

# 2017–18 Basin-scale evaluation of Commonwealth environmental water – Vegetation Diversity

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## Final Report

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# 2017–18 Basin-scale evaluation of Commonwealth environmental water — Vegetation Diversity

Report prepared for the Commonwealth Environmental Water Office by La Trobe University

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The La Trobe University offices are located on the land of the Latje Latje and Wiradjuri peoples. We undertake work throughout the Murray–Darling Basin and acknowledge the traditional owners of this land and water. We pay respect to Elders past, present and future.

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## Abbreviations

ANAE	Australian National Aquatic Ecosystem (classification)
CEWO	Commonwealth Environmental Water Office
GIS	geographical information system
ha	hectare
LTIM	Long Term Intervention Monitoring
MDBA	Murray–Darling Basin Authority

# 1 Introduction

## 1.1 Context

Riverine vegetation is critical to many ecological functions at wetland, valley and Basin scales and supports a diverse range of socio-economic and cultural values (Capon et al. 2013). Vegetation is also very sensitive to hydrology and represents a key component of the Basin Plan's objectives. Consequently, vegetation diversity has been one of the core elements considered in the suite of matters evaluated at the Basin scale in the Long Term Intervention Monitoring (LTIM) project.

Hydrology tends to be the principal driver of vegetation dynamics in riparian, floodplain and other wetland habitats, especially in arid and semi-arid landscapes such as those which comprise much of the Murray-Darling Basin (Capon et al. 2016). In the short-term, individual flood pulses usually have an overriding influence on the survival, growth and reproduction of plants in these habitats, the responses of which vary in relation to their specific traits and life history stage, as well as the characteristics of wetting events, e.g. timing, duration etc., and antecedent conditions, e.g. time since last flood event (Nilsson & Svedmark 2002; Brock *et al.* 2006; Capon 2003, 2016). Over longer time periods, patterns of wetting and drying therefore play a primary role in shaping the composition and structure of riverine vegetation communities and their arrangement across the landscape (Stromberg 2001; Capon 2005, 2016).

Riverine habitats in arid and semi-arid landscapes are characterised by highly variable and unpredictable hydrological regimes. Plants inhabiting riparian zones, floodplains and wetlands in these regions exhibit a wide range of traits that allow them to persist under these fluctuating conditions (Capon & Reid 2016). Many herbaceous plant species persist in these habitats by maintaining large, long-lived soil seed banks from which plants only germinate and establish in the extant vegetation in response to cues signalling favourable conditions for their growth and reproduction (Brock et al. 2006). Germination of submerged, floating and some emergent aquatic plants can occur during periods of inundation, with many dominant perennial aquatic species spreading largely via vegetative growth in habitats that are continuously or frequently inundated. In contrast, most amphibious and terrestrial wetland species establish from soil seed banks during the damp, rather than submerged, conditions that occur following floodwater recession and may only appear in the extant vegetation for brief periods. Consequently, while relatively stable plant communities dominated by aquatic perennials may develop in semi-permanent wetlands, most riverine vegetation communities are more dynamic, shifting in composition and structure in response to short-term fluctuations in hydrological condition. At local scales, it can therefore be expected that the most diverse vegetation communities will occur in intermediately flooded habitats and during periods of drawdown or early phases of drying following floods (e.g. Kenny et al. 2017).

Variation in patterns of flooding and drying, as well as local environmental conditions (e.g. soil characteristics, shading, leaf litter, spatial position etc.) create heterogeneous mosaics of plant habitat across riverine landscapes in space and time (Capon & Reid 2016; Capon et al. 2017),. Different plant species and vegetation communities establish and grow in riverine habitat patches in relation to recent, short-term hydrological conditions as well as longer term flooding regimes - the latter influencing the mature plants and seeds available to respond the former. Both plant species

diversity and vegetation community diversity, at landscape and basin scales, are therefore likely to be enhanced by more spatially heterogeneous hydrological regimes over multiple temporal scales.

Monitoring data collected under the LTIM project provides a unique chance to examine vegetation diversity responses to watering across a range of spatial and temporal scales and to inform adaptive management of Commonwealth, and other, environmental water.

## **1.2 Evaluation objectives**

The major questions addressed by the Basin scale evaluation of vegetation diversity are:

1. What did Commonwealth environmental water contribute to plant species diversity?
2. What did Commonwealth environmental water contribute to vegetation community diversity?

Each annual Vegetation Diversity Basin Matter evaluation seeks to describe vegetation diversity responses to Commonwealth environmental water in both the current water year (i.e. 2017-18) and over the duration of the entire LITM program to date (i.e. since 2014-15).

The evaluation is based predominantly on analyses of monitoring data collected from six Selected Areas across the Murray-Darling Basin: the Gwydir river system, the Lachlan river system, the Murrumbidgee river system, the Junction of the Warrego and Darling rivers, the Edward-Wakool river system and the Goulburn River. Over each time period (i.e. annual or cumulative since 2014-15), the Basin scale evaluation seeks to compare and contrast vegetation responses within these Selected Areas as well as consider aggregated responses across all monitored Selected Areas (i.e. Basin Scale Evaluation). Available hydrologic data and ecosystem mapping data are also considered to enable assessment of likely vegetation responses beyond these monitored Selected Areas in the Basin Scale Evaluation.

The specific questions addressed by the Basin scale evaluation of vegetation diversity in the 2017-18 evaluation report are:

### *Annual evaluation:*

1. What did Commonwealth environmental water contribute to plant species diversity within and across monitored Selected Areas during 2017-18?
2. What did Commonwealth environmental water contribute to vegetation community diversity within and across monitored Selected Areas during 2017-18 at local and landscape scales?
3. What did Commonwealth environmental water likely contribute to vegetation community diversity in unmonitored areas during 2017-18?

### *Cumulative (i.e. 1-4 year) evaluation:*

4. What did Commonwealth environmental water contribute to plant species diversity within and across monitored Selected Areas between 2014-15 and 2017-18?
5. What did Commonwealth environmental water contribute to vegetation community diversity within and across monitored Selected Areas between 2014-15 and 2017-18 at local and landscape scales?

6. What did Commonwealth environmental water likely contribute to vegetation community diversity in unmonitored areas between 2014-15 and 2017-18?

### **1.3 Summary of Basin Matter outcomes to date**

The first three years of the LTIM project (2014-15, 2015-16 and 2016-17) have comprised a wide range of environmental conditions across the Basin including periods of drought as well as large natural flood events. Vegetation diversity responses to Commonwealth environmental water observed in the monitored Selected Areas have varied considerably during this period. Despite this high level of variability, however, some key findings have emerged from previous evaluations of vegetation diversity:

- native plant species diversity, particularly that of grasses and sedges, is very likely to have been enhanced by the delivery Commonwealth environmental water since 2014-15 at both Selected Area and Basin scales;
- inundation by Commonwealth environmental water has generated vegetation communities with greater cover and species richness in many, but not all, locations;
- inundation by Commonwealth environmental water has contributed to reductions in the cover of exotic plant species in many, but not all, locations;
- inundation by Commonwealth environmental water has resulted in shifts in the composition of vegetation communities, especially with respect to the abundance of native species, towards communities with a greater abundance of wetland plant species;
- higher species richness tends to occur in vegetation communities that experience variable wetting and drying regimes in the short-term (i.e. annually) and over longer time periods, with numbers of species generally declining in wetlands subject to continuous inundation;
- cover and diversity of exotic plant species is usually greatest under dry conditions; and
- inundation by Commonwealth environmental water has promoted the diversity of vegetation communities at a landscape scale with Selected Areas and at a Basin scale.

### **1.4 Summary of watering actions with expected outcomes for the year relevant to this Basin Matter evaluation**

Sixty-nine watering actions, comprising a total of 1,779,607 ML, were delivered by the Commonwealth Environmental Water Office (CEWO) during 2017-18 for expected outcomes associated with vegetation diversity across the Basin (Appendix A). Of these, thirty watering actions, comprising a total of 184,931 ML, were conducted by CEWO during 2017-18 for vegetation outcomes in the Selected Areas relevant to the Vegetation Diversity Basin Matter (Table 1).

Amongst the four wetland Selected Areas relevant to the Vegetation Diversity Basin Matter, Commonwealth environmental water delivered during this year (i.e. 2017-18) only resulted in inundation of LTIM vegetation monitoring sites during the 2017-18 sampling period in the

Murrumbidgee river system (Table 1). No Commonwealth environmental water was delivered during 2017-18 to the Junction of the Warrego and Darling rivers or the Lachlan river system Selected Areas for vegetation diversity outcomes, although there was a watering action delivered to the Gwydir river system for vegetation diversity outcomes but this did not result in inundation of any sites monitored under the LTM project.

Several watering actions were conducted in the two riverine Selected Areas relevant to the Vegetation Diversity Basin Matter. In the Edward-Wakool river system, vegetation diversity monitoring focused on the effects of two watering actions (Watts et al. 2018) while in the Goulburn River Selected Area, vegetation diversity monitoring conducted in the LTIM project has focused predominantly on investigating the effects of Commonwealth environmental watering actions that contribute to Spring freshes (Webb et al. 2018).



(Photo: Clear Lake, Narran Lakes Nature Reserve, 2017. S. Capon)

**Table 1. Summary of watering actions with expected outcomes related to vegetation diversity at Selected Areas monitored for vegetation diversity in 2017–18.**

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>	Inundation of LTIM monitoring sites during 2017-18 vegetation sampling period
1718-EWK-03	10070-03	Edward Wakool: Colligen-Neimur	13832	13832.00	1/9/17	1/5/18	Fresh	Maintain health of riparian and in-channel aquatic native vegetation communities.	Yes
1718-EWK-06	10054-12	Edward Wakool: Colligen-Neimur	6370	6370.00	1/7/17	30/8/17	Baseflow	Maintain health of riparian and in-channel aquatic native vegetation communities. Instream aquatic plant regeneration post 2016 flood.	Yes
1718-EWK-02	10070-01	Edward Wakool: Tuppal Creek	1641	3282.00	21/8/17	10/11/17	Baseflow	Maintain health of riparian and in-channel aquatic native vegetation communities. Improve the condition of the fringing vegetation community including river red gums and black box.	
1718-EWK-04	10070-04	Edward Wakool: Tuppal Creek	933	3712.00	29/3/18	5/5/18	Baseflow	Maintain health of riparian and in-channel aquatic native vegetation communities. Improve the condition of the fringing vegetation community including river red gums and black box.	

1718-EWK-01	10070-01	Edward Wakool: Yallakool Wakool System	16452	16452.00	1/9/17	1/5/18	Fresh	Maintain health of riparian and in-channel aquatic native vegetation communities.	Yes
1718-EWK-05	10054-11	Edward Wakool: Yallakool Wakool System	7915	7915.00	1/7/17	30/8/17	Baseflow	Maintain health of riparian and in-channel aquatic native vegetation communities. Instream aquatic plant regeneration post 2016 flood.	Yes
1718-GLB-01	10064	Goulburn: Lower Goulburn River	112232	142489.00	1/7/17	24/7/17	Fresh	Contribute to a winter fresh to provide vegetation.	Prior to monitoring period
1718-GLB-02	10064	Goulburn: Lower Goulburn River	74205	99204.00	16/9/17	11/10/17	Fresh	Contribute to long-duration freshes in spring to water bank vegetation, provide soil moisture to banks and benches, distribute seed and allow plants to flower and seed for later germination and distribution.	Yes (N.B. This is the main Commonwealth environmental action evaluated at this Selected Area).
1718-GLB-03	10064	Goulburn: Lower Goulburn River	3487	29065.00	8/10/17	19/11/17	Baseflow	Contribute to baseflows to maintain water quality and provide suitable habitat and food resources for native fish and macroinvertebrate and to water bank vegetation.	Yes

1718-GLB-05	10064	Goulburn: Lower Goulburn River	852	8315.00	27/11/17	5/12/17	Baseflow	Contribute to baseflows to maintain water quality and provide suitable habitat and food resources for native fish and macroinvertebrate and to water bank vegetation.	Yes
1718-GLB-06	10064	Goulburn: Lower Goulburn River	6112	97639.00	2/12/17	22/12/17	Bankfull	Protect fish, water bug and vegetation habitat and bank condition.	Yes
1718-GLB-07	10064	Goulburn: Lower Goulburn River	5560	287127.00	19/12/17	9/1/18	Baseflow	Contribute to baseflows to maintain water quality and provide suitable habitat and food resources for native fish and macroinvertebrate and to water bank vegetation.	Post monitoring period
1718-GLB-08	10064	Goulburn: Lower Goulburn River	49989	91943.00	22/6/18	30/6/18	Fresh	Contribute to a winter fresh to provide vegetation and maintain macroinvertebrate habitat.	Post monitoring period
1718-GWY-01	10069-01	Gwydir: Gwydir Wetlands	4000	8000.00	19/12/17	17/1/18	Wetland	Support vegetation survival, condition and reproduction.	None
1718-MBG-07	10068-04	Murrumbidgee: Coonancoocabil Lagoon	900	900.00	11/12/17	2/1/18	Wetland	Maintain water quality and riparian vegetation and contribute to the ecological health and resilience of the wetlands and creek systems.	None
1718-MBG-04	10062-03	Murrumbidgee: Gooragool Lagoon	1426	1426.00	18/7/17	11/8/17	Wetland	Maintain and improve the condition of wetland vegetation.	Yes
1718-MBG-14	10068-11	Murrumbidgee: Gooragool Lagoon	750	1500.00	1/6/18	30/6/18	Wetland	Maintain water quality and riparian vegetation and contribute to the ecological health and resilience of the wetlands and creek systems.	Post monitoring period

1718-MBG-02	10062-01	Murrumbidgee: Mid-Murrumbidgee wetlands	159283	236205.00	24/7/17	1/9/17	Fresh, Wetland	Support reproduction and improved condition of vegetation, waterbirds, native fish and other biota.	Yes
1718-MBG-01	10034-13	Murrumbidgee: Nimmie-Caira	1738	1738.00	15/12/17	18/12/17	Baseflow	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.	Yes
1718-MBG-13	10068-10	Murrumbidgee: Nimmie-Caira	5000	13850.00	15/4/18	28/5/18	Wetland	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.	Post monitoring period
1718-MBG-05	10068-02	Murrumbidgee: North Redbank	5528	5528.00	9/10/17	19/10/17	Wetland	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.	Yes
1718-MBG-08	10068-05	Murrumbidgee: Oak Creek	620	620.00	28/12/17	2/1/18	Wetland	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.	No
1718-MBG-11	10068-08	Murrumbidgee: Sandy Creek	400	400.00	17/2/18	23/4/18	Wetland	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.	No
1718-MBG-12	10068-09	Murrumbidgee: Tuckerbill Swamp	600	600.00	9/4/18	16/4/18	Wetland	Maintain the ecological character of this Ramsar site which requires environmental water to maintain vegetation condition, and in particular critical habitat for the critically endangered (EPBC Act) Australasian bittern, supporting a	No

									range waterbirds, native fish, frogs and turtles.	
1718-MBG-03	10062-02	Murrumbidgee: Yarradda Lagoon	326	826.00	4/7/17	24/7/17	Wetland		Maintain and improve the condition of wetland vegetation.	Yes
1718-MBG-09	10068-06	Murrumbidgee: Yarradda Lagoon	178	177.64	20/11/17	25/11/17	Wetland		Consolidate and maintain native vegetation condition and water quality in Yarradda Lagoon.	Yes

<sup>1</sup> As reported by CEWO.

## 2 Methods

### 2.1 Evaluation approach

This report provides an evaluation of vegetation diversity outcomes of Commonwealth environmental water for the 2017-18 water year (i.e. annual evaluation) as well as over the duration of the LTIM project between 2014-15 and 2017-18 (i.e. cumulative evaluation). For each time period, the evaluation investigates:

1. *Plant species diversity responses:*
  - effects of Commonwealth environmental water on the presence and distribution of plant species within and across Selected Areas
2. *Vegetation community diversity responses:*
  - effects of Commonwealth environmental water on diversity vegetation community diversity within Selected Areas including total vegetation cover, species richness, exotic species cover and community composition
  - effects of Commonwealth environmental water on vegetation community composition across all Selected Areas combined
  - effects of Commonwealth environmental water on inundation of vegetation communities at a Basin scale including unmonitored areas

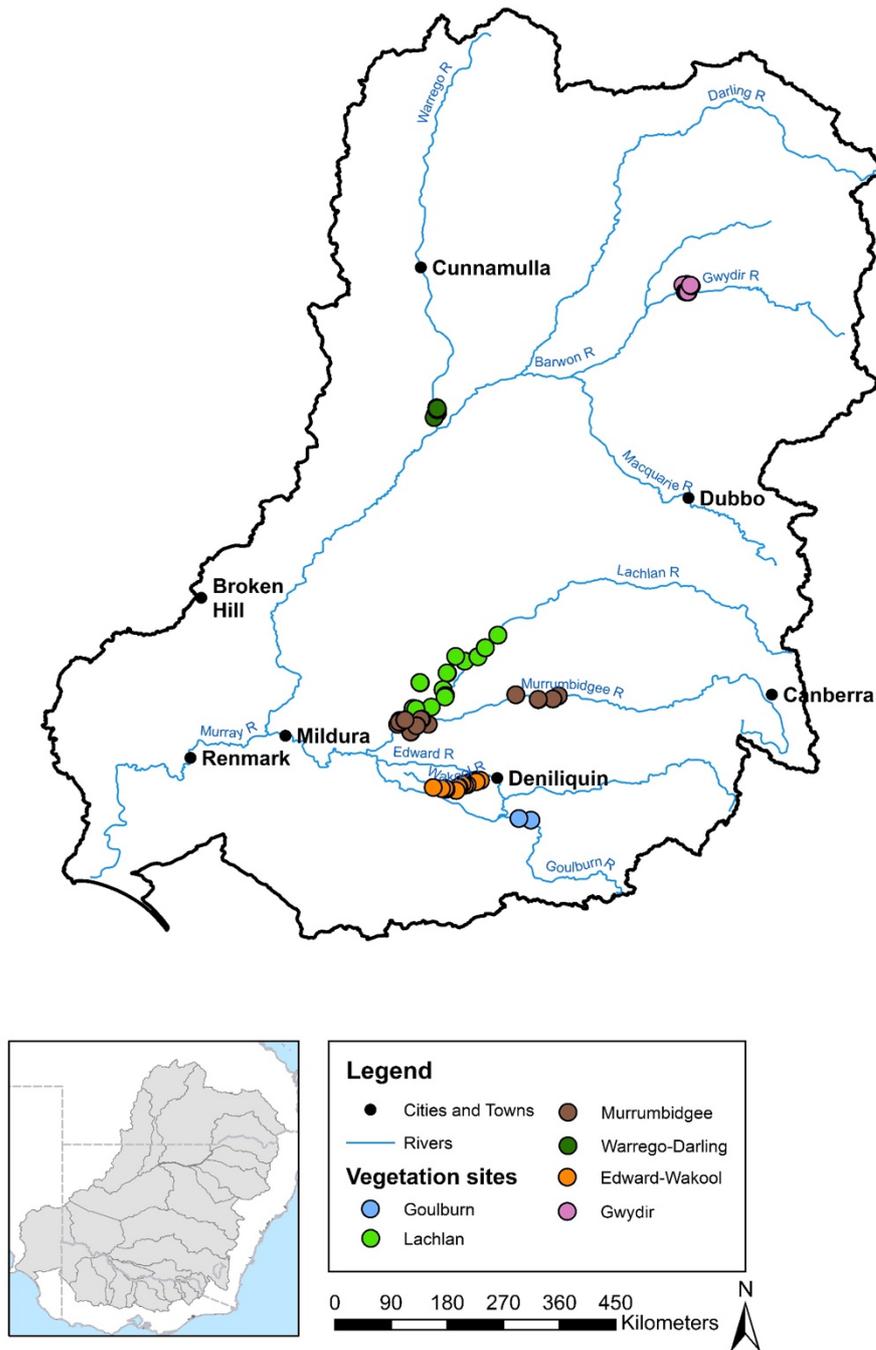
### 2.2 Data used in this evaluation

#### Vegetation diversity monitoring data

Vegetation diversity data are collected under the LTIM project from four wetland Selected Areas (the Gwydir river system, the Lachlan river system, the Murrumbidgee river system and the Junction of the Warrego and Darling rivers) and two riverine Selected Areas (the Edward–Wakool river system and the Goulburn River; Figure 1). In each Selected Area, data is collected regarding the percent cover of plant species present during multiple sampling trips (at least 2) each watering year within groundlayer, understorey and overstorey layers of the vegetation. A range of relevant environmental variables are also recorded including canopy cover (%), bare ground (%), litter cover (%), and log cover (%), as well as various observations of hydrological conditions, e.g. soil moisture. Sampling designs vary considerably between Selected Areas in relation to local wetland characteristics, especially between wetland and riverine Selected Areas. A summary of vegetation diversity sampling within Selected Areas is provided in Table 2.

