQ4		80	
card3	21a	49	
brick2	20b	64	
card1	20b	63	
card2	20b	73	
card5	20b	65	
card6	20b	59	
APBF-1	20a	75	
APBF-2	20a	70	
GOLF-1	20a	60	
KOON-1	20a	65	
KOON-2	20a	63	
LAND-1	20a	71	
M53	20a	64	
ARQ5		67	
YULE-3	21c	53	
ARQ6		71	
YULE-3	21c	53	
talb10	20c	79	
talb11	20c	49	
talb3	20c	63	
talb5	20c	60	
talb7	20c	51	
talb8	20c	73	
talb9	20c	70	
talb2	20c	79	
talb6	20c	49	
ARQ7		28	
CARAB-3	11	30	
PAGA-6	25	28	
rowe01	11	15	
ELLEN-7	6	23	
low10b	11	24	
ARQ8		36	
WATER-3	3c	38	
yarl01	3c	20	
DUCK-1	3c	38	
DUCK-2	3c	44	
ELLEN-6	3c	42	
ARQ9		63	
card3	21a	49	
brick2	20b	64	
card1	20b	63	
card2	20b	73	
card5	20b	65	
card6	20b	59	

Figure 2 (cont). Relevant portions of Single Site insertion Dendrogram

site	FCT	sp	dendrogram
APBF-1	20a	75	_____
APBF-2	20a	70	_____|_____
ARQ10		64	_____ |
M53	20a	64	_____|_____|__
ARQ11		49	_____
card12	3b	58	_____ |
card13	3b	66	_____|_____ |
waro 01	3b	74	_____|__ |
card3	21a	49	_____ | |
waro 02	3b	77	_____|_____|__|_____
APBF-1	20a	75	_____
APBF-2	20a	70	_____|_____
ARQ12		78	_____ |
M53	20a	64	_____|_____|_
APBF-1	20a	75	_____
APBF-2	20a	70	_____|_____
ARQ13		98	_____ |
M53	20a	64	_____|_____|
GOLF-1	20a	60	_____ ||
KOON-1	20a	65	_____ | ||
KOON-2	20a	63	_____|_____ | ||
LAND-1	20a	71	_____|_____|_____||_____
ARQ14		67	_____
card3	21a	49	_____ |
waro 02	3b	77	_____|_|_____
card12	3b	58	_____ |
card13	3b	66	_____|_____ |
waro 01	3b	74	_____|____|_____
ARQ15		88	_____
card12	3b	58	_____ |
card13	3b	66	_____|_____|____
card3	21a	49	_____ |
waro 02	3b	77	_____|____|__
waro 01	3b	74	_____|_____
ARQ16		82	_____
card3	21a	49	_____ |
waro 02	3b	77	_____|__|____
card12	3b	58	_____ |
card13	3b	66	_____|_____ |
waro 01	3b	74	_____|___|_____

(Airport Rail Link quadrats ARQ*)

4.3 Determination of floristic community type using Nearest Neighbour method

The nearest neighbours of a site tends to be its geographically proximal neighbours and sites from its cohort study. Thus, most of the nearest neighbours of the ARQ sites are other ARQ sites. The 10 nearest from the SCP are presented in Table 1.

The nearest neighbour analysis (based on the dissimilarity value) suggests that the sites may also belong to related communities.

Table 1. Results of Nearest Neighbour analysis (only SCP sites)

s	s1	fct1	v1	s2	fct2	v2	s3	fct3	v3	s4	fct4	v4	s5	fct5	v5
ARQ1	M53	20a	0.541	APBF-1	20a	0.563	talb9	20c	0.564	YULE-3	21c	0.566	talb2	20c	0.581
ARQ2	talb9	20c	0.496	talb2	20c	0.545	waro 02	3b	0.557	talb8	20c	0.557	card1	20b	0.561
ARQ3	card3	21a	0.565	talb5	20c	0.575	M53	20a	0.592	talb9	20c	0.6	talb11	20c	0.622
ARQ4	card3	21a	0.5	M53	20a	0.533	waro 02	3b	0.539	card5	20b	0.55	APBF-1	20a	0.557
ARQ5	YULE-3	21c	0.604	card5	20b	0.625	M53	20a	0.625	APBF-1	20a	0.626	talb8	20c	0.627
ARQ6	waro 02	3b	0.606	KING-2	28	0.613	BULLER-1	21a	0.630	yarl03	3b	0.645	card12	3b	0.649
ARQ7	WELL-1	21a	0.777	yarl01	3c	0.793	rowe01	11	0.809	low06b	21c	0.811	CRAMPT-2	21a	0.820
ARQ8	WATER-3	3c	0.615	card12	3b	0.643	card1	20b	0.647	yarl03	3b	0.666	BULL-1	28	0.685
ARQ9	card3	21a	0.516	talb9	20c	0.522	M53	20a	0.551	card13	3b	0.568	talb5	20c	0.571
ARQ10	M53	20a	0.531	card3	21a	0.536	talb9	20c	0.557	talb11	20c	0.569	talb5	20c	0.588
ARQ11	card12	3b	0.586	card13	3b	0.604	card1	20b	0.616	M53	20a	0.623	talb2	20c	0.629
ARQ12	M53	20a	0.521	card3	21a	0.524	waro 02	3b	0.577	talb9	20c	0.579	talb2	20c	0.580
ARQ13	talb2	20c	0.510	talb9	20c	0.550	card13	3b	0.557	waro 02	3b	0.563	M53	20a	0.573
ARQ14	card3	21a	0.541	M53	20a	0.553	waro 02	3b	0.559	CRAMPT-2	21a	0.576	talb9	20c	0.578
ARQ15	card13	3b	0.5	talb9	20c	0.526	card12	3b	0.530	card3	21a	0.539	brick8	3a	0.553
ARQ16	card3	21a	0.532	M53	20a	0.561	low06a	21c	0.567	waro 02	3b	0.581	APBF-1	20a	0.582