For the purposes of this evaluation report, monitoring data recorded at each Selected Area, and entered into the LTIM project database, were aggregated at the level of Sample Point (Table 2). The data used in this evaluation comprised % cover values for each plant taxa recorded in the groundlayer of each Sample Point on each trip (i.e. mean values across any replicate sampling units within each Sample Point at each sampling time). Mean values for a range of environmental

variables were similarly calculated for each Sample Point for each sampling trip: i.e. canopy cover (%), bare ground (%), litter cover (%) and log cover (%). Environmental variables were only considered for the four wetland Selected Areas in this year’s evaluation because this data was only available for one of the riverine Selected Areas (i.e. the Goulburn river). Sample Points for which there was very patchy data available in the database (e.g. only a few sampling trips or less) were also excluded from the analyses.



**Figure 1. Map showing Selected Areas monitored for vegetation diversity under the LTIM project.**

**Table 2. Vegetation diversity sampling design at the six Selected Areas monitored for vegetation diversity in the LTIM project.**

Selected Area	Annual sampling times	Number of Sample Points	Number of replicate plots / transects per Sample Point	Sampling unit description
<b><i>Riverine Selected Areas</i></b>				
Edward-Wakool	Monthly (since Jan 2016)	16	6 x 20m long transects parallel to river up the bank	Entire 20 m transect
Goulburn	Sept/Oct/Dec; Dec/Feb/Apr	2	Up to 9 perpendicular transects on each river bank	20 x 2 m sub-transects along each perpendicular transect up the bank
<b><i>Wetland / floodplain Selected Areas</i></b>				
Gwydir	Oct; Mar	13	1-4 x 0.04 ha plots	Entire 0.04 ha plot
Lachlan	Oct/ Nov; May	1-9	2-4 x 100 m transects	1 m <sup>2</sup> quadrats every 10 m along transect
		4-17	2-4 x 0.1 ha plots (trees) with nested 0.04 ha plots (understorey)	Entire 0.04 ha plot (Note: canopy cover recorded for 0.1 ha plot)
Murrumbidgee	Sept/Oct; Nov/Dec; Jan/Feb; Mar/May	12	3-5 x 90 – 250 m long transects, depending on wetland bathymetry and area	3 – 5 x 1 × 10 m <sup>2</sup> quadrats along transect
Warrego	Feb/Aug/Dec/ Sept; May/Mar/Apr	8	3 x 0.04 ha plots	Entire 0.04 ha plot

### *Note regarding vegetation monitoring data*

While vegetation sampling conducted in the LTIM project is guided by standard methods, sampling designs and monitoring teams vary considerably between Selected Areas. Consequently, numerous challenges have emerged during this project regarding consistency and standardisation of vegetation monitoring data between Selected Areas and years (e.g. Table 2). Over the last year, substantial efforts have been made by the Basin matter team (especially Shane Brooks and Julia Mynott), all of the relevant Selected Area teams and the Commonwealth Environmental Water Office to remedy recognised problems and overhaul the centralised database and its associated quality control processes. Some of the key changes made have included a standardised list of plant taxa and processes for adding new taxa to this. Workshops conducted during this period, involving the vegetation diversity team from both Selected Areas and the Basin Matter, have also led to improved alignment of sampling designs across Selected Areas within the database. The overall result of this process is a completely revised vegetation diversity database for the first four years of the LTIM project. While this has taken considerable time and effort to achieve, there are now much greater opportunities for improved data analyses and quantitative modelling in the final year of the current project. However, as a caveat to this, the results of previous Basin scale evaluations of vegetation diversity may differ from current findings due to previous discrepancies in the database. Also,

because of the time involved in generating this revised and clean dataset, less time has been available for the year 4 evaluation which is consequently more exploratory in its approach.

### Inundation data

Multiple sources of information were used to characterise the hydrological regimes of the Sample Points of the four wetland Selected Areas considered here across multiple time periods (Table 3). These sources included observations made at Sample Points during sampling trips, consultation with Selected Area monitoring teams, annual maps of inundation extents across the Basin including extents inundated / influenced by Commonwealth environmental water, observations reported in annual Selected Area reports and information provided by the Commonwealth Environmental Water Office concerning watering actions that were delivered during 2017-18 (Table 1; Appendix 1). Because of the contrasting nature of the sampling designs at the two riverine Selected Areas, similar hydrological attributes were not relevant at the level of Sample Points. Instead, wetting histories for these Sample Points were inferred from information provided in relevant annual Selected Area reports and from the 2017-18 water action information (Table 1; Appendix 1).

**Table 3. Hydrological characteristics attributed to Sample Points for each sampling trip in the four wetland Selected Areas monitored for vegetation diversity in the LTIM project.**

Code	Attribute	Source	Relevant time period	Levels*	Notes
Hydrostate	Soil moisture	Selected Area monitoring	Time of sampling (i.e. Trip)	dry; damp; waterlogged; submerged	Dominant condition across sampling units in Sample Point used
STFR	Short-term flood regime	Selected Area monitoring, consultation with Selected Area teams	Relevant watering year of sampling (i.e. Year)	dry; var-dry; var-mid; var-wet; wet	'Dry' and 'wet' only allocated to Sample points with these conditions at all Trips during the year. Other levels reflect dominant conditions as per Hydrostate.
MTRF	Mid-term flood regime	Selected Area monitoring, consultation with Selected Area teams, annual Basin-wide inundation extent maps	Relevant watering year. N.B. calculated from cumulative conditions so changes each year.	dry; var-dry; var-mid; var-wet; wet	Dominant condition across sampling units in Sample Point.
CEWR	Commonwealth environmental watering regime	annual Basin-wide inundation extent maps	per Sample Point	dry; var-dry; var-mid; var-wet; wet	Inundated state defined as <= 50 m from inundation extent
WOFS	Long-term flood regime	Water observations from space dataset	per Sample Point	% of years inundated between 1987 and 2007	data is known to be problematic for vegetated wetlands

\* N.B. Water regime levels were assigned as follows: dry – dry in all relevant trips; var-dry – some wetting but mostly dry during relevant trips; var-mid - moderate wetting during relevant trips; var-wet – mostly wet during relevant trips; wet – wet in all relevant trips.

## 2.3 Analysis

### Plant species diversity responses

All observed plant taxa were initially assigned a status (i.e. native or exotic), a life history group (i.e. annual, perennial or variable) and a life form (i.e. forb, grass, sedge/rush, sub-shrub, shrub, mistletoe, tree) based on information in PlantNet (<https://www.http://plantnet.rbgsyd.nsw.gov.au/>) and the Atlas of Living Australia (<https://www.ala.org.au/>). Plants were then grouped according to life history and life form, e.g. annual forb, perennial grass etc. (Appendix B). Plant species diversity responses to Commonwealth environmental water were then assessed by investigating patterns in the presence of recorded plant taxa, as well as various groups of plant taxa, within each time period (i.e. annual and cumulative) in relation to a range of grouping variables, e.g. Selected Area, Hydrostate, Short-term flood regime etc.

For the cumulative evaluation, plants species diversity responses at the Basin scale were also assessed in relation to key grouping variables (e.g. Hydrostate, CEWR; Table 3) via indicator species analysis using the INDICESPEICES package in R (De Caceres and Legendre, 2009).

### Vegetation community diversity responses

Patterns in key vegetation community metrics (i.e. mean total vegetation cover, species richness and mean exotic plant cover) per Sample Point were visually inspected for each Selected Area in both time periods. Where relevant (i.e. wetland Selected Areas), separate plots were created for Sample Points under different Commonwealth environmental watering regimes (CEWR; Table 3) in order to explore potential differences in temporal patterns in relation to watering.

Patterns in vegetation community composition were considered within individual Selected Areas and at a basin scale (i.e. across all Selected Areas) via non-metric multidimensional scaling (nMDS) based on Bray-Curtis dissimilarities of  $\log(x+1)$  transformed species cover matrices in the VEGAN package in R (Oksanen et al. 2019). The ANOSIM and ENVFIT functions in VEGAN were also used in to explore differences in vegetation community composition between major relevant grouping variables, e.g. Selected Area, sample timing and various hydrological categories (Table 3). The BETADISPER function was used to investigate differences in the heterogeneity of samples within various groups.

### Inundation of vegetation communities in unmonitored areas

Inundation by Commonwealth environmental water of vegetation communities in unmonitored areas was assessed using analyses conducted in the Basin scale evaluation of Ecosystem Diversity (see Brooks 2019).

### 3 Annual (2017-18) evaluation

#### 3.1 Key findings

##### *Plant species diversity*

- A significant proportion of plant taxa recorded across all monitored Selected Areas in 2017-18 were only recorded from Sample Points that were inundated by Commonwealth environmental water delivered during 2017-18. These included 30 plant taxa (i.e. ~9 % of all plant taxa recorded across the Basin in 2017-18) from Sample Points inundated by Commonwealth environmental water in the Murrumbidgee river system as well as 30 taxa and seven taxa only recorded from the Goulburn River and the Edward-Wakool river system respectively. Many of these unique taxa likely benefitting from Commonwealth environmental water were aquatic or amphibious forbs, grasses and sedges/rushes.

##### *Vegetation community diversity at a Selected Area scale*

- Commonwealth environmental water was delivered to both riverine Selected Areas in 2017-18 for vegetation diversity outcomes. The Murrumbidgee river system was the only wetland Selected Area in which monitored locations were inundated by Commonwealth environmental water delivered in 2017-18 during the sampling period.
  - Monitored wetlands inundated during this year in this Selected Area, the majority of which were inundated by Commonwealth environmental water, tended to have greater vegetation cover, particularly by the final sampling trip.
  - In wetlands which experienced drier conditions throughout this year, plant species richness tended to decline with reductions of almost 50 % apparent in most. In contrast, wetlands that were inundated early in the year and then experienced a drawdown of floodwaters during this year all exhibited substantial increases in species richness as they dried before declining with further drying by the final sampling trip.
  - Vegetation community composition in the Murrumbidgee river system was significantly influenced by short-term flood regimes during this year. Wetlands experiencing wetter conditions during the year had particularly distinctive vegetation communities at a landscape scale, characterized especially by the native perennial forb *Persicaria prostrata*.

##### *Vegetation community diversity at a Basin scale*

- Across all monitored Selected Areas, vegetation community composition strongly reflected both location (i.e. Selected Area) and ANAE ecosystem type. Sample Points with wetter short-term flood regimes, mainly represented by wetlands in the Murrumbidgee river system that were inundated by Commonwealth environmental water during this year, exhibited relatively distinct vegetation communities at a Basin scale.
- Twenty-three ANAE wetland ecosystem types, twelve floodplain ecosystem types and eleven watercourse ecosystem types were inundated, or influenced by, Commonwealth environmental water inundated during 2017-18. All of these ecosystem types likely exhibited different

vegetation diversity responses to watering given the significant relationship between ANAE ecosystem type and vegetation community composition at monitored Selected Areas.

### 3.2 Effects of Commonwealth environmental water on plant species diversity within and across Selected Areas in 2017-18

At least 295 plant species, including 96 exotic taxa, were recorded from the groundlayer of monitored Selected Areas during LTIM surveys in 2017-18 (Appendix B). Of the 334 plant taxa recorded (i.e. all taxa including those not identified to species), 95 were annual forbs, 72 were perennial grasses, 27 were perennial sub-shrubs, 26 were annual sub-shrubs, 20 were perennial sedges/rushes, 15 were annual grasses, 8 were tree species, 3 were annual sedges/rushes and one was a perennial mistletoe.

The highest number of taxa was recorded during 2017-18 from the Lachlan river system (172 taxa) followed by the Murrumbidgee river system (135 taxa), Gwydir river system (85 taxa) and Junction of the Warrego and Darling rivers (73 taxa). Fewer taxa were recorded from two riverine Selected Areas, i.e. 55 taxa from the Goulburn River and 30 taxa from the Edward-Wakool river system, reflecting the significantly smaller sampling area at these Selected Areas. Amongst all of the plant taxa recorded during 2017-18, 215 taxa were only recorded from a single Selected Area with a further 66 taxa solely observed in two Selected Areas. Only two taxa (*Alternanthera denticulata* and *Juncus*) were recorded from all six Selected Areas during this year while a further four taxa (*Centipeda cunninghamii*, *Cirsium vulgare*, *Paspalidium jubiform* and *Sonchus oleraceus*) were observed in five of the six Selected Areas.

Amongst the wetland Selected Areas, only monitored Sample Points from the Murrumbidgee river system were inundated by Commonwealth environmental water delivered during 2017-18 (Table 1). A total of 52 plant taxa were solely recorded from the Murrumbidgee river system during 2017-18 (Table 4). Of these, 30 taxa were only recorded from Sample Points that were inundated by Commonwealth environmental water during this year, including 7 exotic species all of which were annual forbs (Table 4).

Commonwealth environmental water was also delivered to both riverine Selected Areas during 2017-18 (Table 1). Thirty taxa, including thirteen exotic taxa, were only recorded in 2017-18 from the Goulburn River while six taxa, all native, were only observed in the Edward-Wakool river system in this year (Table 4).

**Table 4. Plant species only present in 2017-18 in Selected Areas with Sample Points inundated by Commonwealth environmental water delivered during 2017-18. N.B. For the Murrumbidgee river system, only taxa present in Sample Points inundated by Commonwealth environmental water are shown while all taxa uniquely recorded from the Goulburn river and the Edward-Wakool river system in 2017-18 are listed. Note: asterisks (\*) indicate exotic species.**

Plant group	Murrumbidgee	Goulburn	Edward-Wakool
Annual forbs	<i>Arctotheca calendula</i> * <i>Calotis hispidula</i> <i>Craspedia variabilis</i>	<i>Vellereophyton dealbatum</i> * <i>Oxalis exilis</i> <i>Persicaria hydropiper</i>	<i>Pseudognaphalium luteoalbum</i> <i>Callitriche</i>

	<i>Damasonium minus</i> <i>Erodium malacoides*</i> <i>Euchiton sphaericus</i> <i>Physalis*</i> <i>Plantago lanceolata*</i> <i>Raphanus raphanistrum*</i> <i>Rapistrum rugosum*</i> <i>Senecio quadridentatus</i> <i>Sonchus oleraceus*</i> <i>Tetragonia tetragonoides</i>	<i>Fumaria*</i> <i>Lepidium africanum*</i> <i>Sonchus asper*</i> <i>Lythrum</i>	
Perennial forbs	<i>Azolla filiculoides</i> <i>Brachyscome papillosa</i> <i>Calotis scapigera</i> <i>Dichondra repens</i> <i>Lemna</i> <i>Nymphoides crenata</i> <i>Potamogeton crispus</i> <i>Ranunculus undosus</i> <i>Triglochin procera</i> <i>Utricularia gibba</i> <i>Vallisneria gigantea</i> <i>Verbena gaudichaudii</i>	<i>Kickxia elatine*</i> <i>Romulea rosea*</i> <i>Euchiton involucratus</i> <i>Oxalis perennans</i> <i>Wahlenbergia gracilis</i>	<i>Gratiola</i>
Annual grasses		<i>Bromus diandrus*</i> <i>Eragrostis elongata</i> <i>Lolium perenne*</i>	
Perennial grasses	<i>Eragrostis australasica</i>	<i>Panicum coloratum*</i> <i>Poa labillardierei</i> <i>Paspalum dilatatum*</i> <i>Themeda triandra</i> <i>Phragmites australis</i> <i>Rytidosperma</i>	
Perennial sedges/rushes		<i>Carex tereticaulis</i> <i>Cyperus eragrostis*</i> <i>Juncus amabilis</i> <i>Cyperus exaltatus</i> <i>Carex</i>	
Annual sub-shrubs and shrubs		<i>Erigeron bonariense*</i>	
Perennial sub-shrubs and shrubs	<i>Einadia nutans</i> <i>Maireana aphylla</i> <i>Sida corrugata</i>		
Trees	<i>Acacia stenophylla</i>	<i>Acacia dealbata</i>	
Variable forbs			<i>Limosella</i>

Variable grasses		<i>Bromus*</i>	
Variable sedge/rushes			<i>Isolepis</i>
Variable sub-shrubs and shrubs		<i>Erigeron</i>	
Other			<i>Hypericum</i>

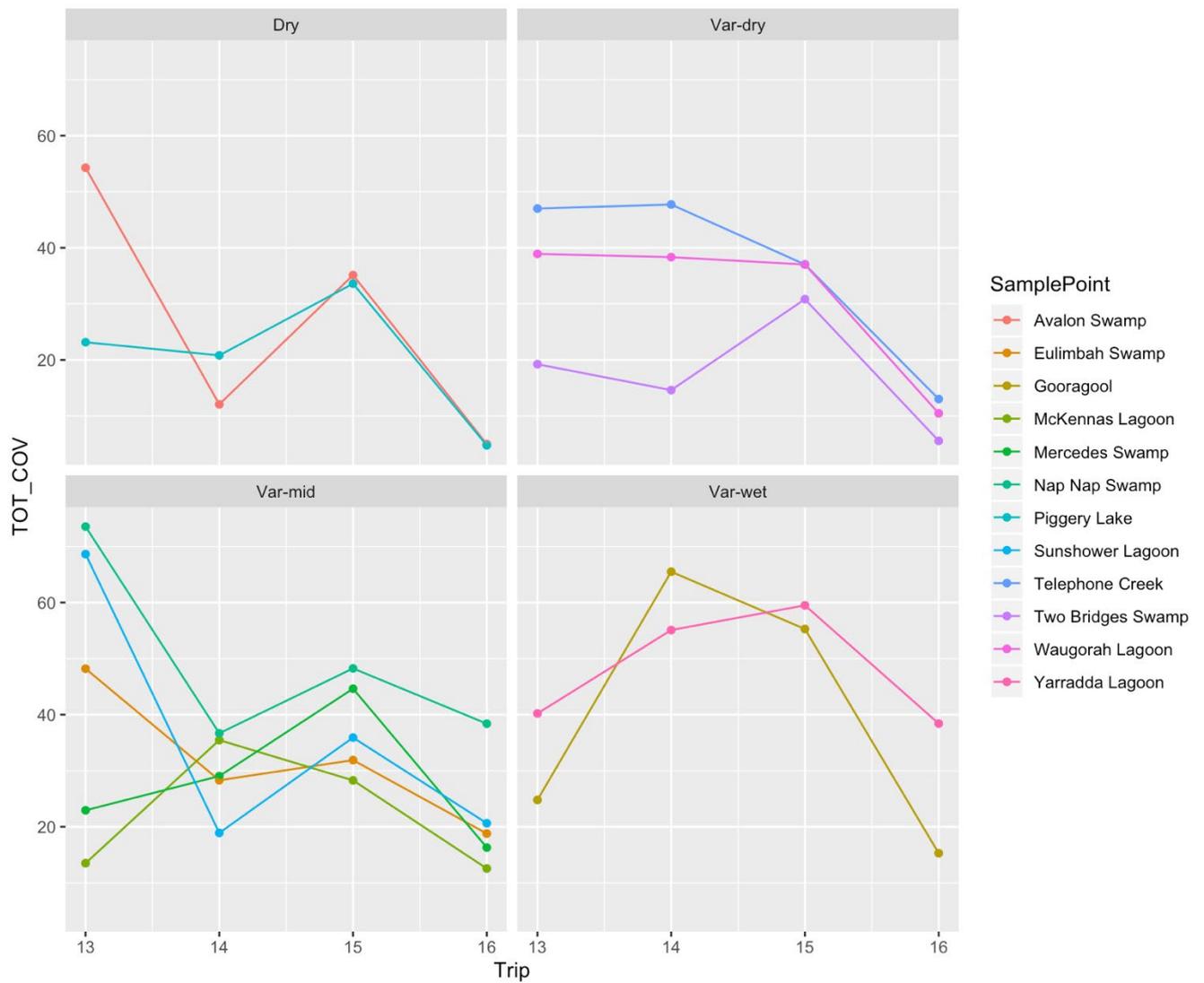
### 3.3 Effects of Commonwealth environmental water on vegetation community diversity within Selected Areas in 2017-18

The only wetland Selected Area with Sample Points inundated by Commonwealth environmental water delivered during the 2017-18 monitoring period was the Murrumbidgee river system. Vegetation community diversity responses to wetting at this Selected Area are considered here. An annual evaluation of vegetation community data was not conducted for either of the two riverine Selected Areas, both of which received Commonwealth environmental water during 2017-18, due to time and data constraints (see Preface).

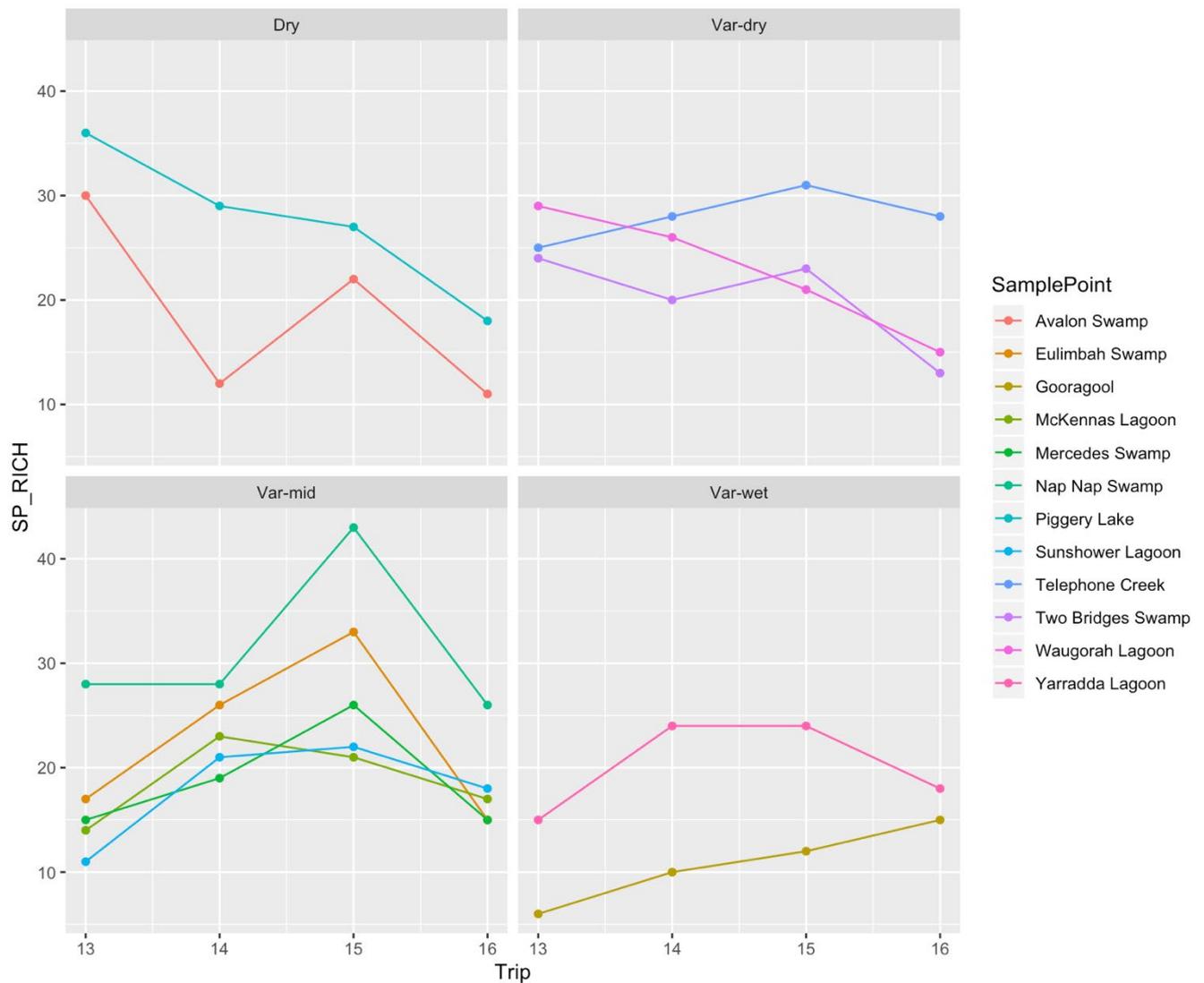
#### Murrumbidgee river system

Total vegetation cover varied considerably between Sample Points and sampling trips in the Murrumbidgee river system during 2017-18 (Figure 2). Nevertheless, similar trends were apparent in temporal fluctuations in total vegetation cover amongst Sample Points that experienced the same short-term flood regimes (STFR; Table 3) during this year. In particular, total vegetation cover tended to be lower by the final sampling trip in Sample Points subject to drier conditions during the year (Figure 2). Total vegetation cover also tended to be greater in the middle of the sampling year (i.e. trips 14 and 15) in sites with wetter short-term flooding regimes (Figure 2).

Species richness at Sample Points in the Murrumbidgee river system also varied over time during 2017-18 but again, similar trajectories were apparent in relation to short-term flood regimes (STFR; Table 3). Numbers of species in Sample Points that experienced wetter conditions during 2017-18 (i.e. Gooragool and Yarradda Lagoon) increased overall during the year while in moderately wet Sample Points (i.e. STFR = Var-mid), species numbers tended to rise as wetlands dried until the final trip when species richness consistently declined with further drying (Figure 3). In general, species richness was lower in the wettest Sample Points compared to those with more intermediate short-term flooding regimes. Overall declines in species richness were apparent in most of the Sample Points under the drier (i.e. Dry and Var-dry) short-term flood regimes.



**Figure 2. Mean total vegetation cover in Sample Points in the Murrumbidgee river system at each sampling trip during 2017-18. Data is arranged by short-term flooding regimes (STFR; Table 3). All inundation of Sample Points during this year was attributed to Commonwealth environmental water actions except New South Wales water deliveries to Eulimbah Swamp (trips 13 and 14) and unregulated flows in Telephone Creek (trip 14), Nap Nap Swamp (trip 14) and Mercedes Swamp (trips 15 and 16).**



**Figure 3. Numbers of species recorded from Sample Points in the Murrumbidgee river system at each sampling trip during 2017-18. Data is arranged by short-term flooding regimes (STFR; Table 3). All inundation of Sample Points during this year was attributed to Commonwealth environmental water actions except New South Wales water deliveries to Eulimbah Swamp (trips 13 and 14) and unregulated flows in Telephone Creek (trip 14), Nap Nap Swamp (trip 14) and Mercedes Swamp (trips 15 and 16).**

Vegetation community composition also reflected short-term flood regimes (STFR; Table 3), shifting along a broad gradient from wetter to drier conditions (Figure 3), with a significant difference detected by ANOSIM in relation to STFR ( $R = 0.1361$ ,  $p = 0.0084^{**}$ ). The composition of vegetation communities under 'Var-wet' short-term flood regimes appeared to be particularly distinctive at a landscape scale (Figure 3). Of the environmental variables considered, bare ground and long-term flood regime (i.e. WoFS; Table 3) significantly correlated ( $p < 0.0001^{***}$  and  $p < 0.001^{**}$  respectively), the latter closely reflecting short-term flood regime.

Nineteen plant taxa were identified as significant indicators of differences in vegetation community composition in relation to STFR groups including: *Marrubium vulgare*, *Chenopodium album*, *Mentha australis* to Dry conditions; *Acacia stenophylla* to Var-dry conditions; *Calotis scapigera*, *Glinus*

*Iotoides*, *Potamogeton tricarinatus* to Var-mid conditions and *Persicaria prostrata* to Var-wet conditions. Five plant taxa were also identified as significant indicators of current soil moisture conditions at the time of sampling (i.e. Hydrostate; Table 3) in the Murrumbidgee during 2017-18: *Eleocharis pallens* to damp conditions; *Dysphania pumilio* to dry conditions; *Eleocharis sphacelata* to damp + waterlogged conditions; *Heliotropium europaeum* to dry + waterlogged conditions and *Chamaesyce drummondii* to damp + dry + waterlogged conditions.

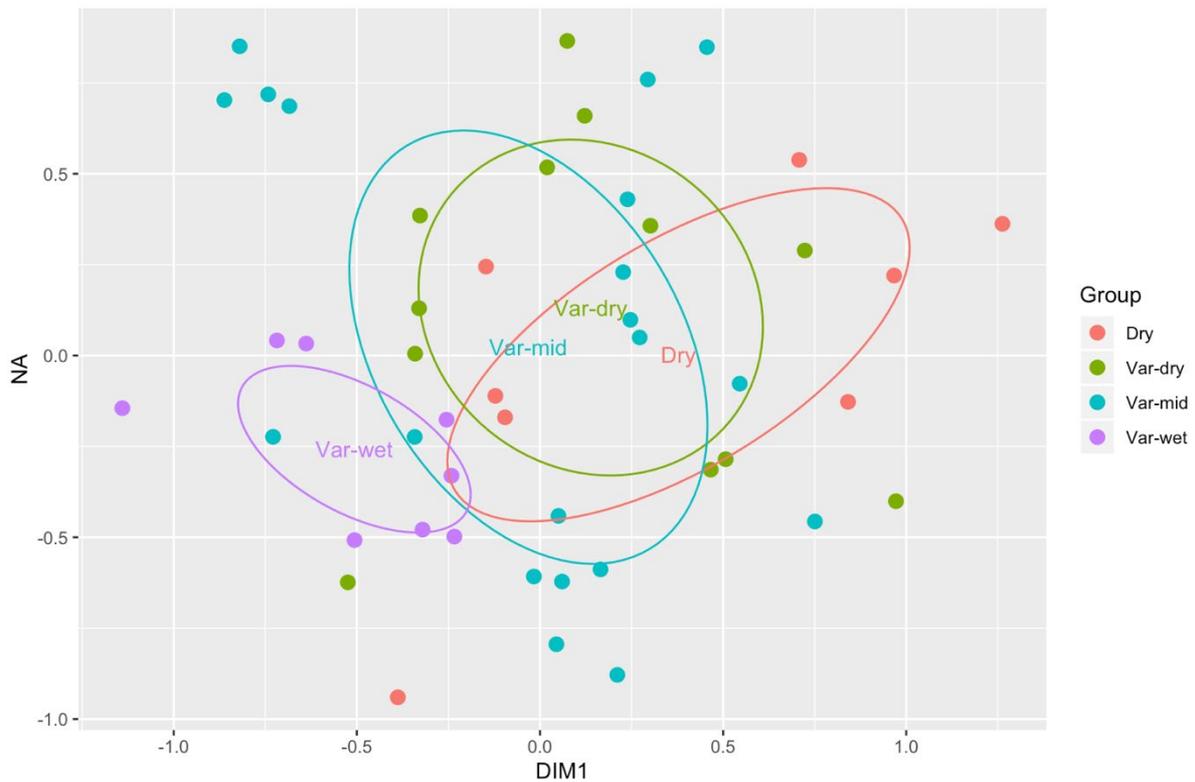
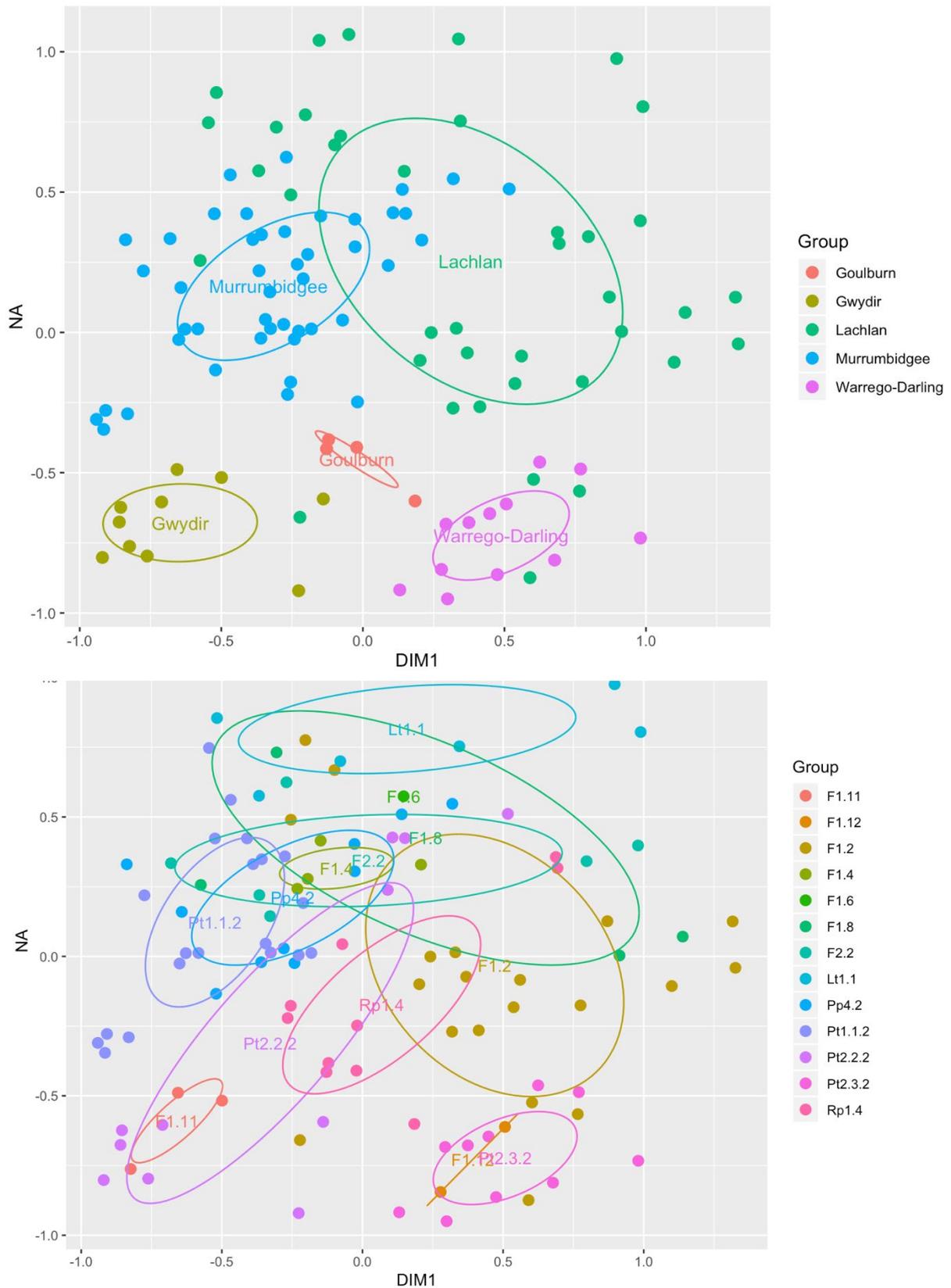


Figure 4. nMDS ordination of vegetation community composition at Sample Points surveyed in each Trip during 2017-18 in the Murrumbidgee river system in relation to short-term flood regime (STFR; Table 3). Stress = 0.2099357.

### 3.4 Effects of Commonwealth environmental water on vegetation community diversity across all Selected Areas in 2017-18

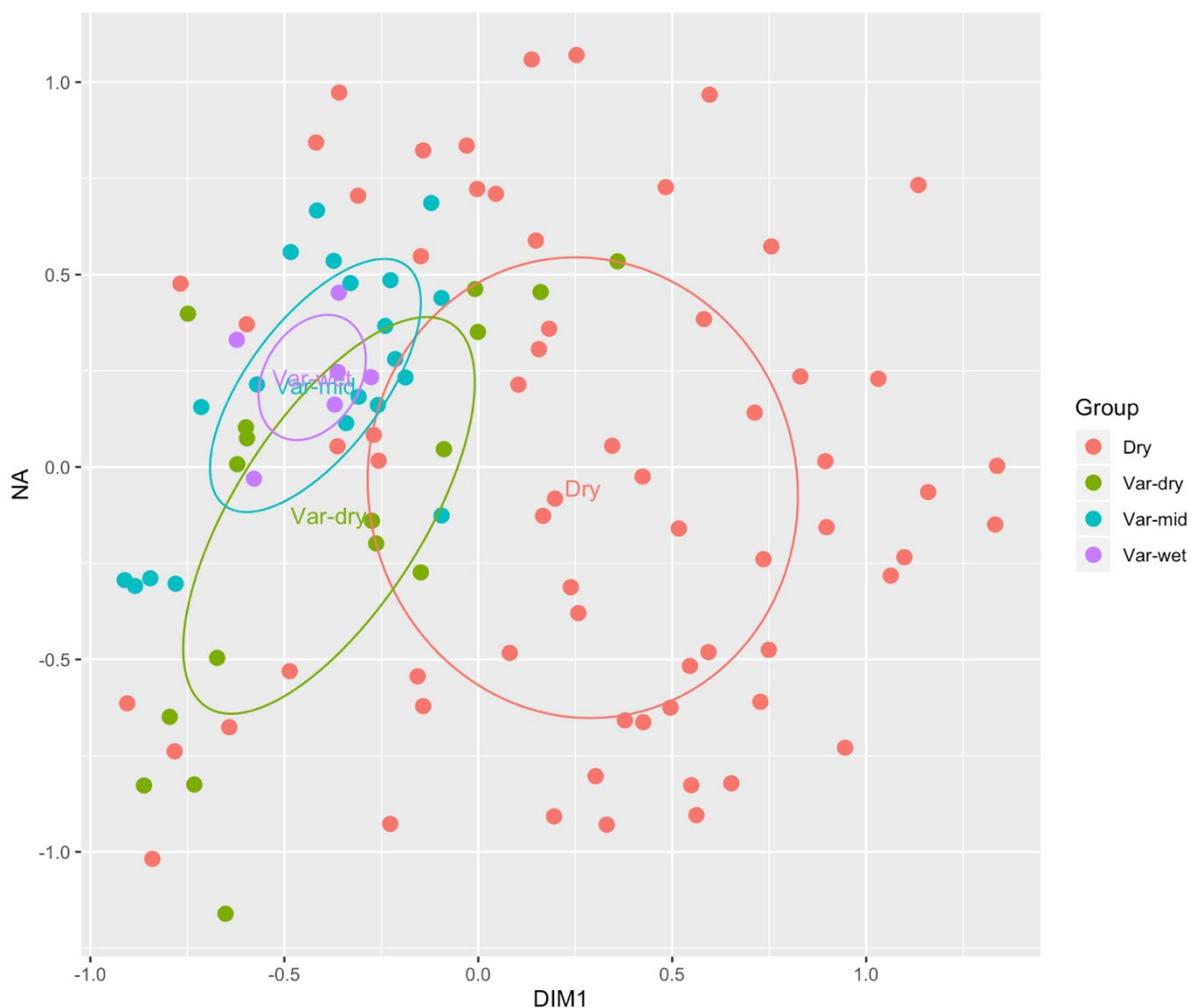
#### Aggregated analysis of Selected Areas

Vegetation community composition at Sample Points in 2017-18 differed significantly ( $R = 0.5024$ ,  $p < 0.0001$ ) between Selected Areas and between ANAE ecosystem types ( $R = 0.4523$ ,  $p < 0.0001$ ; Figure 5). Similarities and distances between Selected Areas strongly reflect geographic location with the two northern Basin Selected Areas and the two southern Basin Selected Areas separating in the ordination space in relation to the y axis (Figure 5). To some degree, overlap in community composition between Selected Areas appears to reflect commonalities in ANAE ecosystem type between Selected Areas (Figure 5).