Table 1 (cont)

s	s6	fct6	v6	s7	fct7	v7	s8	fct8	v8	s9	fct9	v9	s10	fct1	v10
ARQ1	WELL-2	21a	0.593	card5	20b	0.606	talb8	20c	0.609	APBF-2	20a	0.609	waro 02	3b	0.609
ARQ2	card3	21a	0.578	YULE-3	21c	0.578	M53	20a	0.584	APBF-1	20a	0.588	brick8	3a	0.589
ARQ3	talb7	20c	0.622	waro 02	3b	0.631	TWIN-7	21c	0.638	APBF-2	20a	0.649	card13	3b	0.650
ARQ4	BULLER-	21a	0.564	APBF-2	20a	0.571	talb9	20c	0.573	card1	20b	0.576	card2	20b	0.578
ARQ5	APBF-2	20a	0.627	talb9	20c	0.631	KOON-2	20a	0.636	card1	20b	0.636	WARI-2	28	0.64
ARQ6	WIRR-2	23a	0.654	WARI-2	28	0.656	MANEA-3	21b	0.66	card13	3b	0.660	MTB-1	24	0.662
ARQ7	TRIG-4	28	0.822	PAGA-8	25	0.826	yarl03	3b	0.833	TRIG-3	28	0.836	low06a	21c	0.836
ARQ8	BULL-9	28	0.688	SHENT-1	28	0.689	DUCK-1	3c	0.7	card11	6	0.7	AMBR-1	1b	0.706
ARQ9	talb2	20c	0.578	BULLER-1	21a	0.590	waro 02	3b	0.592	talb11	20c	0.595	card1	20b	0.6
ARQ10	card13	3b	0.603	waro 02	3b	0.606	card12	3b	0.608	TWIN-8	21c	0.609	MANEA-3	21b	0.62
ARQ11	talb9	20c	0.631	KOOLJ-5	3b	0.641	BULL-1	28	0.642	APBF-1	20a	0.642	waro 02	3b	0.644
ARQ12	low06a	21c	0.582	card7	21a	0.582	card13	3b	0.607	talb3	20c	0.610	talb5	20c	0.611
ARQ13	FL-1	4	0.575	BULL-10	28	0.590	talb8	20c	0.591	MILT-4	28	0.594	LAND-1	20a	0.597
ARQ14	GUTHR-3	21a	0.588	card13	3b	0.588	TWIN-8	21c	0.590	talb2	20c	0.596	LAND-1	20a	0.6
ARQ15	card1	20b	0.559	waro 02	3b	0.570	FL-1	4	0.584	talb8	20c	0.585	talb2	20c	0.588
ARQ16	talb2	20c	0.584	MILT-4	28	0.585	AUSTRA-1	21a	0.588	card13	3b	0.593	card12	3b	0.596

s – the site being compared
s1 to s10 – the 1st to 10th most similar sites
f1 to f10 – the FCT of the similar sites (only for SCP sites)
v1 to v10 – the dissimilarity value between the site and the similar sites (values above 0.6 tendto indicate low similarity)

4.4 Combining the results

It is common for the classification to indicate a simple result and the nearest neighbour analysis to be less conclusive. This is more a product of the classification process often suggesting an over simplified view than of inconsistency of the analyses.

It is important to appreciate that classification cannot be absolute; evidence for which is that when new sites are added to an analysis set some clusters can change. It remains to be demonstrated to what degree a new site should belong to an existing community even if it is quite similar to one or more members of another community. But commonly a new site is quite similar to more than one existing community.

Table 2 Summary of results

Site	Dendrogram FCT	NNB FCT	SSI FCT	Recommend to Consider
ARQ1	20/3b	20a/20c	20a	20a/20c
ARQ10	20/3b	20a/21a/20c	20a	20a
ARQ11	20/3b	?3b	?3b/21a	?3b
ARQ12	20/3b	20a/21a	20a	20a
ARQ13	20/3b	20c	20a	20c/20a
ARQ14	20/3b	21a/20a/3b	?21a/3b	21a/3b
ARQ15	20/3b	3b/20c	?3b/21a	3b/20c/21a
ARQ16	20/3b	21a/20a	?21a/3b	21a/20a
ARQ2	20/3b	20c	20c	20c
ARQ3	20/3b	?21a/20c	?21c/20c	20c/21a/21c
ARQ4	20/3b	21a/20a/3b	21a/20b	21a/20a
ARQ5	20/3b	??21c/20b/20a	?21c/20a	??21c/20a
ARQ6	20/3b	??3b/28	?21c/20c	??3b/21c
ARQ7	11	???21a/3c/11	???11/6	???11/21a
ARQ8	3c	??3c	3c	?3c
ARQ9	20/3b	21a/20c	21a/20b	21a/20b

For the most part, the Single Site insertion is consistent with the nearest neighbor inferences. The FCT recommended to consider are largely from Single Site insertion, but modified by the NNB .

4.0 REFERENCES

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5.0 APPENDIX

Appendix 1 Species combinations made to assist in reconciling taxonomic changes and identification difficulties between this survey and SCP data.

Species	Lookup
Triglochin nana	Triglochin centrocarpum
Aira cupaniana	Aira caryophyllea/cupaniana group
Austrostipa campylachne	Austrostipa semibarbata/campylachne
Avena barbata	Avena barbata/fatua
Lolium perenne x rigidum	Lolium perenne
Pentameris airoides subsp. airoides	Pentaschistis airoides/pallida
Rytidosperma occidentale	Austrodanthonia occidentalis
Vulpia myuros forma myuros	Vulpia myuros
Lepidosperma aff. pubisquameum	Lepidosperma angustatum/squamatum
Lepidosperma pubisquameum 'flat form'	Lepidosperma angustatum/squamatum
Schoenus caespititius	Schoenus aff. brevisetis
Schoenus sp.	omitted
Alocasia brisbanensis	Schoenus nanus
Lepyrodia sp.	omitted
Lyginia imberbis	Lyginia barbata
Calectasia narragara	Calectasia cyanea
Chamaescilla corymbosa var. corymbosa	Chamaescilla spiralis/corymbosa
Thysanotus manglesianus	Thysanotus patersonii/manglesianus
Thysanotus manglesianus/patersonii	Thysanotus patersonii/manglesianus
Burchardia congesta	Burchardia umbellata/congesta
Anigozanthos manglesii subsp. manglesii	Anigozanthos manglesii
Conostylis aculeata subsp. aculeata	Conostylis aculeata
Conostylis setigera subsp. setigera	Conostylis setigera
Freesia alba x leichtlinii	Freesia aff. leichtlinii
Patersonia occidentalis var. occidentalis	Patersonia occidentalis
Watsonia meriana	Watsonia meriana/bulbifera
Caladenia flava subsp. flava	Caladenia flava
Caladenia sp.	omitted
Microtis media subsp. media	Microtis media
Monadenia bracteata	Disa bracteata
Pterostylis sp.	omitted
Adenanthos cygnorum	Adenanthos cygnorum subsp. cygnorum
Banksia dallanneyi var. dallanneyi	Dryandra nivea
Grevillea bipinnatifida subsp. bipinnatifida	Grevillea bipinnatifida
Synaphea spinulosa subsp. spinulosa	Synaphea spinulosa
Petrorhagia dubia	Petrorhagia velutina
Polycarpon tetraphyllum	omitted
Drosera erythrorhiza subsp. erythrorhiza	Drosera erythrorhiza
Drosera macrantha subsp. macrantha	Drosera macrantha
Drosera porrecta	Drosera stolonifera
Crassula closiana	Crassula pedicellosa
Crassula colorata var. colorata	Crassula colorata
Billardiera fraseri	Pronaya fraseri
Acacia applanata	Acacia willdenowiana
Acacia pulchella var. pulchella	Acacia pulchella
Gompholobium glutinosum	Gompholobium aristatum
Hovea trisperma	Hovea trisperma var. trisperma
Isotropis cuneifolia subsp. cuneifolia	Isotropis cuneifolia
Nemcia capitata	Gastrolobium capitatum
Templetonia biloba	Cristonia biloba
Trifolium arvense var. arvense	Trifolium arvense
Trifolium campestre var. campestre	Trifolium campestre
Oxalis sp.	omitted
Boronia ramosa subsp. anethifolia	Boronia ramosa
Monotaxis grandiflora var. grandiflora	Monotaxis grandiflora
Baeckea camphorosmae	Babingtonia camphorosmae
Eucalyptus calophylla	Corymbia calophylla
Eucalyptus marginata subsp. marginata	Eucalyptus marginata

Species	Lookup
Leptospermum laevigatum	omitted
Verticordia densiflora var. densiflora	Verticordia densiflora
Olea europaea subsp. europaea	omitted
Hemiandra linearis	Hemiandra pungens/linearis
Lobelia sp.	omitted
Conyza albida	Conyza sumatrensis
Dimorphotheca ecklonis	omitted
Hypochaeris radicata	Hypochaeris glabra
Millotia tenuifolia var. tenuifolia	Millotia tenuifolia
Monoculus monstrosus	omitted
Ursinia anthemoides subsp. anthemoides	Ursinia anthemoides

APPENDIX TWO. PATN Analysis: inclusion of supplementary SCP data, weed species removed

Report by Ted Griffin

1.1 INTRODUCTION

1.2 Purpose of this report

The current report is intended to help clarify the assignment of Floristic Community type (FCT) designation to vegetation community (site) data. FCTs were defined by Gibson et al (1994) based on site data collected from vegetation on the Swan Coastal Plain. In particular, the potential that a Threatened Ecological Community (English and Blyth 1997) is represented by the data collected needs to be clarified. The Gibson *et al* (1994) SCP dataset included weed species.

Under Bush Forever (eg Government of Western Australia 2000) 590 additional sites 'supplementary data') were considered and allocated to the Gibson *et al*. (1994) FCTs or to 20 new FCTs that were recognized through the process used. The data from Keighery *et al*. (2012) was used in this study (Gibson *et al*. (1994) SCP dataset plus 'supplementary data').

This report sought to improve the accuracy of the study site FCT determinations by both including the 'supplementary data' and excluding weed species. By including the 'supplementary data' in the PATN analysis, the study sites could be compared to many more SCP sites and in particular, many more eastern SCP sites, some of which were local to the study area. Weed species were excluded from the analysis in case the higher number of weed species in the study site quadrats was biasing the FCT allocation.

1.3 Location of Airport Rail Link Sites

The sites were from four areas adjacent to Dundas Rd in the area around the Dundas Rd-Maida vale Rd intersection, on the east side of the Kewdale rail freight yards.

1.4 Brief background to floristic analysis of vegetation on the Swan Coastal Plain

Floristic analysis (ie., analysis of variation in vegetation based on the species present, rather than description of structural variation and dominance) as a significant component of the understanding of the variation present in the native vegetation of the Swan Coastal Plain dates to Gibson *et al* (1994 – all references to the SCP survey in the current report refer to this publication), the first publication to document the floristics of the vegetation of a large part of the Swan Coastal Plain. While the SCP survey is based on a very significant amount of work, it must be viewed as a "first pass" survey, limited, in the context of the great variety of vegetation present in the very large area surveyed, by the relatively limited number (509) of sites (quadrats) it is based on. To a limited degree, this limitation has subsequently been addressed in an "update" to the work of the SCP survey (which describes additional units). However, there is no detailed publication of the results of this update available and the additional data used are not readily available in an appropriate form (ie., one that would enable ready comparison of new data to the overall data set).

The units described by the SCP survey are a series of "floristic community types", a "unit" whose rank is defined by the use within a study. The SCP survey surveyed a very large survey area and defined a relatively small number of floristic community types. Consequently, the floristic community types they have described are of a very high order (see Trudgen 1999, volume 1, for further discussion of this point). This is an extremely important point to fully grasp in interpreting the analysis presented by the SCP survey and in understanding the meaning of analysis of other data sets when they are compared to the floristic community types of the SCP survey.

The important effects of the limited size data set used by the SCP survey and of the

relatively small number of floristic community types defined by them, can be summarized by the following points:

1. the definition of all but six of the Threatened Ecological Communities for vegetation on the Swan Coastal Plain (DPAW 2014) has been based on the floristic community types of the SCP survey. It therefore follows, that with six exceptions, only vegetation units from one study that are different at a very high order of floristics are treated as rare by Government. No account is taken of other important differences, such as differences in structure and dominance;

2. for the definition of floristic community types to be robust, a sufficient sized database is needed to give adequate precision in their definition. About half of the floristics community types (or sub types) of the SCP survey are based on less than 10 sites. It is likely that with a larger data set there would be significant alteration in the classification of those floristic community types from the SCP survey based on small numbers of sites.

3. as noted above, many (if not most) of the floristic community types defined by the SCP survey are very broad. They contain very significant variation in floristics, structure and dominance. Some (or in more highly cleared parts of the Swan Coastal Plain much) of this variation may be rare by any reasonable definition, but it is currently "buried" within larger groups;

4. there is likely to be significant variation not sampled by the SCP survey. This includes some variation at a high level of floristic difference (see Trudgen 1999, volume 1, for an example of this) and undoubtedly quite significant (large!) amounts of variation at "medium" and "low" levels.

5. the document, and its use by Government, has focussed attention in the environmental impact assessment process on the high level of units described, deflecting attention from the layers of variation beneath these units that also have significant conservation value.

From these points it is obvious that there is a need for a major "upgrade" to the floristic analysis of the vegetation of the Swan Coastal Plain to provide a more detailed floristic classification that considers not only more of the variation present, but explicitly recognises more of the variation present in formally described units.

Obviously, such a reworking would have some effect on what vegetation is considered rare on the Swan Coastal Plain. It needs to be stressed that it would be very unlikely to find that any of the vegetation currently considered to be rare on the basis of the SCP survey*'s* classification was not rare. On the other hand, it is likely that such a review would very probably consider to be rare some vegetation which is not currently considered rare.