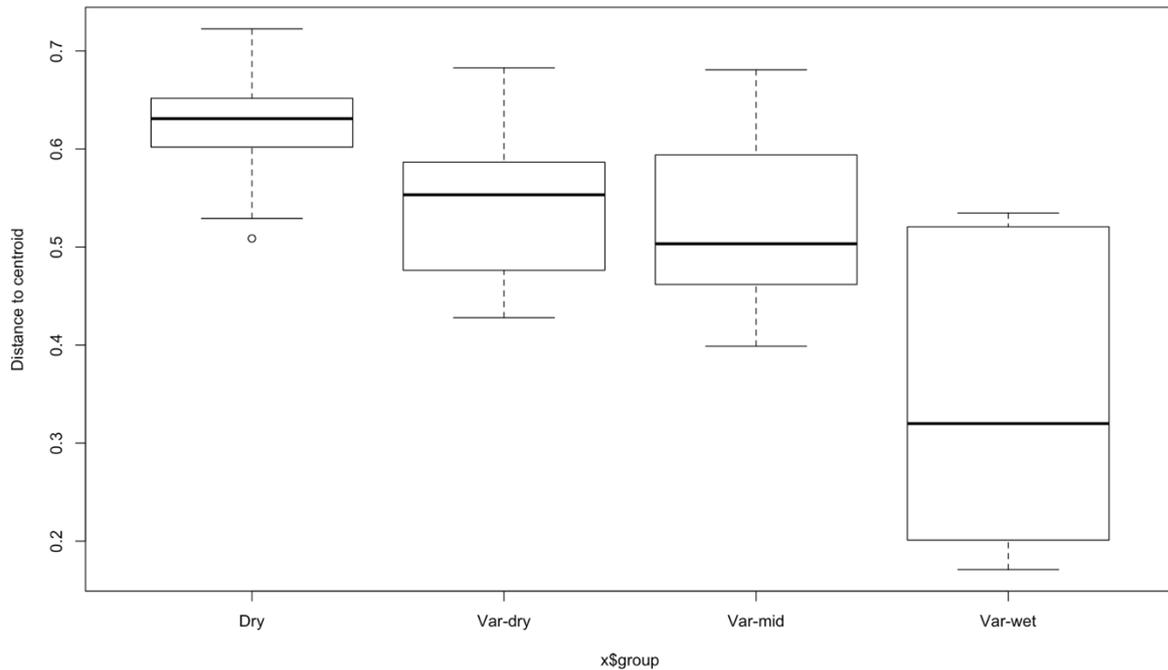


**Figure 5. nMDS ordination of vegetation community composition at Sample Points surveyed in each Trip during 2017-18 across all Selected Areas in relation to (top) short-term flood regime (STFR; Table 3) and bottom (ANAEC ecosystem types). Stress = 0.2477118. N.B. All Edward-Wakool sites were excluded from this analysis due to data processing criteria.**

Similar patterns were evident from consideration of the four wetland Selected Areas only in relation to the broader range of hydrological attributes available for these Sample Points (Table 3; Figure 6). Vegetation community composition amongst these Selected Areas differed significantly in relation to Sample Point ( $R = 0.909$ ,  $p < 0.0001$ ) and ANAE ecosystem type ( $R = 0.4741$ ,  $p < 0.0001$ ) but not between short-term flood regime (STFR) or Hydrostate categories. Furthermore, of the environmental variables considered, only longitude and latitude were significantly correlated with the ordination. Nevertheless, vegetation community composition did reflect short-term flood regimes during the year with greater dispersion amongst vegetation communities occurring under drier conditions (Figure 7). In particular, the composition of vegetation communities in Sample Points experiencing wetter conditions (i.e. STFR = Var-mid and Var-wet) during 2017-18, largely as a result of inundation by Commonwealth environmental water in the Murrumbidgee Selected Area, tended to be relatively distinct from that of drier Sample Points throughout the Basin (Figure 6.)



**Figure 6. nMDS ordination of vegetation community composition at Sample Points surveyed in each trip during 2017-18 across the four wetland Selected Areas in relation to short-term flood regime (STFR; Table 3). Stress = 0.23967.**



**Figure 7. Boxplot showing dispersion amongst vegetation communities at Sample Points in each short-term flood regime (STFR; Table 3) category during 2017-18 in the four wetland Selected Areas.**

### **3.5 Effects of Commonwealth environmental water on inundation of vegetation communities at a Basin scale in 2017-18**

Commonwealth environmental water inundated, or influenced inundation, of 23 ANAE wetland ecosystem types, 12 floodplain ecosystem types and 11 watercourse ecosystem types during 2017-18 (Table 5). This included inundation of significant proportions (> 10 %) of eight wetland ecosystem types and four watercourse ecosystem types at a Basin scale (Table 5). In particular, significant proportions (i.e. >20 %) of the Basin’s temporary red gum swamp (Pt1.1.2), permanent tall emergent marsh (Pt2.1.2), permanent wetland (Pp4.2), permanent saline wetland (Psp4) and floodplain or riparian wetland (Pt4.1) were influenced by Commonwealth environmental water in 2017-18 (Table 5).

Given the significant relationship between ANAE ecosystem type and vegetation community composition at monitored Selected Areas (Figure 5), it can be expected that different vegetation diversity responses to watering will have occurred in unmonitored areas according to their ecosystem type.

**Table 5. Proportion of ANAE ecosystem types (by area or length) inundated or influence by Commonwealth environmental water during 2017-18 (Source: Brooks 2019).**

Australian National Aquatic Ecosystem (ANAE) wetland type	Total ex Coorong and Lower Lakes	Inundated*		Influenced*	
	area (ha) / length (km)+	Area (ha) / Length (km)+	% of total	Area (ha)	% of total
<b>Wetland ecosystems</b>					
Pt1.1.2: Temporary river red gum swamp	74 721	8035	10.8	34 910	46.7
Pp4.2: Permanent wetland	77 300	11 945	15.5	23 018	29.8
Pt2.2.2: Temporary sedge/grass/forb marsh	135 475	5198	3.8	15 776	11.6
Lp1.1: Permanent lake	127 660	14 518	11.4	15 292	12.0
Pt2.1.2: Temporary tall emergent marsh	68 622	2884	4.2	4154	6.1
Lt1.1: Temporary lake	459 347	717	0.2	3730	0.8
Pt2.3.2: Freshwater meadow	125 128	719	0.6	3620	2.9
Pp2.1.2: Permanent tall emergent marsh	7995	409	5.1	3451	43.2
Pt4.1: Floodplain or riparian wetland	10 494	389	3.7	2495	23.8
Pt1.8.2: Temporary shrub swamp	234 393	648	0.3	2218	0.9
Pt3.1.2: Clay pan	129 736	335	0.3	1654	1.3
Psp4: Permanent saline wetland	2114	495	23.4	629	29.8
Pt4.2: Temporary wetland	26 892	170	0.6	602	2.2
Pt1: Temporary swamp	3767	384	10.2	576	15.3
Pt1.6.2: Temporary woodland swamp	216 625	323	0.1	494	0.2
Pt1.7.2: Temporary lignum swamp	49 962	4	0.0	446	0.9
Lst1.1: Temporary saline lake	27 897	0	0.0	307	1.1
Pt1.2.2: Temporary black box swamp	60 272	106	0.2	239	0.4
Pu1: Unspecified wetland	1763	0	0.0	95	5.4
Pp2.3.2: Permanent grass marsh	1507	11	0.7	85	5.6
Pp2.4.2: Permanent forb marsh	738	1	0.1	22	3.0
Pp2.2.2: Permanent sedge/grass/forb marsh	3590	20	0.6	21	0.6
Pst2.2: Temporary salt marsh	40 294	3	0.0	4	0.0
<b>Floodplain ecosystems</b>					
F1.2: River red gum forest riparian zone or floodplain	639 022	25 708	4.0		
F1.4: River red gum woodland riparian zone or floodplain	325 221	4887	1.5		
F1.8: Black box woodland riparian zone or floodplain	779 639	1830	0.2		
F2.2: Lignum shrubland riparian zone or floodplain	143 886	1474	1.0		
F1.10: Coolabah woodland and forest riparian zone or floodplain	1 215 726	1335	0.1		
F1.11: River cooba woodland riparian zone or floodplain	11 541	840	7.3		
F2.4: Shrubland riparian zone or floodplain	408 614	473	0.1		
F1.6: Black box forest riparian zone or floodplain	131 442	265	0.2		
F1.12: Woodland riparian zone or floodplain	318 686	93	<0.1		
F4: Unspecified riparian zone or floodplain	201 086	36	<0.1		
F3.2: Sedge/forb/grassland riparian zone or floodplain	833 102	0	0.0		
F1.13: Paperbark riparian zone or floodplain	17	0	0.0	N.A.	
<b>Watercourses</b>					
Rp1.4: Permanent lowland stream	40 783	11 533	28.3		
Rt1.4: Temporary lowland stream	198 613	2109	1.1		
Rp1.2: Permanent transitional zone stream	17 920	633	3.5		
Rp1.1: Permanent high energy upland stream	59 080	587	1.0		
Rp1.3: Permanent low energy upland stream	545	148	27.2		
Rt1: Temporary stream	174	101	58.0		
Rt1.1: Temporary high energy upland stream	167 220	89	0.1		
Rp1: Permanent stream	293	69	23.5	N.A.	

Australian National Aquatic Ecosystem (ANAE) wetland type	Total ex Coorong and Lower Lakes	Inundated*		Influenced*	
	area (ha) / length (km)+	Area (ha) / Length (km)+	% of total	Area (ha)	% of total
Rt1.2: Temporary transitional zone stream	116 557	26	<0.1		
Rt1.3: Temporary low energy upland stream	2795	24	0.9		
Rw1: Permanent river (landform unknown)	308	3	1.0		

+ Numbers for Watercourses refer to length rather than area.

## 4 Cumulative (2014 – 2018) evaluation

### 4.1 Key findings

#### *Plant species diversity*

- Over 600 (~626) plant taxa have been recorded from the groundlayer of the six Selected Areas monitored for vegetation diversity in the four years of the LTIM project since 2014-15.
  - During this four-year period, numbers of native species have increased overall with 138 native plant species recorded in 2014-15, 82 in 2015-16, 56 in 2016-17 and 144 in 2017-18.
  - Exotic plant species observed have declined overall during this four-year period with 60 exotic plant species recorded in 2014-15, 40 in 2015-16, 32 in 2016-17 and 47 in 2017-18.
- Only a small proportion of observed plant taxa (~2 %) are associated with specific Hydrostates (i.e. soil moisture conditions at the time of sampling) with most of these being indicator species of damp conditions. A similar number of plant taxa were associated with specific Commonwealth environmental watering regimes over the entire four-year period including *Typha* spp. and *Typha domingensis* emerging as strong indicators of vegetation communities in Sample Point that experienced wetter watering regimes.

#### *Vegetation community diversity at a Selected Area scale*

- Mean total vegetation cover at Sample Points has been highly variable between sampling Trips over the four-year period of the LTIM project.
  - The only clear trajectory apparent is in the Goulburn River where there has been an overall increase of approximately 10 % in vegetation cover on river banks over the four years.
  - In most of the wetland Selected Areas, temporal patterns in vegetation cover have been dominated by sharp increases in response to flooding in 2016-17 followed by steady declines in response to drying. Such dramatic shifts in vegetation cover appear to have been dampened in Sample Points in the Murrumbidgee river system that have experienced environmental watering prior to and following the 2016-17 floods.
- Temporal patterns in species richness at Sample Points vary considerably between Selected Areas over the four-year period of the LTIM project.
  - In the Goulburn River, species richness, while fluctuating seasonally, has declined overall, probably reflecting early dry conditions enabling establishment of plant species followed by loss of plant cover and species as a result of high natural flows in 2016-17.
  - Species richness in the Gwydir river system has remained relatively stable, following early declines, in Sample Points that have experienced both drier and the wettest

watering regimes while a steady decline in species numbers has occurred over the four years in Sample Points that have had a variable, but wet, watering regime.

- In the Junction of the Warrego and Darling rivers, the Lachlan river system and the Murrumbidgee river system, temporal patterns in species richness have been dominated by sharp declines in response to floods in 2016-17 followed by rapid increases in species numbers with floodwater recession and subsequent drying. As per total cover, this response was not as clear in Sample Points in the Murrumbidgee river system that had experienced frequent Commonwealth environmental watering during the preceding and subsequent period.
- A steady overall decline in species numbers over the four-year period is apparent in Sample Points under drier conditions in the Murrumbidgee river system.
- Temporal patterns in mean total cover of exotic plants have varied between and with Selected Areas over the four years.
  - A steady increase in exotic plant cover, where present, has occurred in the Edward-Wakool river system while in the Goulburn River, exotic plant cover appears to have remained relatively stable despite large seasonal fluctuations.
  - In the Gwydir river system, exotic plant cover has been low and stable following early declines in Sample Points with wetter watering regimes but has been much more variable, with substantial recent increases apparent, in drier Sample Points.
  - A steady, but slight increase in exotic plant cover over the four-year period is apparent in the Junction of the Warrego and Darling rivers, the Lachlan river system and the Murrumbidgee river system, a trend which does not appear to vary in relation to watering regimes of Sample Points.

#### *Vegetation community diversity at a Basin scale*

- Vegetation communities recorded during the entire LTIM project differ significantly in relation to year, Selected Area and ANAE ecosystem type.
  - Community composition of F1.11 (River cooba woodland riparian zone or floodplain), F1.12 (Woodland riparian zone or floodplain), Pt2.2.2 (Temporary sedge/grass/forb marsh) and Pt2.3.2 (Permanent grass marsh) are particularly distinctive at a Basin scale.
  - Heterogeneity of vegetation communities at a Basin scale also varied between years with greater dispersion amongst samples across all Selected Areas in 2015-16 and 2016-17.
- Amongst Wetland Selected Areas only, vegetation community composition differed significantly with respect to Hydrostate, mid-term flooding regime and Commonwealth environmental watering regimes (CEWR) over the four years with a clear gradient was apparent from drier to wetter samples.
  - Greater heterogeneity amongst vegetation communities within CEWR categories was evident within intermediate watering regimes while less heterogeneous communities occurring under both Wet and Dry watering regimes.

- Commonwealth environmental water has inundated, or influenced inundation, of 35 ANAE ecosystem types over the four-year period of the LTIM project including 24 wetland ecosystem types and 11 floodplain ecosystem types.
  - Twenty-six ecosystem types have received Commonwealth environmental water in every year while three ecosystem types have only been watered in a single year.
  - The diversity of ecosystem types watered has been remained relatively steady (i.e. 27-30) in all years except for 2016-17 when only 23 wetland types received Commonwealth environmental water.
  - Vegetation communities that have had significant proportions of their area (i.e. <10 %) inundated by Commonwealth environmental water in most years include temporary river red gum swamp (Pt1.1.2), permanent tall emergent marsh (Pp2.12), permanent wetland (Pp4.2), temporary sedge/grass/forb marsh (Pt2.2.2) and freshwater meadow (Pt2.3.2).

#### **4.2 Effects of Commonwealth environmental water on plant species diversity within and across Selected Areas between 2014-15 and 2017-18**

A total of 626 plant taxa have been recorded from the groundlayer of the six Selected Areas monitored for vegetation diversity in the four years of the LTIM project since 2014-15 (Appendix B). Of these, there have been 175 annual forb taxa recorded, 155 perennial forbs, 69 perennial sub-shrubs, 45 perennial grasses, 34 annual sub-shrubs, 31 annual grasses, 24 perennial sedge/rushes, 11 trees, 3 annual sedge/rushes and 3 mistletoe species. At least 180 exotic species have been recorded from Selected Areas during this period including 82 annual forb taxa, 30 perennial forbs, 23 annual grasses, 14 annual sub-shrubs, 11 variable forbs, 9 perennial grasses, 5 perennial sub-shrubs, 3 perennial sedge/rushes, 2 variable grasses and 1 variable sub-shrub.

Overall numbers of plant taxa recorded across all Selected Areas have declined over the four-year period of the LTIM project with 411 taxa recorded in 2014-15, 400 in 2015-16, 372 in 2016-17 and 336 in 2017-18, although this may largely reflect improvements in taxonomic resolution over time. In contrast, numbers of identified native species have increased overall with 138 native plant taxa recorded in 2014-15, 82 in 2015-16, 56 in 2016-17 and 144 in 2017-18. Similarly, identified exotic plant taxa have declined overall during this period with 60 exotic plant taxa recorded in 2014-15, 40 in 2015-16, 32 in 2016-17 and 47 in 2017-18.

A significant proportion (~34 %) of all plant taxa recorded under the LTIM project, including 60 exotic taxa, have only been observed in a single year with 87 taxa solely recorded in 2014-15, 59 taxa only in 2015-16, 40 only in 2016-17 and 25 only in 2017-18. Around 31 % of all taxa observed over the four-year period (i.e. 194 taxa), including 47 exotic taxa, have been observed in every year of the project. Indicator species analysis detected 40 plant taxa significantly associated with different years (or groups of years) including: the exotic annual grass *Echinochloa colona* (2014-15); the native annual grass *Lachnagrostis filiformis* and the perennial forb *Lemna* spp. (2016-17); and native annual

forb *Pseudognaphalium luteoalbum* and the exotic annual sub-shrub *Abutilon theophrasti* (2017-18; N.B. no indicator species were detected for 2015-16).

With respect to Selected Area, the highest proportion of all plant taxa recorded has been observed in the Lachlan river system (~ 49 %) followed by the Murrumbidgee river system (~ 37 %), the Junction of the Warrego and Darling rivers (~ 38 %), the Gwydir river system (~ 30 %), the Goulburn River (~ 21 %) and the least from the Edward-Wakool river system (~ 6.7 %).

Amongst the wetland Selected Areas only, Indicator species analysis detected thirteen plant taxa significantly associated with specific Hydrostates (i.e. soil moisture conditions at the time of sampling; Table 3), including: the exotic annual forb *Malva parviflora* to Dry conditions, the native annual forb *Tetragonia eremaea*, the native annual grass *Lachnagrostis filiformis*, the native perennial forb *Asperula gemelli*, the native forb *Rumex* spp., the native grass *Eragrostis* spp., the native perennial sub-shrubs *Atriplex vesicaria* and *Senecio cunninghamii*, the exotic annual forb *Sisymbrium erysimoides* the exotic perennial forbs *Phyla nodiflora* and *Verbena officinalis* to Damp conditions, the native annual forb *Ranunculus pentandrus* to Waterlogged conditions and the native annual sub-shrub *Aeschynomene indica* to Submerged conditions.

A further 93 indicator species were identified which significantly associated with particular Commonwealth environmental watering regimes and groups, of which 13 were associated with a single CEWR category (CEWR; Table 3) over the four-year period of the LTIM project. These included: the native perennial rush *Typha* spp. to Wet regimes; the native perennial rush *Typha domingensis* to Var-wet regimes; the exotic annual forbs *Verbena supina* and *Malva parviflora*, and the exotic annual grass *Echinochloa colona* to Var-mid regimes; the native perennial forb *Calotis scapigera* and the native perennial sub-shrub *Sclerolaena birchii* to Var-dry regimes; and the native annual forbs *Pseudognaphalium luteoalbum* and *Tetragonia eremaea*, the native annual sub-shrub *Zygophyllum apiculatum*, the native perennial sub-shrubs *Atriplex vesicaria* and *Maireana* spp. and the exotic annual forb *Sisymbrium erysimoides* to Dry regimes.

### **4.3 Effects of Commonwealth environmental water on vegetation community diversity within Selected Areas between 2014-15 and 2017-18**

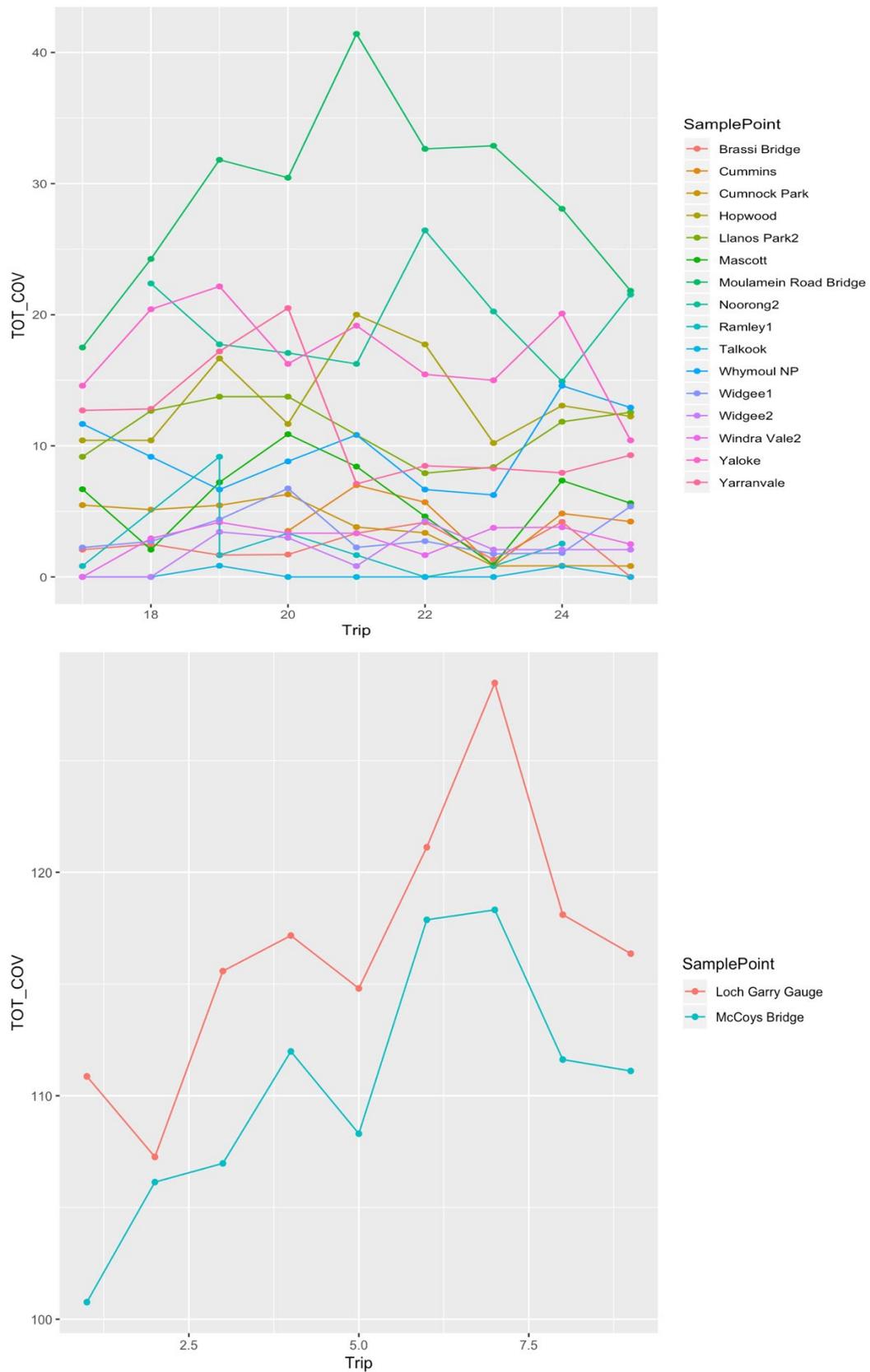
#### **Vegetation cover**

Mean total vegetation cover at Sample Points has been highly variable between sampling Trips over the four-year period of the LTIM project (Figures 8 – 11). The only clear trajectory in vegetation cover over this period is apparent in the Goulburn River where there has been an overall increase of approximately 10 % in vegetation cover on river banks over the four years (Figure 8). In the other riverine Selected Area (i.e. Edward-Wakool river system), however, vegetation cover has remained relatively low and stable in some Sample Points while others have exhibited dramatic increases and declines (Figure 8).

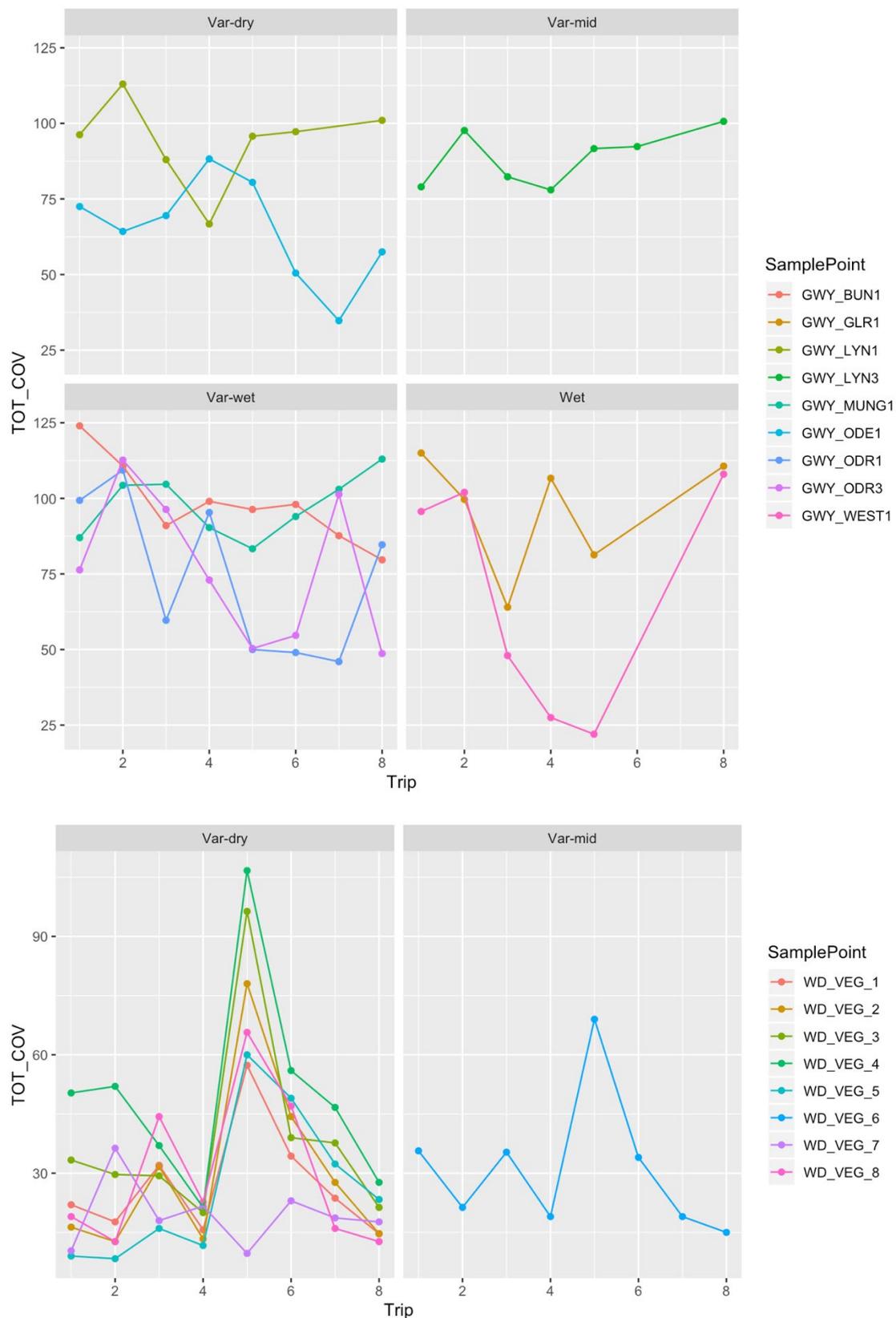
Amongst the two northern Basin wetland Selected Areas, patterns in mean total vegetation cover over time have varied between Sample Points. This is particularly the case in the Gwydir river system where some Sample Points exhibit large fluctuations in vegetation cover while others have had relatively stable vegetation cover over the four years (Figure 9). In the Junction of the Warrego and

Darling rivers, vegetation cover trajectories in all but one Sample Point are dominated by dramatic increases in cover in response to flooding prior to Trip 5 (2016-17) after which time, vegetation cover has steadily declined with continued drying (Figure 9).

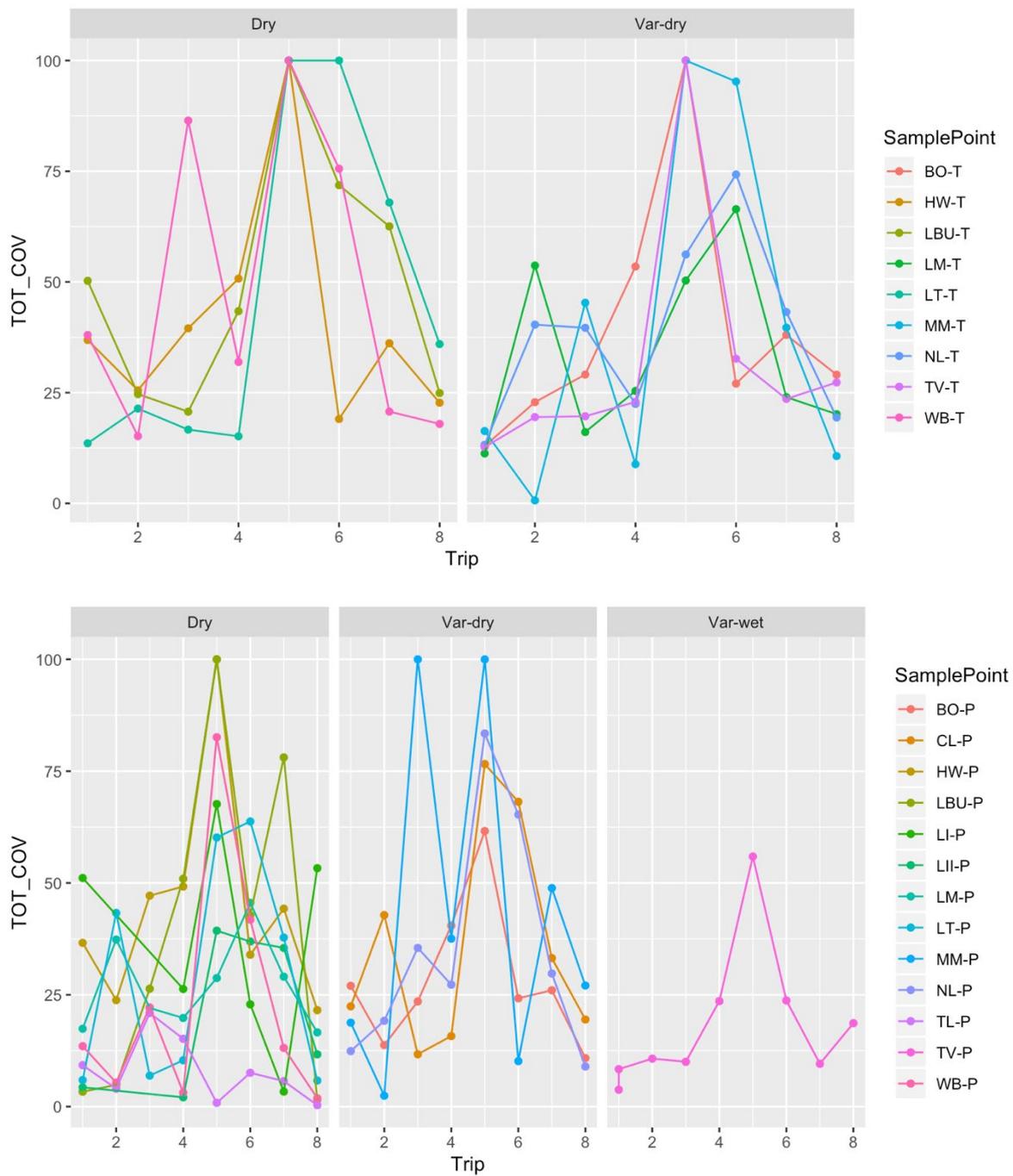
Temporal patterns in mean total vegetation cover at Sample Points in the Lachlan river system have been overwhelmingly dominated by dramatic increases in response to natural flooding in 2016-17 after which time vegetation cover has generally declined with drying to pre-flood levels (Figure 10). In the Murrumbidgee river system, total vegetation cover appears to fluctuate seasonally in many Sample Points, regardless of watering regime, but peaks are also apparent in response to natural flood events (e.g. Trips 9-12; 2016-17; Figure 11). This response to natural flooding appeared to be dampened in Sample Points that had experienced frequent Commonwealth environmental watering during the preceding period (Figure 11).



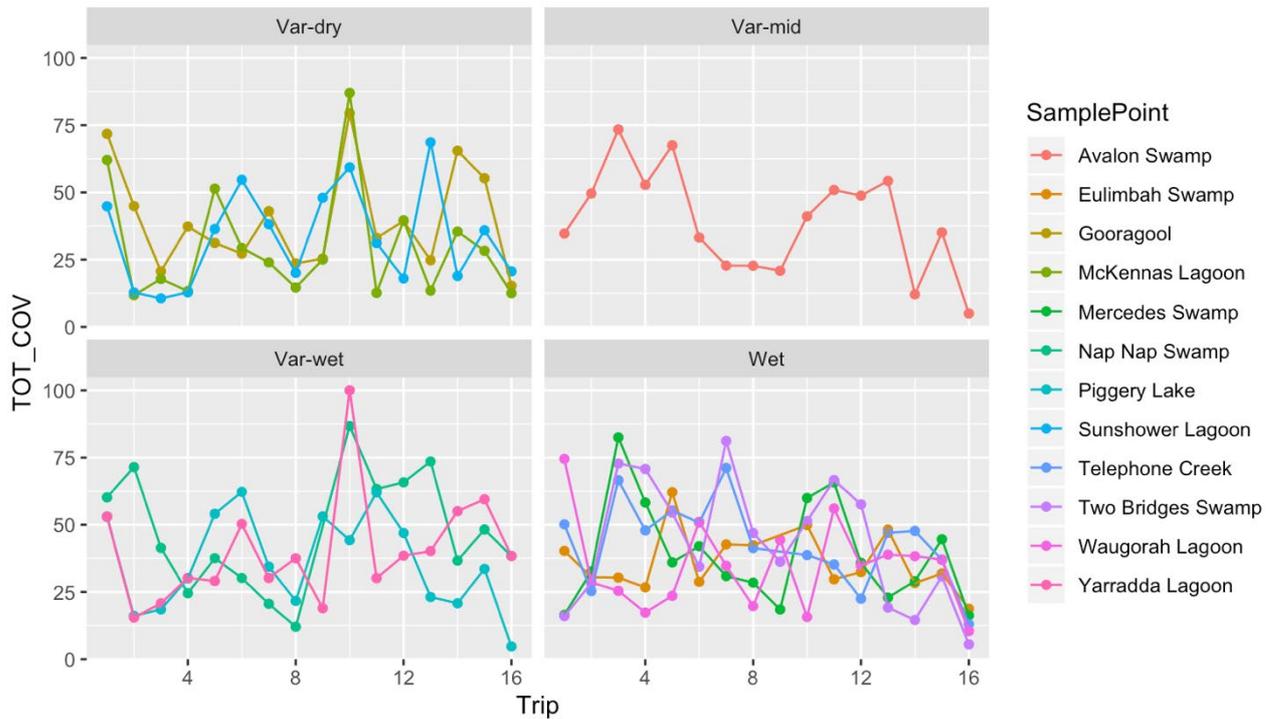
**Figure 8. Changes in mean total vegetation cover at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the two riverine wetland Selected Areas: Edward-Wakool river system (top) and Goulburn River (bottom).**



**Figure 9. Changes in mean total vegetation cover at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the two northern Basin wetland Selected Areas: Gwydir river system (top) and the Junction of the Warrego and Darling rivers (bottom). Data organised according to Commonwealth environmental watering regimes over this four-year period (i.e. CEWR; Table 3).**



**Figure 10. Changes in mean total vegetation cover at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the Lachlan river system Selected Area: in transect samples (top) and plot samples (bottom). Data organised according to Commonwealth environmental watering regimes over this four-year period (i.e. CEWR; Table 3).**



**Figure 11.** Changes in mean total vegetation cover at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the Murrumbidgee river system Selected Area: in transect samples (top) and plot samples (bottom). Data organised according to Commonwealth environmental watering regimes over this four-year period (i.e. CEWR; Table 3).