The "supplementary" FCT study was undertaken largely using the PATN module ALOC with the Gibson et al (1994) groups "fixed" and new sites allocated to those if within a user defined tolerance. Any sites "outside" that tolerance were allocated to new FCTs. One limitation of this approach is the presumption that the Gibson el al (1994) FCTs were reasonably well defined. Probably reasonable for where many sites have contributed, but not reasonable where few sites define diverse groups such as wetland FCTs. (More than a sixth of the FCTs had less than five sites and nearly a half had less than 10 sites.)

1.5 Data provided

It is very important in comparing different sets of floristic data that they are comparable in the application of names, in the intensity of the survey (ie, the effort of searching resulting in similar proportion of the flora at sites being recorded) and in the size of the site recorded. If the data from different data sets is not comparable in these ways, it reduces the clarity of the results of the analyses carried out. If the discrepancy in the comparability of the data sets is large, the results may become meaningless.

2.1 METHODS

2.2 Data Preparation

The data from the Airport Rail Link sites were provided into a standard MS Access based database designed for this type of data. One virtue of the database is that the species recorded at each site are stored against standard codes (numbers, those used by the Western Australian Herbarium) for each species. This facilitates ready comparison of data from different surveys stored in the same system.

After the data were incorporated into the database (containing the data from other projects), a process of reconciliation of flora species names with those used in the SCP survey (Keighery et al 2012) was undertaken. This step was necessary at least because of changes in nomenclature over the last ten years and the potential of survey specific variations in the application of names. The reconciliation involved:

- reducing some infra-specific names to the relevant species name,
- combining some taxa where confusion is known to have occurred in field observations and identifications, and
- omitting some names (mostly, where a species had only been identified to genus).

The reconciliation process was relatively straight forward as most of the names had already been standardised. Most reconciliation was to conform with the methods that the SCP survey used to manage confusing taxa plus some nomenclatural changes (see Appendix). Weed species were then removed from the combined study area sites and Gibson *et al*. (1994) dataset.

2.3 Comparability of datasets

It was not easy to make any firm conclusions about the compatibility of the data from general summaries.

2.4 Comparisons made

The data from the 16 sites plus the 1098 (508 SCP, 590 sup) sites from the SCP survey of the southern part of the Swan Coastal Plain (south of Gingin) (including the ‘supplementary data’) were combined. This enabled various analyses to be performed.

The main purpose was intended to assign the individual sites to the Floristic Community Types (FCTs) defined in the SCP supplementary survey.

These data are provided in BM_Airport.mdb.)

2.5 Analyses carried out

The approach was the use of numerical classification techniques (PATN) based on the similarity of the floristic composition of the Airport Rail Link sites to sites in the SCP supplementary survey data set.

2.4.1 PATN

Several modules of the numerical classification package PATN (Belbin 1987) were used for the analyses. The parameter values were the same as used by Gibson et al (1994) to ensure consistency of analysis with that study.

The ALOC (a non-hierarchal classification use to allocate the supplementary sites to the SCP FCTs and where apparently different from the existing, create new ones) was **not used** because it is likely that some SCP FCTs were inadequately defined.

The PATN modules used were ASO (calculation of similarity matrix), FUSE (classification based on the results of ASO), DEND (representation of classification) and NNB (determination of sites most similar to each site – nearest neighbours). The results of the analyses were imported into a database (BM_airport.mdb) so that site characteristics and previous classifications (eg. Floristic Community Types derived in earlier classifications) could be associated and various analyses based on these data could be performed.

The assignment of floristic community types to the Airport Rail Link sites was made by summarising the results of two different methods:

- the classification (all site classification and 'single site insertion' (SSI) classification), and
- the forty nearest neighbours.

Experience demonstrates that the results of these are likely to vary, but that from nearest neighbours is likely to make more sense than the 'all site' classification.

To the classification dendrogram of the combined dataset, the FCT assigned by the SCP survey was associated with the SCP survey sites. The apparent FCTs were assigned to the Airport Rail Link sites by interpreting the position of these sites in the dendrogram (particularly by the way they joined to the SCP sites. (FCTs were assigned for the 'single site insertion' classifications in the same way, and were considered more powerful than the 'all site' classification because SSI is less disruptive to the groupings of the previous classifications.)

The 40 sites in the combined data set that were most similar to each of the Airport Rail Link sites were obtained from the nearest neighbour method (NNB). By associating those nearest neighbours from the SCP survey, the most likely FCTs for each of the Airport Rail Link sites were determined.

An attempt was then made to reconcile these different assignments of a Floristic Community Type.

3.0 LIMITATIONS

It has been found in earlier projects that the addition of new sites to the SCP survey data set to produce a combined classification disrupts the original classification. The more data added, the higher the level of the disruption. This problem can make it difficult to assign Floristic Community Types to new sites using this method.

Secondly, it is common for new data to group to their cohorts. In some cases this has proven to result from common deficiencies in the data, ie. whole groups of species missing. This absence tends to draw them together. The more sites in the added batch, the tighter they draw together.

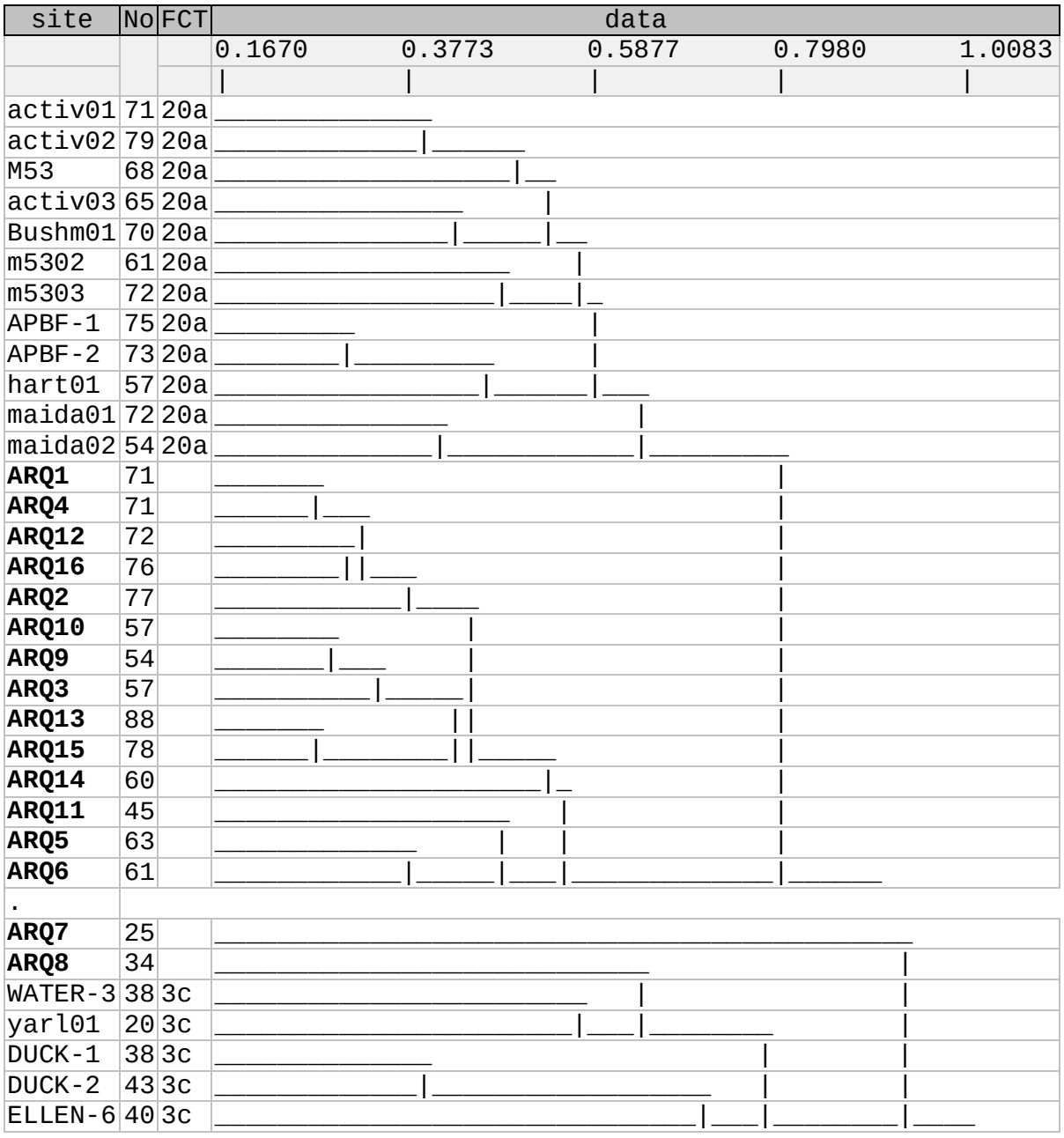
The analyses are conducted without personal knowledge of the sites and no photographs were provided.

4.1 RESULTS

4.2 Determination of floristic community type by classification

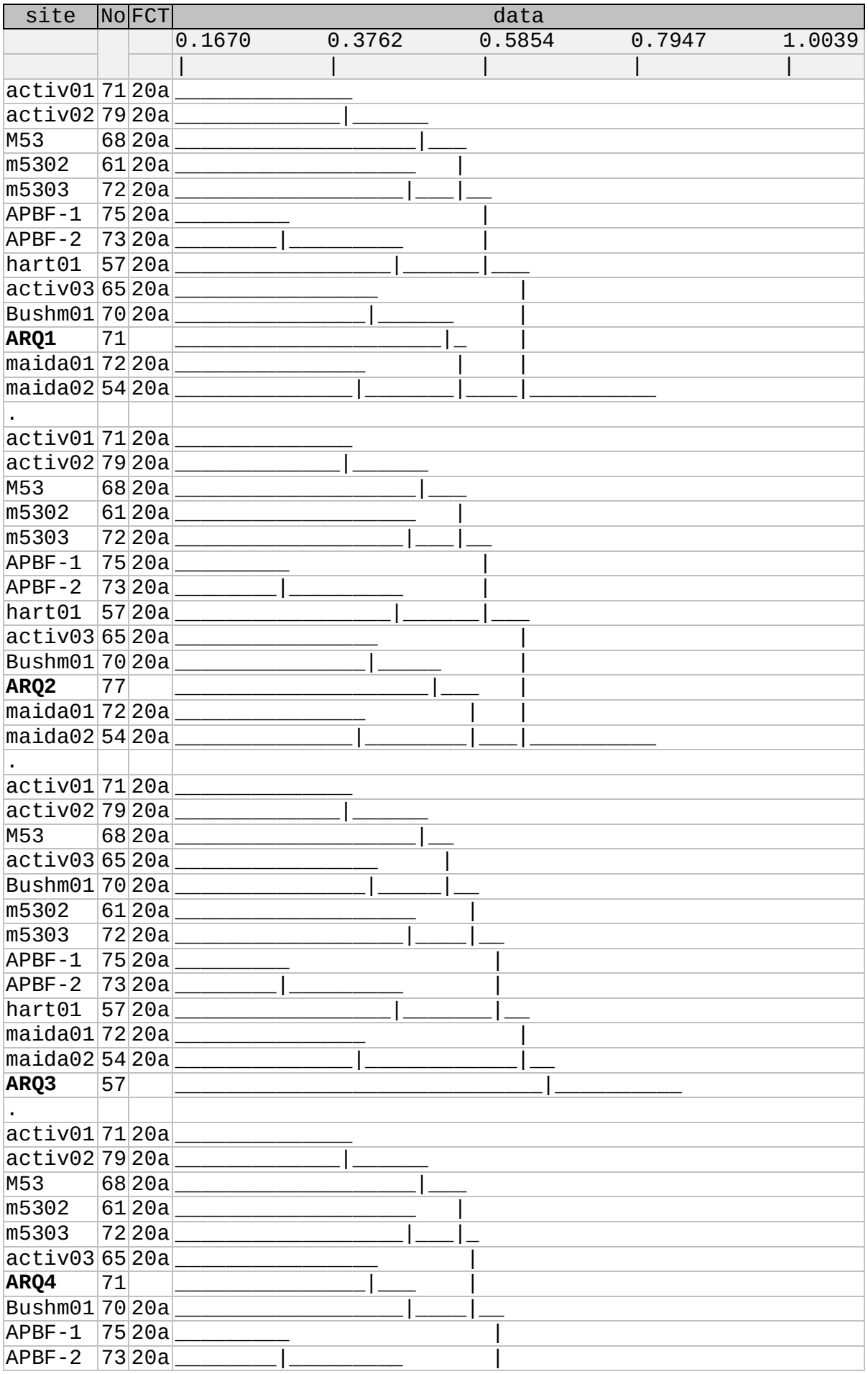
The classifications were strongly influenced by the new sites being much more similar to each other than to the SCP sites (Figure 1). Thus, determining the FCT from this classification was impossible.