### Species richness

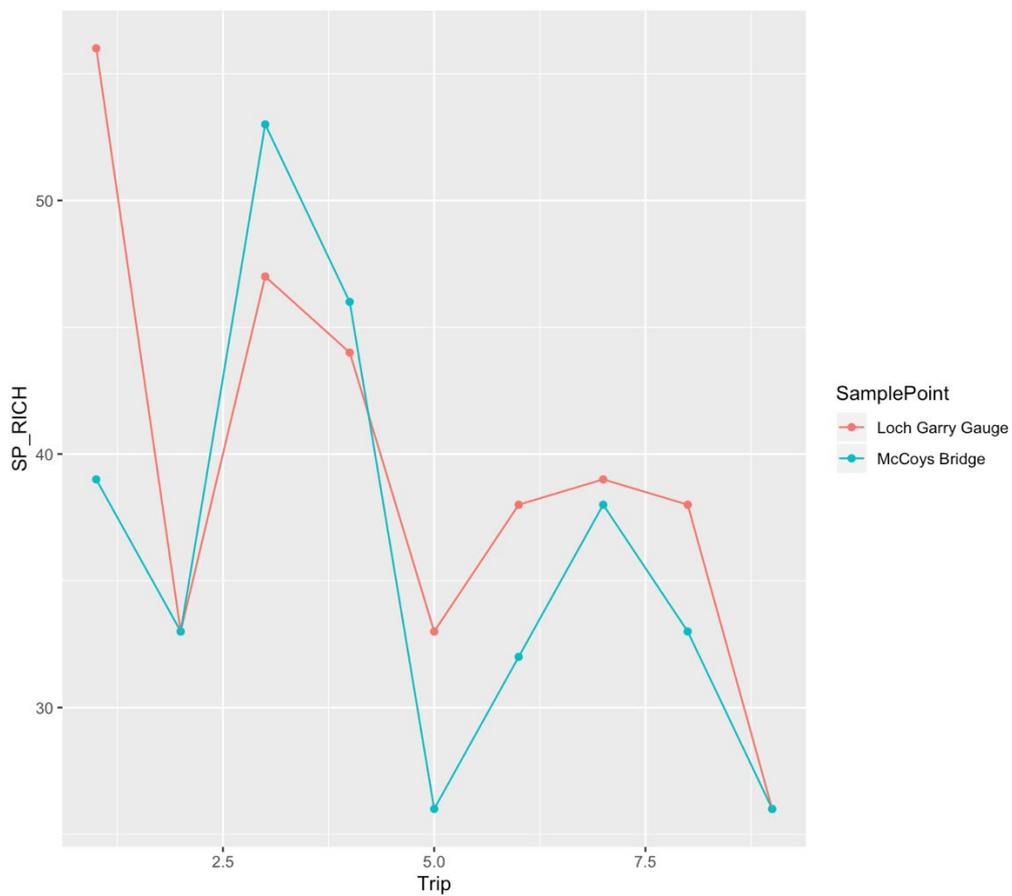
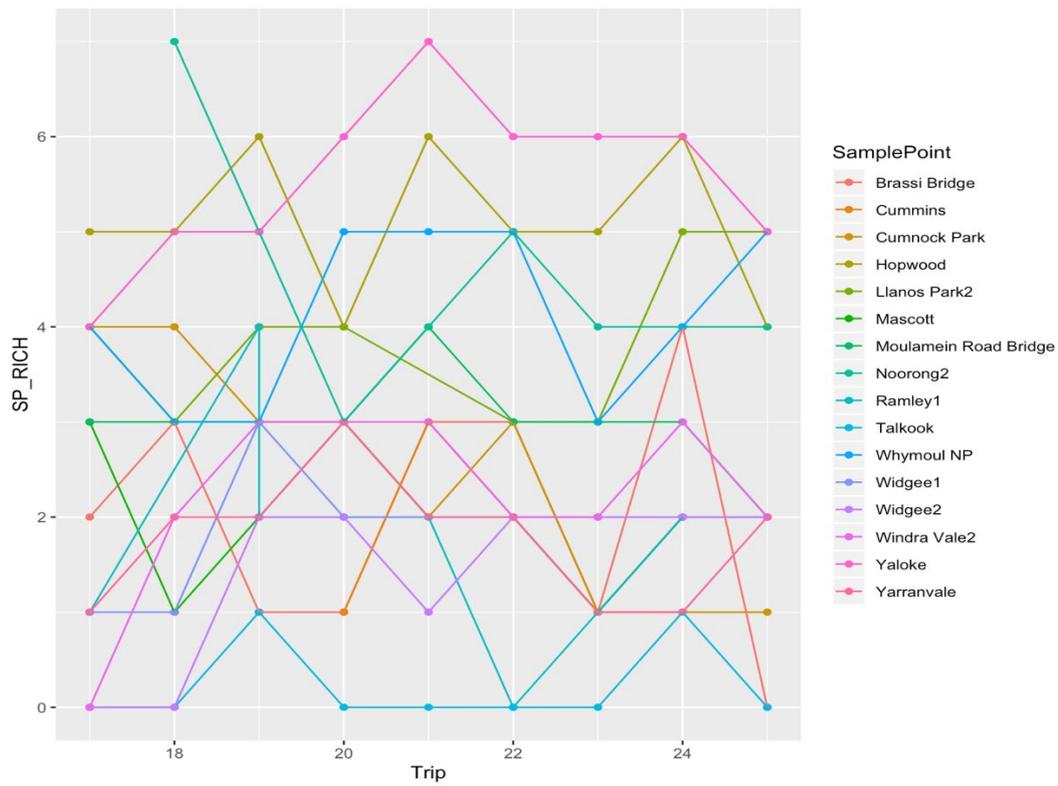
Temporal patterns in species richness at Sample Points have also varied considerably between Selected Areas (Figures 12-15). As per shifts in total vegetation cover, changes in species richness in the Edward-Wakool river system have been highly variable between Sample Points with no clear overall trajectories apparent (Figure 12). In the Goulburn River, however, species richness has declined overall during the four-year period although exhibits clear seasonal fluctuations (Figure 12). This decline is likely to be a response to the loss of river bank vegetation in response to high natural flows in 2016-17, prior to which species richness is likely to have been enhanced as a result of more mesic species establishing on riverbanks under drier conditions (Webb et al. 2018).

In the Gwydir river system, species richness has remained relatively stable, following initial declines, in Sample Points that have experienced drier watering regimes (i.e. CEWR = Var-dry and Var-mid; Figure 13). Under slightly wetter watering regimes (i.e. CEWR = Var-wet), Sample Points display a steady decline in species richness over the four years with species numbers more than halving in several cases (Figure 13). Under the wettest watering regime (i.e. CEWR = Wet), however, early declines in species richness have been followed by relative stability. In contrast, in the Junction of the Warrego and Darling rivers, species richness has been highly variable over time in most Sample Points with sharp declines apparent in response to flooding during Trip 5 (2016-17).

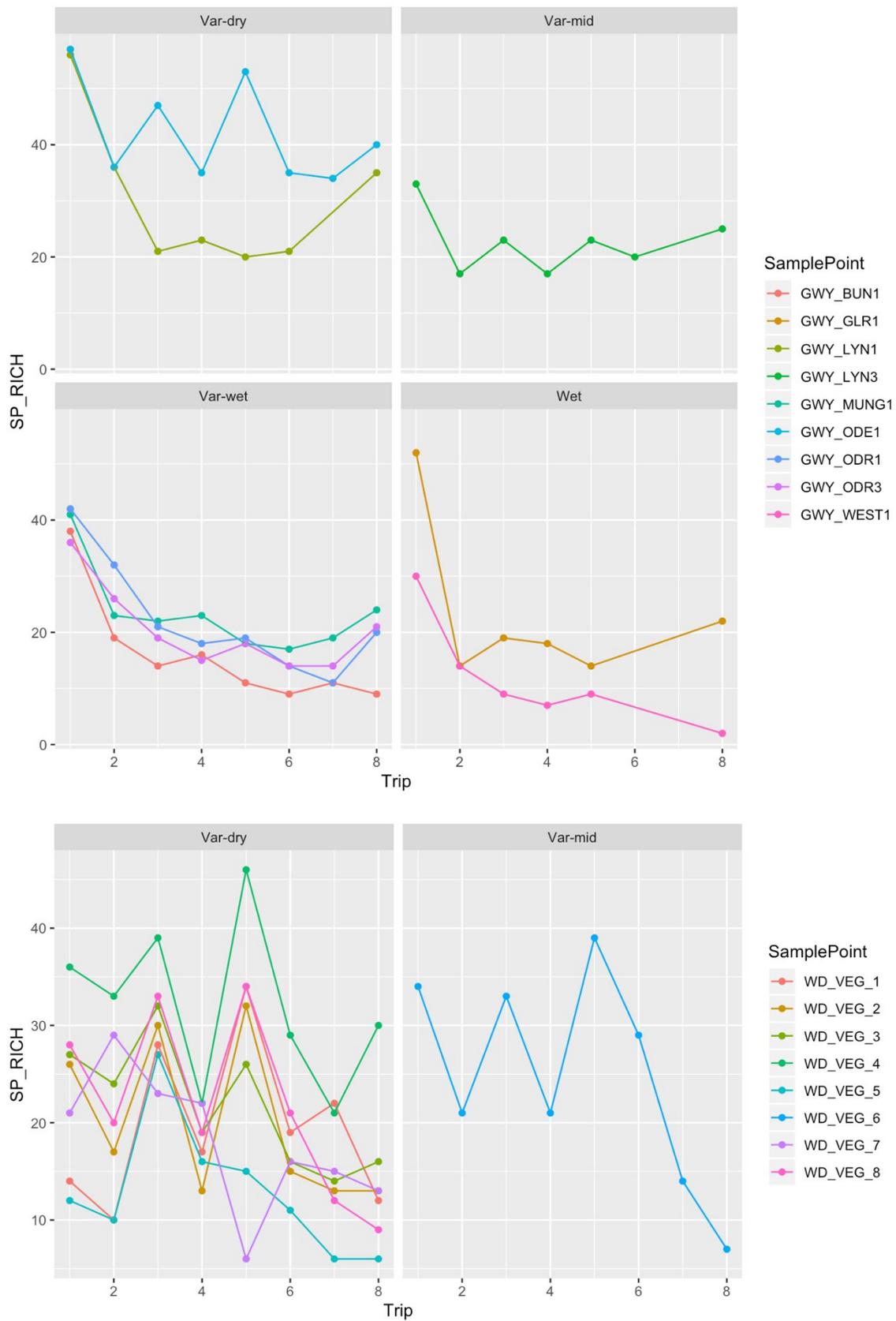
In the Lachlan river system, temporal patterns in species richness are also overwhelmingly dominated by responses to natural flooding in 2016-17 (i.e. Trip 5; Figure 14) which appears to have

resulted in sharp declines in species richness in most Sample Points followed by substantial increases in numbers of species with subsequent recession of floodwaters and drying. In the most recent year (i.e. 2017-18), species richness has mostly declined to pre-flood levels with further drying (Figure 14).

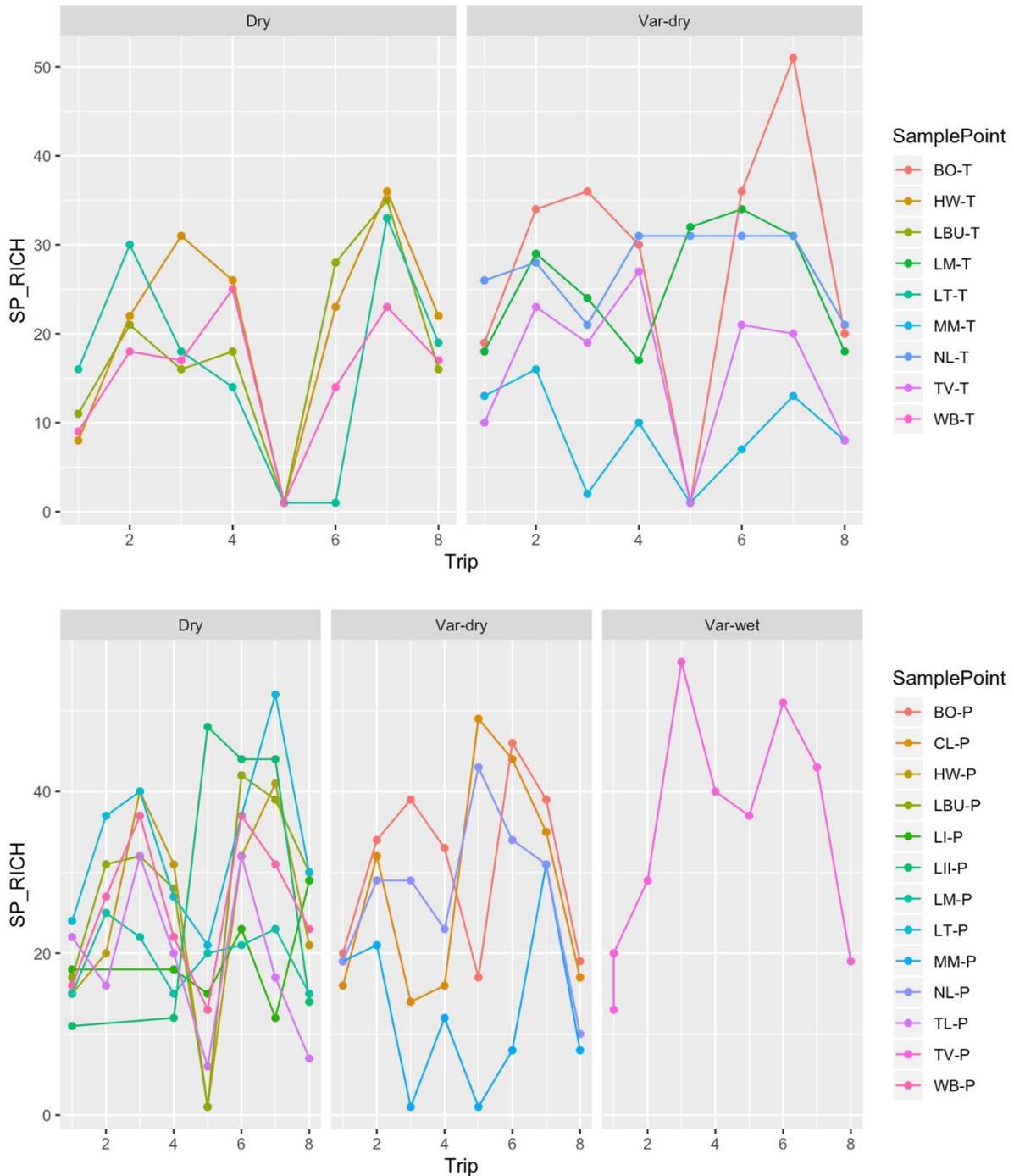
Finally, in the Murrumbidgee river system, species richness, like total vegetation cover at this Selected Area, appears to fluctuate seasonally (Figure 15). Sharp declines followed by rapid recover of species numbers are also apparent in numerous Sample Points in response to the large natural flood event of 2016-17 (i.e. Trips 9-12; 2016-17). As per total cover, this response was not as clear in Sample Points that had experienced frequent Commonwealth environmental watering during the preceding period (Figure 15). Furthermore, while species richness has remained relatively stable over the entire period in Sample Points with wetter watering regimes (i.e. CEWR = Var-wet and Wet), there appears to have been an overall decline in species numbers in Sample Points under drier conditions (i.e. CEWR = Var-mid and Var-dry; Figure 15).



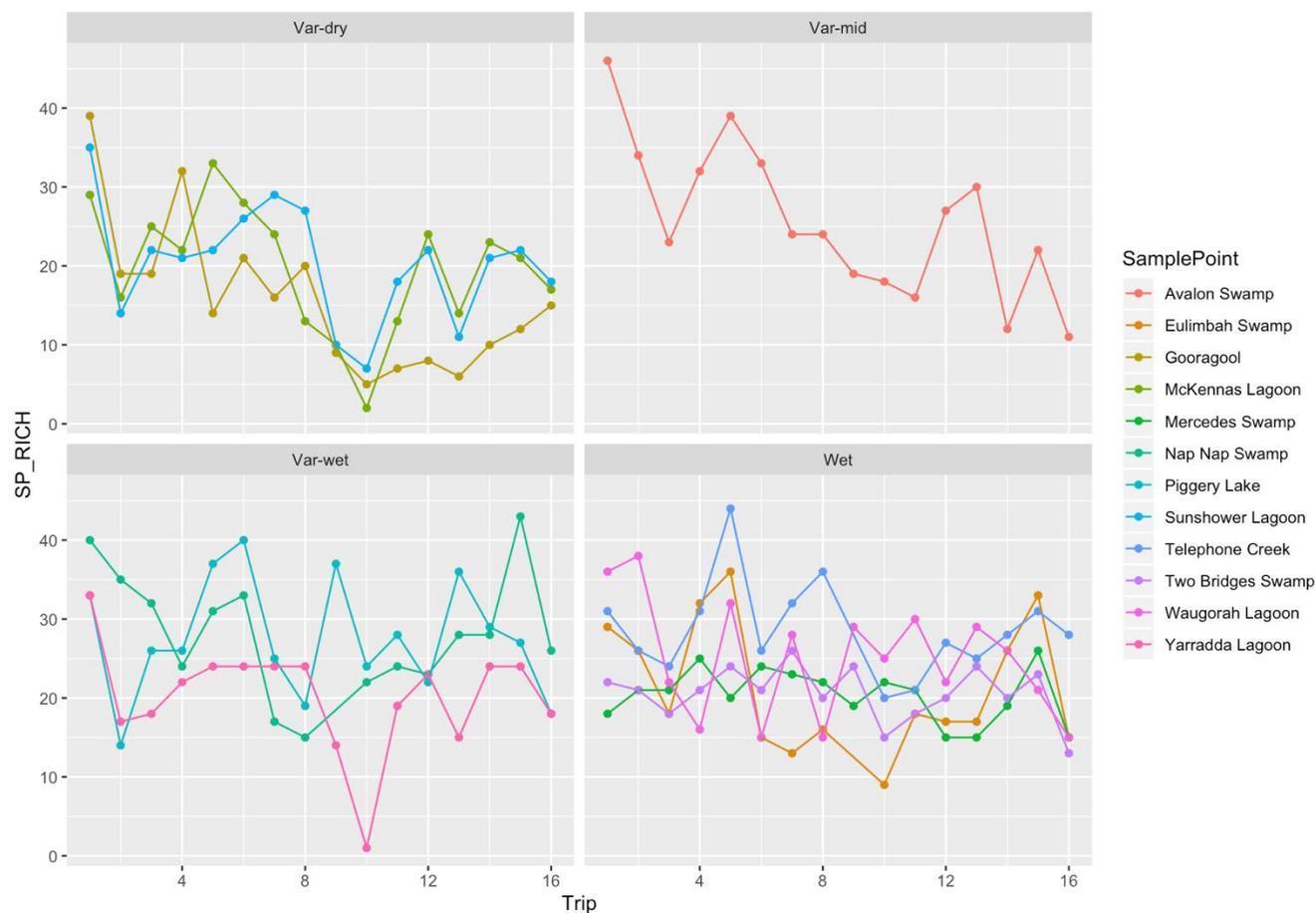
**Figure 12. Changes in species richness at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the two riverine wetland Selected Areas: Edward-Wakool river system (top) and Goulburn River (bottom).**



**Figure 13. Changes in species richness at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the two northern Basin wetland Selected Areas: Gwydir river system (top) and the Junction of the Warrego and Darling rivers (bottom). Data organised according to Commonwealth environmental watering regimes over this four-year period (i.e. CEWR; Table 3).**