Figure 1. Relevant portions of Dendrogram



(Airport Rail Link quadrats ARQ*)

Figure 2 Relevant portions of Single Site insertion Dendrogram



site	No	FCT	data
			0.1670 0.3762 0.5854 0.7947 1.0039
hart01	57	20a	
maida01	72	20a	
maida02	54	20a	
.			
activ01	71	20a	
activ02	79	20a	
M53	68	20a	
activ03	65	20a	
Bushm01	70	20a	
m5302	61	20a	
m5303	72	20a	
APBF-1	75	20a	
APBF-2	73	20a	
hart01	57	20a	
maida01	72	20a	
maida02	54	20a	
ARQ5	63		
YULE-3	53	21c	
.			
ARQ6	61		
YULE-3	53	21c	
Bushm02	32	20c	
card11	23	6	
talb10	79	20c	
talb11	50	20c	
talb3	63	20c	
talb5	61	20c	
talb7	46	20c	
talb8	73	20c	
talb9	70	20c	
talb2	78	20c	
talb6	49	20c	
.			
ARQ7	25		
DUCK-1	38	3c	
DUCK-2	43	3c	
ELLEN-6	40	3c	
Redh05	24	S15	
WATER-3	38	3c	
yarl01	20	3c	
.			
ARQ8	34		
WATER-3	38	3c	
yarl01	20	3c	
DUCK-1	38	3c	
DUCK-2	43	3c	
ELLEN-6	40	3c	
.			
activ01	71	20a	
activ02	79	20a	
m5303	72	20a	
M53	68	20a	
activ03	65	20a	
Bushm01	70	20a	

site	No	FCT	data				
			0.1670	0.3762	0.5854	0.7947	1.0039
			|	|	|	|	|
APBF-1	75	20a	_____				
APBF-2	73	20a	_____				
hart01	57	20a	_____				
maida01	72	20a	_____				
maida02	54	20a	_____				
ARQ9	54		_____				
m5302	61	20a	_____				
.							
activ01	71	20a	_____				
activ02	79	20a	_____				
m5303	72	20a	_____				
M53	68	20a	_____				
activ03	65	20a	_____				
Bushm01	70	20a	_____				
APBF-1	75	20a	_____				
APBF-2	73	20a	_____				
hart01	57	20a	_____				
maida01	72	20a	_____				
maida02	54	20a	_____				
ARQ10	57		_____				
m5302	61	20a	_____				
.							
ARQ11	45		_____				
much01	56	28	_____				
perth03	54	20b	_____				
BRIX-2	49	3a	_____				
waro 01	73	3b	_____				
card12	57	3b	_____				
card13	66	3b	_____				
card3	50	21a	_____				
waro 02	79	3b	_____				
DUNS-1	67	3b	_____				
KOOLJ-5	46	3b	_____				
R116703	58	1b	_____				
.							
activ01	71	20a	_____				
activ02	79	20a	_____				
M53	68	20a	_____				
m5302	61	20a	_____				
m5303	72	20a	_____				
APBF-1	75	20a	_____				
APBF-2	73	20a	_____				
hart01	57	20a	_____				
activ03	65	20a	_____				
Bushm01	70	20a	_____				
ARQ12	72		_____				
maida01	72	20a	_____				
maida02	54	20a	_____				
.							
activ01	71	20a	_____				
activ02	79	20a	_____				
M53	68	20a	_____				
activ03	65	20a	_____				
Bushm01	70	20a	_____				

site	No	FCT	data				
			0.1670	0.3762	0.5854	0.7947	1.0039
			|	|	|	|	|
APBF-1	75	20a	_____		|		
APBF-2	73	20a	_____|_____		|		
hart01	57	20a	_____|_____|__				
ARQ13	88		_____ |				
m5302	61	20a	_____ | |				
m5303	72	20a	_____|__|____|_				
maida01	72	20a	_____ |				
maida02	54	20a	_____|_____|_____				
.							
ARQ14	60		_____				
card3	50	21a	_____ |				
waro 02	79	3b	_____|_|____				
card8	47	20b	_____ |				
card9	54	20b	_____|_____|_____				
.							
activ01	71	20a	_____				
activ02	79	20a	_____|_____				
m5303	72	20a	_____|___				
M53	68	20a	_____|				
activ03	65	20a	_____ |				
Bushm01	70	20a	_____|_____|___				
APBF-1	75	20a	_____ |				
APBF-2	73	20a	_____|_____ |				
hart01	57	20a	_____|_____|___				
maida01	72	20a	_____ |				
maida02	54	20a	_____|_____|_____				
ARQ15	78		_____ |				
m5302	61	20a	_____|_____ |				
m5306	62	3a	_____|____ |				
xlamb01	95	20b	_____|___|_____				
.							
activ01	71	20a	_____				
activ02	79	20a	_____|_____				
M53	68	20a	_____|___				
m5302	61	20a	_____ |				
m5303	72	20a	_____|___|_				
activ03	65	20a	_____ |				
Bushm01	70	20a	_____|_____ |				
ARQ16	76		_____|_|__				
APBF-1	75	20a	_____ |				
APBF-2	73	20a	_____|_____ |				
hart01	57	20a	_____|_____|___				
maida01	72	20a	_____ |				
maida02	54	20a	_____|_____|_____				

(Airport Rail Link quadrats ARQ*)

4.3 Determination of floristic community type using Nearest Neighbour method

The nearest neighbours of a site tends to be its geographically proximal neighbours and sites from its cohort study. Thus, most of the nearest neighbours of the ARQ sites are other ARQ sites. The 10 nearest from the SCP are presented in Table 1.

The nearest neighbour analysis suggests that the sites may also belong to related communities. It is interesting that most of the ARQ sites are most similar to active03, a site within 3 km. The majority of the ARQ sites are most similar to those from FCT 20a. This is an FCT localised to the eastern side of the coastal plain (Figure 3).