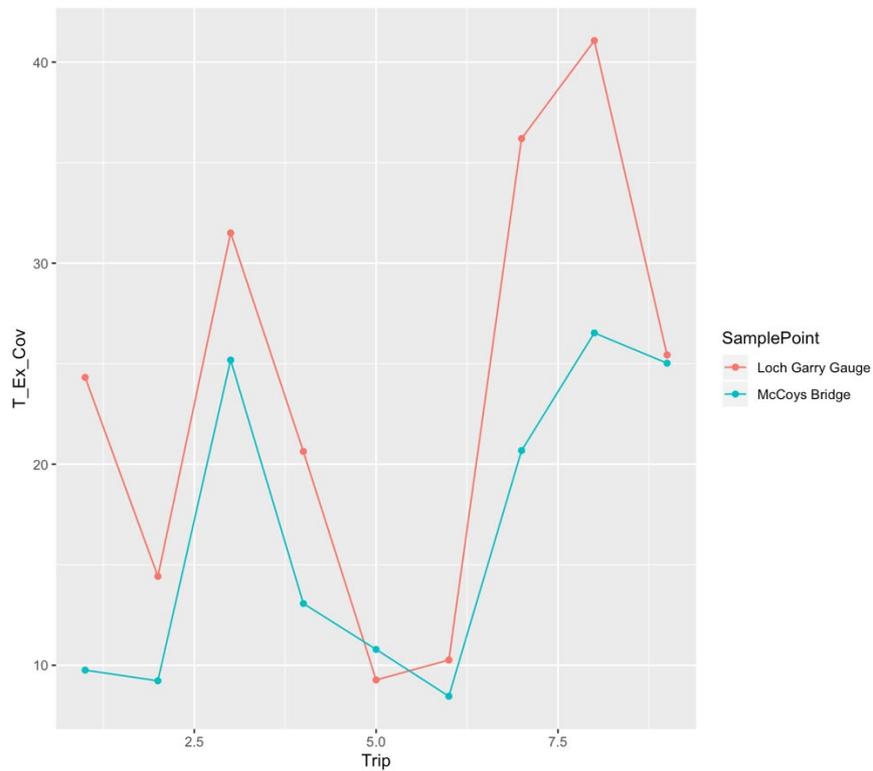
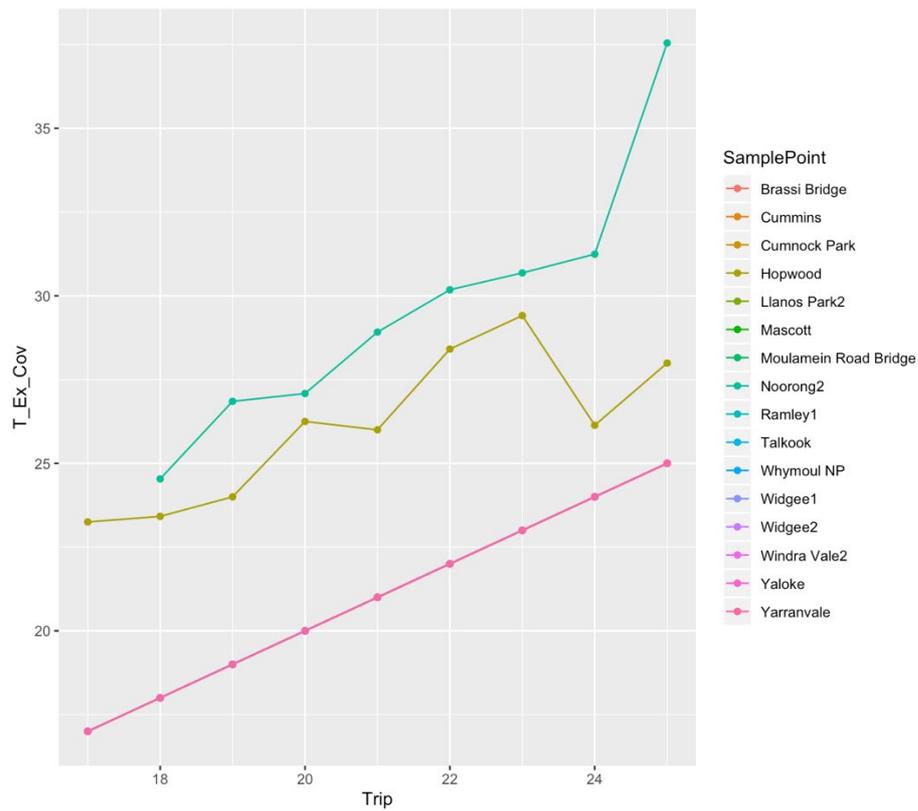
**Figure 14. Changes in species richness at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the Lachlan river system Selected Area: in transect samples (top) and plot samples (bottom). Data organised according to Commonwealth environmental watering regimes over this four-year period (i.e. CEWR; Table 3).**



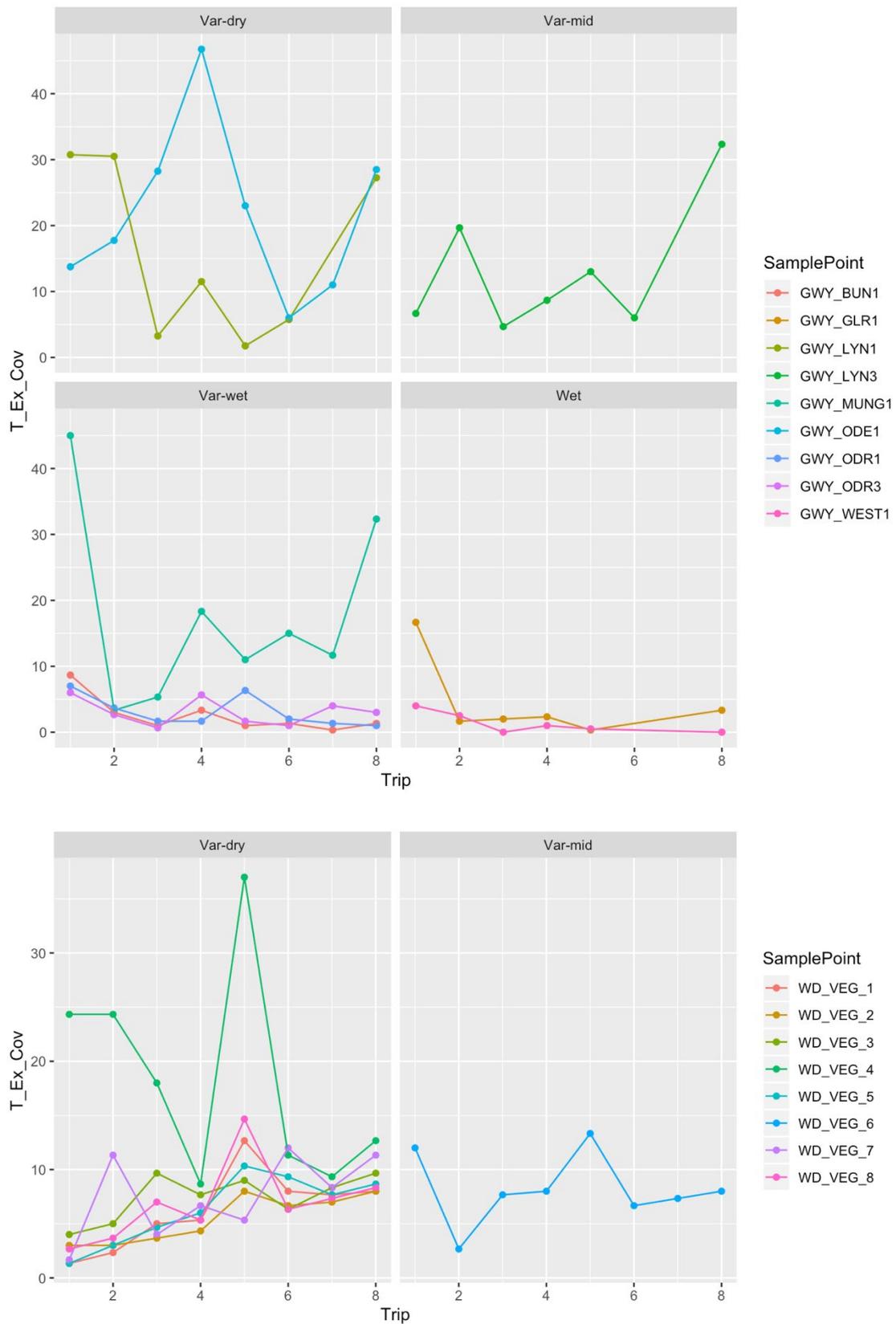
**Figure 15. Changes in species richness at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the Murrumbidgee river system Selected Area: in transect samples (top) and plot samples (bottom). Data organised according to Commonwealth environmental watering regimes over this four-year period (i.e. CEWR; Table 3).**

### Exotic species cover

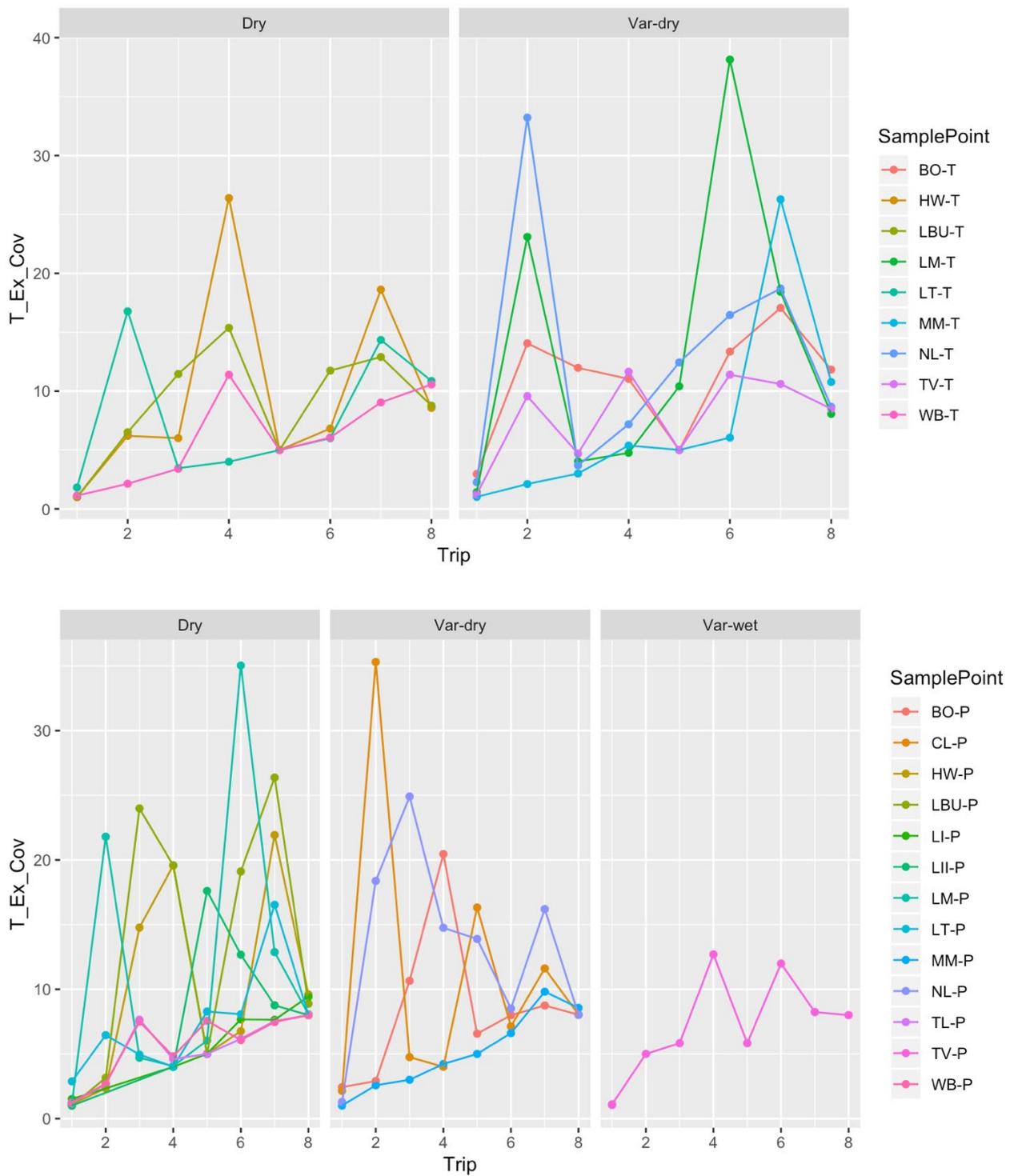
Temporal patterns in the mean cover of exotic species have varied between and within Selected Areas over the four-year period of the LTIM project (Figures 16-19). Amongst the two riverine Selected Areas, there has been a steady increase in exotic plant cover over this period, where present, in the Edward-Wakool river system while exotic plant cover has varied seasonally in the Goulburn River but appears to be relatively stable (Figure 16). In the Gwydir river system, exotic plant cover has remained relatively low in most Sample Points under wetter watering regimes (i.e. CEWR = Var-wet and Wet; Figure 17) after early declines. Under drier conditions, however, exotic plant cover has been much more variable with substantial recent increases apparent in these Sample Points (Figure 17). In the Junction of the Warrego and Darling rivers, the Lachlan river system and the Murrumbidgee river system, there appears to have been a steady, but slight, increase in exotic plant cover over the four years, with some Sample Points also exhibiting dramatic spikes and declines along this overall trajectory (Figures 17 -19). These trajectories in exotic plant cover do not appear to vary in relation to the assigned watering regimes of Sample Points, however.



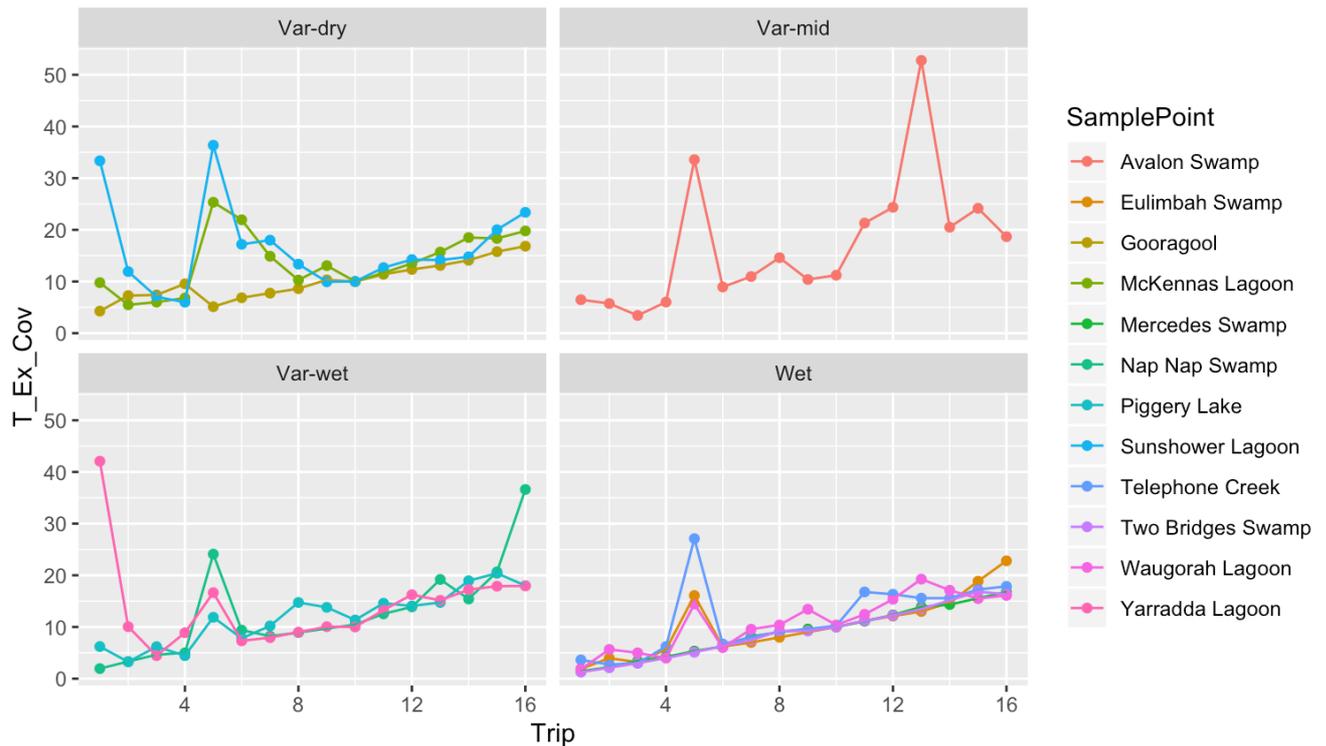
**Figure 16. Changes in mean cover of exotic plant taxa at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the two riverine wetland Selected Areas: Edward-Wakool river system (top) and Goulburn River (bottom).**



**Figure 17. Changes in mean cover of exotic plant taxa at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the two northern Basin wetland Selected Areas: Gwydir river system (top) and the Junction of the Warrego and Darling rivers (bottom). Data organised according to Commonwealth environmental watering regimes over this four-year period (i.e. CEWR; Table 3).**



**Figure 18. Changes in mean cover of exotic plant taxa at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the Lachlan river system Selected Area: in transect samples (top) and plot samples (bottom). Data organised according to Commonwealth environmental watering regimes over this four-year period (i.e. CEWR; Table 3).**



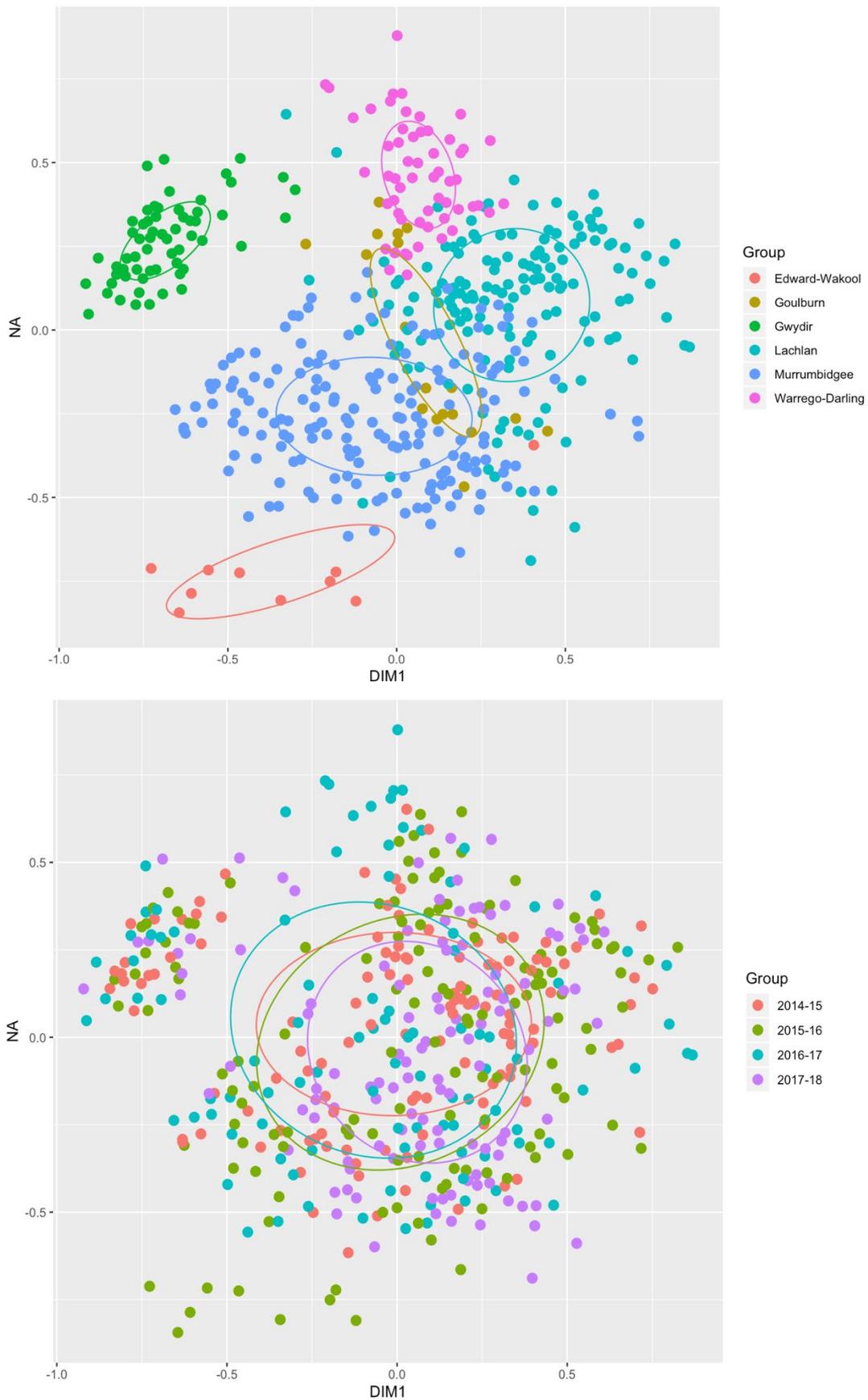
**Figure 19.** Changes in mean cover of exotic plant taxa at Sample Points at each sampling Trip between 2014-15 and 2017-18 in the Murrumbidgee river system Selected Area: in transect samples (top) and plot samples (bottom). Data organised according to Commonwealth environmental watering regimes over this four-year period (i.e. CEWR; Table 3).