Table 1. Results of Nearest Neighbour analysis (only SCP sites)

s	s1	fct	v1	s2	fct	v2	s3	fct	v3	s4	fct4	v4	s5	fct	v5
ARQ1	n_activ03	20a	0.5085	n_m5302	20a	0.5304	n_Bushm01	20a	0.536	n_m5303	20a	0.5433	n_maida02	20a	0.5495
ARQ2	n_activ03	20a	0.4876	n_m5302	20a	0.5085	s_talb9	20c	0.5276	n_Bushm01	20a	0.5313	n_maida01	20a	0.5504
ARQ3	n_activ03	20a	0.5385	n_m5302	20a	0.5446	n_activ02	20a	0.5763	s_card3	21a	0.587	s_talb5	20c	0.6
ARQ4	n_activ03	20a	0.431	n_m5302	20a	0.4867	n_Bushm01	20a	0.5122	n_Cresw01	23a	0.5185	s_card3	21a	0.5192
ARQ5	n_activ03	20a	0.514	n_hart01	20a	0.5769	n_maida02	20a	0.58	n_Cresw01	23a	0.596	n_maida01	20a	0.6
ARQ6	n_activ03	20a	0.5327	n_leda02	28	0.5922	s_KING-2	28	0.5955	s_waro 02	3b	0.6134	s_BULLER-1	21a	0.6304
ARQ7	s_yarl01	3c	0.7241	s_WELL-1	21a	0.7778	n_bold17	S15	0.7778	n_much04	25	0.8	s_rowe01	11	0.8095
ARQ8	s_WATER-3	3c	0.6154	n_bold17	S15	0.641	s_card1	20b	0.6471	s_card12	3b	0.6486	s_yarl01	3c	0.6585
ARQ9	n_m5302	20a	0.46	n_activ03	20a	0.4757	s_card3	21a	0.5385	s_talb9	20c	0.5413	s_M53	20a	0.5856
ARQ10	n_m5302	20a	0.4476	n_activ03	20a	0.5185	s_card3	21a	0.5625	s_M53	20a	0.569	s_talb9	20c	0.5789
ARQ11	n_activ03	20a	0.4845	n_perth03	20b	0.5862	s_card12	3b	0.6136	s_card1	20b	0.6162	n_m5302	20a	0.617
ARQ12	n_activ03	20a	0.469	n_m5302	20a	0.5091	n_perth08	23a	0.5192	s_card3	21a	0.5446	s_M53	20a	0.5537
ARQ13	n_m5302	20a	0.4884	s_talb2	20c	0.5245	n_activ03	20a	0.5303	n_m5306	3a	0.552	n_maida01	20a	0.5571
ARQ14	s_card3	21a	0.5464	n_activ03	20a	0.5596	n_m5302	20a	0.566	s_waro 02	3b	0.5702	s_M53	20a	0.5726
ARQ15	n_m5302	20a	0.459	n_activ03	20a	0.504	s_card13	3b	0.52	n_perth03	20b	0.5304	s_talb9	20c	0.542
ARQ16	n_activ03	20a	0.479	n_Cresw01	23a	0.5135	n_m5302	20a	0.5172	n_Kens01	23a	0.5424	n_m5303	20a	0.5469

s	s6	fct6	v6	s7	fct	v7	s8	fct	v8	s9	fct	v9	s10	fct	v10
ARQ1	s_M53	20a	0.555	n_maida01	20a	0.555	n_Cresw01	23a	0.563	n_perth04	23a	0.569	s_YULE-3	21c	0.570
ARQ2	n_m5303	20a	0.553	s_talb2	20c	0.560	n_perth04	23a	0.563	n_perth03	20b	0.567	s_talb8	20c	0.572
ARQ3	s_M53	20a	0.607	s_talb9	20c	0.618	n_perth08	23a	0.621	n_Bushm01	20a	0.621	s_talb7	20c	0.623
ARQ4	s_M53	20a	0.548	s_card5	20b	0.55	n_activ02	20a	0.553	s_waro 02	3b	0.562	s_BULLER-1	21a	0.564
ARQ5	n_activ02	20a	0.603	n_m5303	20a	0.603	n_Kens01	23a	0.603	s_YULE-3	21c	0.604	n_Bushm0	20a	0.614
ARQ6	n_MGK03	21b	0.642	s_card12	3b	0.653	s_yarl03	3b	0.653	s_WIRR-2	23a	0.654	n_Cresw01	23a	0.656
ARQ7	s_low06b	21c	0.811	n_vines01	25	0.818	n_leda02	28	0.820	s_TRIG-4	28	0.822	s_CRAMPT-2	21a	0.823
ARQ8	n_perth03	20b	0.671	s_yarl03	3b	0.675	s_SHENT-1	28	0.689	s_BULL-1	28	0.690	s_BULL-9	28	0.692
ARQ9	n_m5303	20a	0.589	s_BULLER-1	21a	0.590	n_dian01	23a	0.592	s_card13	3b	0.592	n_perth08	23a	0.595
ARQ10	n_Kens01	23a	0.588	n_m5303	20a	0.589	s_TWIN-8	21c	0.595	n_MGK03	21b	0.604	s_talb11	20c	0.604
ARQ11	n_maida02	20a	0.622	s_card13	3b	0.628	n_maida01	20a	0.638	n_hart01	20a	0.638	s_KOOLJ-5	3b	0.641
ARQ12	n_Cresw01	23a	0.561	n_perth04	23a	0.567	n_Bushm01	20a	0.583	s_low06a	21c	0.587	n_perth03	20b	0.592
ARQ13	n_m5303	20a	0.560	s_talb9	20c	0.565	s_FL-1	4	0.575	s_card13	3b	0.575	s_waro 02	3b	0.583
ARQ14	n_wire01	28	0.572	s_TWIN-8	21c	0.576	s_talb9	20c	0.582	s_CRAMPT-2	21a	0.584	s_REDL-1	21a	0.589
ARQ15	n_m5306	3a	0.542	s_card12	3b	0.551	s_card3	21a	0.557	s_card1	20b	0.559	n_maida01	20a	0.578
ARQ16	s_card3	21a	0.551	s_AUSTRA-1	21a	0.570	s_low06a	21c	0.571	n_Bushm01	20a	0.571	s_M53	20a	0.574

Columns
s – the site being compared
s1 to s10 – the 1st to 10th most similar sites (prefix 's' original SCP sites, 'n' supplement sites)
f1 to f10 – the FCT of the similar sites (only for SCP sites)
v1 to v10 – the dissimilarity value between the site and the similar sites (values above 0.6 tendto indicate low similarity)

Figure 3 Distribution of ARQ sites (blue) with FCT 20a sites (white).

4.4 Combining the results

It is common for the classification to indicate a simple result and the nearest neighbour analysis to be less conclusive. This is more a product of the classification process often suggesting an over simplified view than of inconsistency of the analyses.

It is important to appreciate that classification cannot be absolute; evidence for which is that when new sites are added to an analysis set some clusters can change. It remains to be demonstrated to what degree a new site should belong to an existing community even if it is quite similar to one or more members of another community. But commonly a new site is quite similar to more than one existing community.

Table 2 Summary of results

Site	Dendrogram FCT	NNB FCT	SSI FCT	Recommend to Consider
ARQ1	20a	20a	20a	20a
ARQ2	20a	20a	20a	20a
ARQ3	20a	20a	20a	20a
ARQ4	20a	20a	20a	20a
ARQ5	20a	20a	21c/20a	20a/21c
ARQ6	20a	20a	21c/20c	20a/20c/21c
ARQ7	3c	??3c	3c	??3c
ARQ8	3c	?3c	3c	?3c
ARQ9	20a	20a	20a	20a
ARQ10	20a	20a	20a	20a
ARQ11	20a	20a	20b/28/3b	20a/20b
ARQ12	20a	20a	20a	20a
ARQ13	20a	20a/?20c	20a	20a
ARQ14	20a	21a/20a	21a/3b/20b	20a/21a
ARQ15	20a	20a	20a	20a
ARQ16	20a	20a	20a	20a

For the most part, the Single Site insertion is consistent with the nearest neighbor inferences. The FCT recommended to consider are largely from Single Site insertion.

4.0 REFERENCES

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5.0 APPENDIX

Appendix 1 Species combinations made to assist in reconciling taxonomic changes and identification difficulties between this survey and SCP supplementary data.

FAMILY	Species_LUP.name	Species_LUP_1.name
Anarthriaceae	Lyginia imberbis	Lyginia barbata
Apiaceae	Xanthosia huegelii	Xanthosia huegelii subsp. huegelii
Asparagaceae	Thysanotus manglesianus	Thysanotus manglesianus/patersonii complex
Asparagaceae	Thysanotus manglesianus/patersonii	Thysanotus manglesianus/patersonii complex
Asparagaceae	Thysanotus patersonii	Thysanotus manglesianus/patersonii complex
Brassicaceae	Raphanus raphanistrum	omitted
Campanulaceae	Lobelia sp.	omitted
Cyperaceae	Lepidosperma aff. pubisquameum	Lepidosperma angustatum/squamatum
Cyperaceae	Lepidosperma pubisquameum 'flat form'	Lepidosperma angustatum/squamatum
Cyperaceae	Lepidosperma squamatum	Lepidosperma angustatum/squamatum
Cyperaceae	Schoenus caespititius	Schoenus brevisetis
Cyperaceae	Schoenus sp.	omitted
Droseraceae	Drosera porrecta	Drosera stolonifera subsp. porrecta
Droseraceae	Drosera porrecta	Drosera stolonifera subsp. porrecta
Euphorbiaceae	Monotaxis grandiflora var. grandiflora	Monotaxis grandiflora
Fabaceae	Acacia lasiocarpa var. lasiocarpa	Acacia lasiocarpa
Fabaceae	Acacia pulchella var. glaberrima	Acacia pulchella
Fabaceae	Acacia pulchella var. pulchella	Acacia pulchella
Fabaceae	Daviesia decurrens	Daviesia decurrens subsp. decurrens
Fabaceae	Gompholobium glutinosum	Gompholobium aristatum
Fabaceae	Hovea trisperma	Hovea trisperma var. trisperma
Fabaceae	Templetonia biloba	Cristonia biloba
Fabaceae	Vicia sativa subsp. sativa	Vicia sativa
Haemodoraceae	Conostylis aculeata subsp. aculeata	Conostylis aculeata
Haemodoraceae	Conostylis aculeata subsp. breviflora	Conostylis aculeata
Haemodoraceae	Conostylis aculeata subsp. bromelioides	Conostylis aculeata
Haemodoraceae	Conostylis aculeata subsp. cygnorum	Conostylis aculeata
Haemodoraceae	Conostylis aculeata subsp. preissii	Conostylis aculeata
Hemerocallidaceae	Johnsonia pubescens	Johnsonia pubescens subsp. pubescens
Iridaceae	Patersonia occidentalis var. occidentalis	Patersonia occidentalis
Juncaginaceae	Triglochin nana	Triglochin centrocarpum
Lamiaceae	Hemiandra linearis	Hemiandra pungens/linearis
Lamiaceae	Hemiandra pungens	Hemiandra pungens/linearis
Moraceae	Ficus carica	omitted
Myrtaceae	Baeckea camphorosmae	Babingtonia camphorosmae
Myrtaceae	Eremaea asterocarpa subsp. asterocarpa	Eremaea asterocarpa
Myrtaceae	Eucalyptus calophylla	Corymbia calophylla
Myrtaceae	Eucalyptus marginata	Eucalyptus marginata subsp. marginata
Myrtaceae	Verticordia densiflora	Verticordia densiflora var. densiflora
Myrtaceae	Verticordia plumosa var. brachyphylla	Verticordia plumosa
Myrtaceae	Verticordia plumosa var. pleiobotrya	Verticordia plumosa
Myrtaceae	Verticordia plumosa var. vassensis	Verticordia plumosa
Onagraceae	Epilobium billardiereanum subsp. billardiereanum	Epilobium billardiereanum
Onagraceae	Epilobium billardiereanum subsp. intermedium	Epilobium billardiereanum
Orchidaceae	Caladenia longicauda subsp. albella	Caladenia longicauda
Orchidaceae	Caladenia longicauda subsp. calcigena	Caladenia longicauda
Orchidaceae	Caladenia longicauda subsp. longicauda	Caladenia longicauda
Orchidaceae	Caladenia sp.	omitted
Orchidaceae	Microtis media subsp. media	Microtis media
Orchidaceae	Pterostylis sp.	omitted
Orchidaceae	Thelymitra graminea	Thelymitra macrophylla
Pittosporaceae	Billardiera fraseri	Pronaya fraseri
Plantaginaceae	Veronica sp.	omitted
Poaceae	Pentameris airoides subsp. airoides	Pentaschistis airoides/pallida
Poaceae	Pentaschistis airoides	Pentaschistis airoides/pallida
Poaceae	Pentaschistis pallida	Pentaschistis airoides/pallida
Poaceae	Pentaschistis sp. scps	Pentaschistis airoides/pallida
Poaceae	Rytidosperma occidentale	Austrodanthonia occidentalis
Proteaceae	Banksia dallanneyi var. dallanneyi	Dryandra lindleyana

FAMILY	Species_LUP.name	Species_LUP_1.name
Proteaceae	Grevillea bipinnatifida subsp. bipinnatifida	Grevillea bipinnatifida
Proteaceae	Grevillea sp.	omitted
Proteaceae	Synaphea petiolaris	Synaphea petiolaris subsp. petiolaris
Restionaceae	Lepyrodia sp.	omitted
Rhamnaceae	Trymalium odoratissimum subsp. odoratissimum	Trymalium floribundum
Rutaceae	Boronia ramosa subsp. anethifolia	Boronia ramosa
Rutaceae	Boronia ramosa subsp. ramosa	Boronia ramosa
Scrophulariaceae	Eremophila glabra subsp. albicans	Eremophila glabra
Scrophulariaceae	Verbascum sp. scsp	omitted