#### 4.4 Effects of Commonwealth environmental water on vegetation community diversity across all Selected Areas between 2014-15 and 2017-18

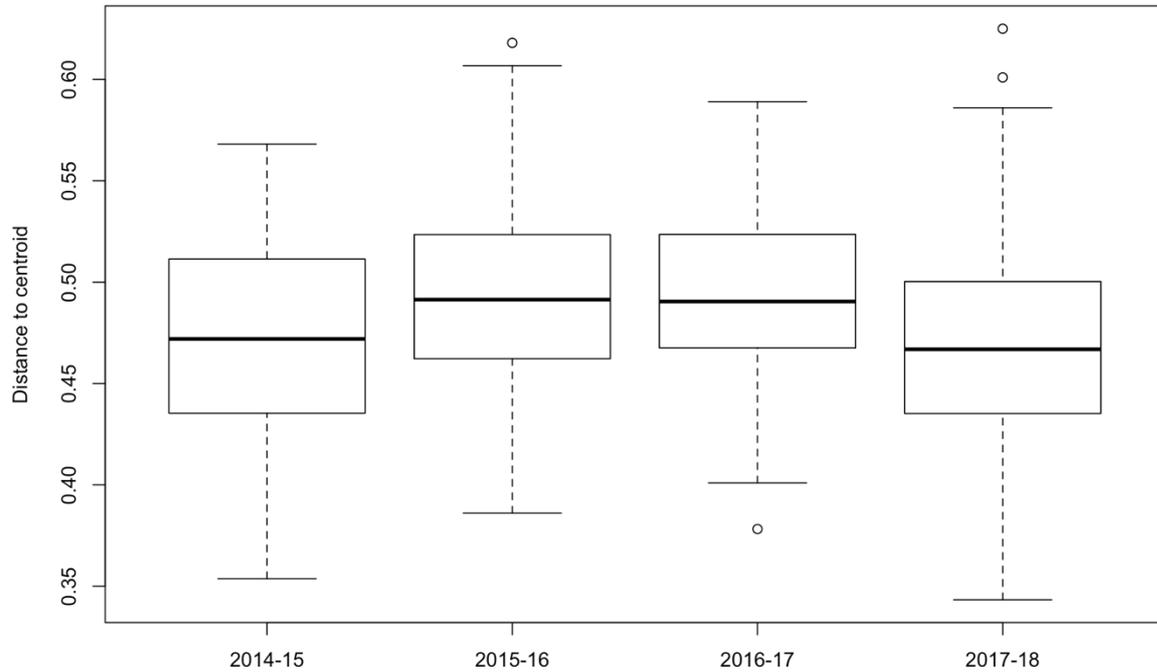
##### All Selected Areas

Vegetation communities recorded during the entire LTIM project exhibit clear differentiation in relation to their Selected Area location (Figure 20). Vegetation communities appear to be particularly distinctive at a Basin scale in the Gwydir river system and the Edward-Wakool river systems while more overlap is apparent between the other four Selected Areas (Figure 20). A significant effect of Selected Area was detected for vegetation community composition by ANOSIM ( $R = 0.4602$ ,  $p < 0.0001$ ). Although difficult to detect visually, a significant effect of sampling year was also identified by ANOSIM ( $R = 0.03283$ ,  $p < 0.0001$ ). Significantly different dispersion of vegetation communities within each sampling year was also detected ( $F = 9.5196$ ,  $p < 0.0001$ ), reflecting lower heterogeneity amongst the vegetation communities of all Sample Points observed in 2014-15 and 2017-18 than in the intervening two years (Figure 21).

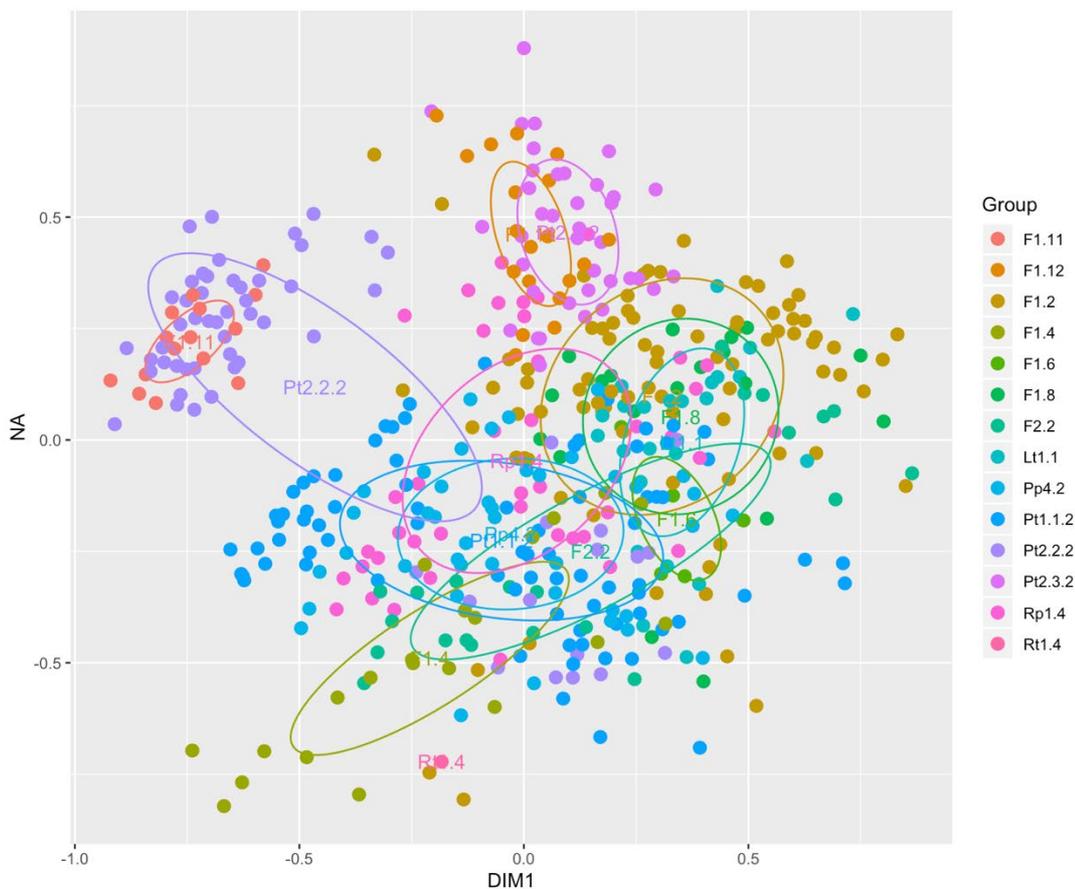
Vegetation community composition at the Basin scale also differed significantly ( $R = 0.4602$ ,  $p < 0.0001$ ) between ANAE ecosystem types (Figure 22). The composition of communities in F1.11 (River cooba woodland riparian zone or floodplain), F1.12 (Woodland riparian zone or floodplain), Pt2.2.2 (Temporary sedge/grass/forb marsh) and Pt2.3.2 (Permanent grass marsh) appeared to be particularly distinctive at a Basin scale (Figure 22).



**Figure 20. nMDS ordination of vegetation community composition at Sample Points surveyed in each Trip between 2014-15 and 2017-18 across all Selected Areas, coded by Selected Area (top) and sampling year (bottom) Stress = 0.2688576.**



**Figure 21. Boxplot showing dispersion amongst vegetation communities at Sample Points in each sampling year across all Selected Areas between 2014-15 and 2017-18.**

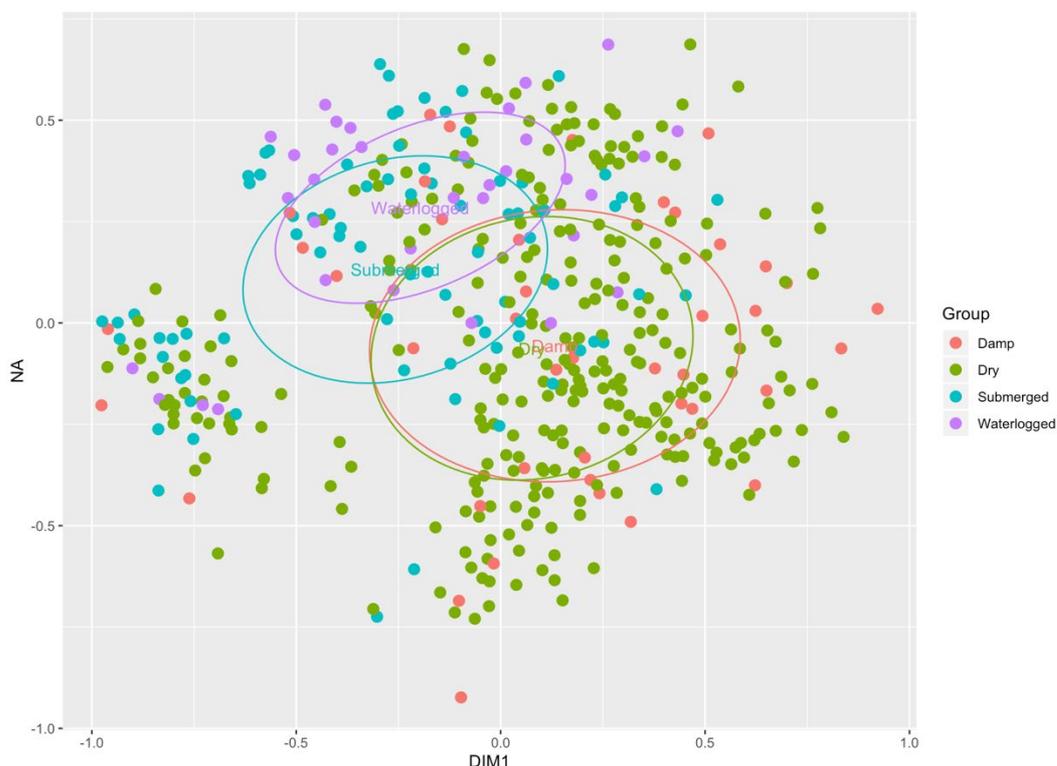


**Figure 22. nMDS ordination of vegetation community composition at Sample Points surveyed in each Trip between 2014-15 and 2017-18 across all Selected Areas, coded by ANAE ecosystem type. Stress = 0.268918.**

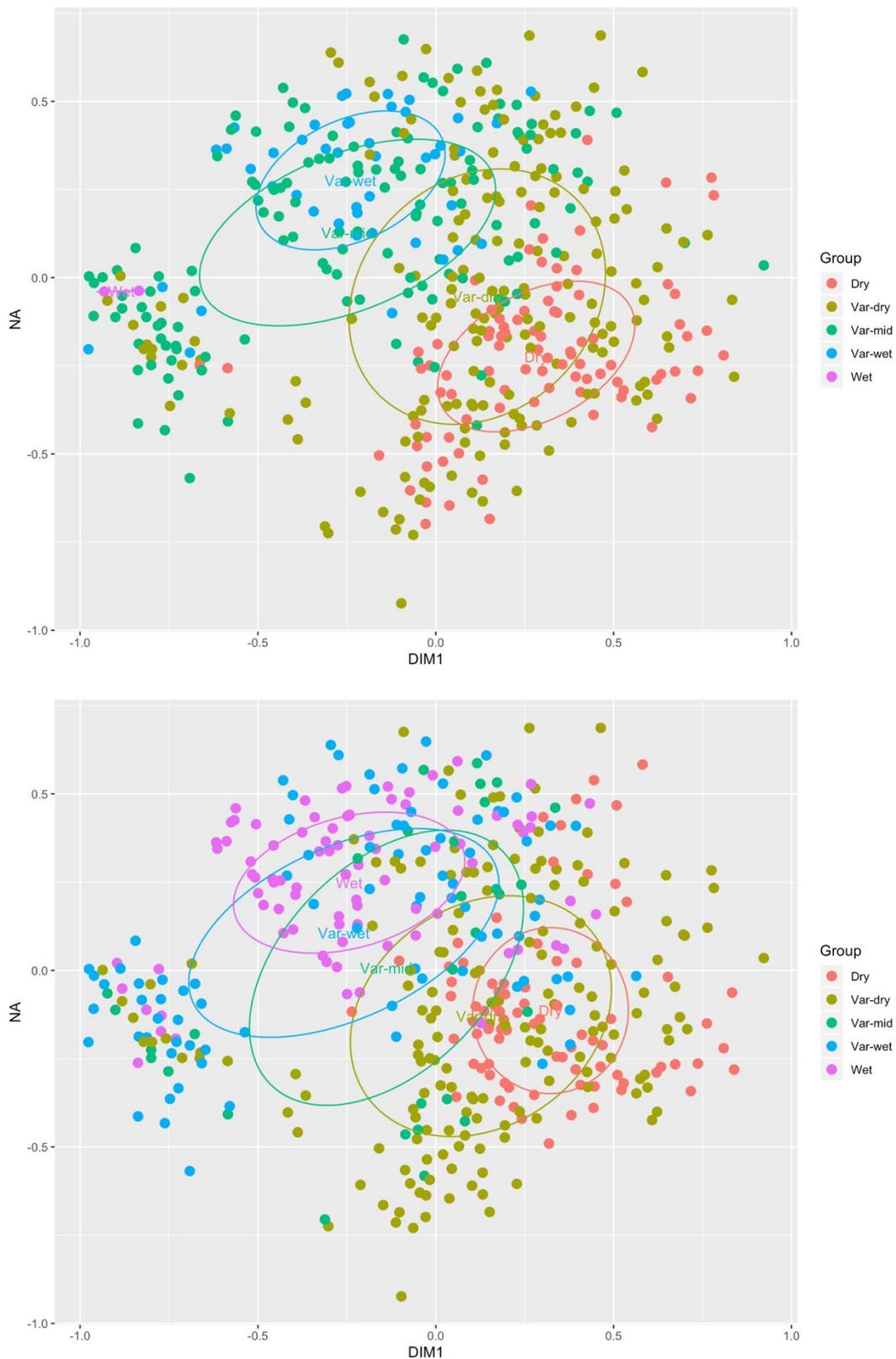
## Wetland Selected Areas

With respect to the Wetland Selected Areas only, vegetation community composition differed significantly in relation to most assigned hydrological groupings (Table 3) including Hydrostate ( $R = 0.1165$ ,  $p < 0.0001$ ; Figure 23), mid-term flooding regimes, i.e. MTRF ( $R = 0.1664$ ,  $p < 0.0001$ ) and Commonwealth environmental watering regimes, i.e. CEWR ( $R = 0.2009$ ,  $p < 0.0001$ ; Figure 24) over the four year period. In all of these cases, a clear gradient was apparent from drier to wetter samples (Figures 23 and 24). This was particularly clear in relation to Commonwealth environmental watering regimes, i.e. CEWR (Figure 24). The diversity of vegetation communities within each CEWR category also appeared to be greater for intermediate watering regimes with less heterogeneous communities occurring under both Wet and Dry watering regimes (Figure 24). This was found to be a significant effect ( $F = 21.362$ ,  $p < 0.0001$ ; Figure 25).

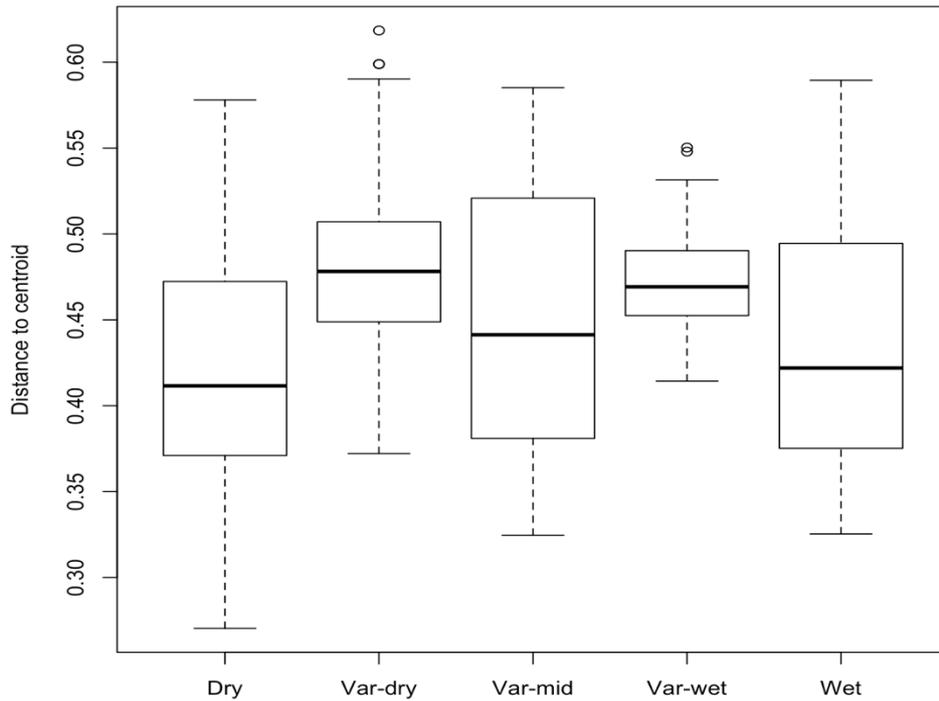
All of the environmental variables considered also strongly correlated ( $p < 0.001$ ) with the ordination space (Figure 26). Separation of the Gwydir river samples and those from the Junction of the Warrego and Darling rivers appears to be closely related to geographical location while sites at the drier end of the gradient are associated with higher values in the variables associated with wooded vegetation, i.e. canopy cover, litter cover, log cover, as well as bare ground (Figure 26). Long-term flood frequency was strongly correlated ( $p < 0.0001$ ) with the y axis of the ordination space, reflecting the gradient of hydrological regimes over the short-term (Figure 26).



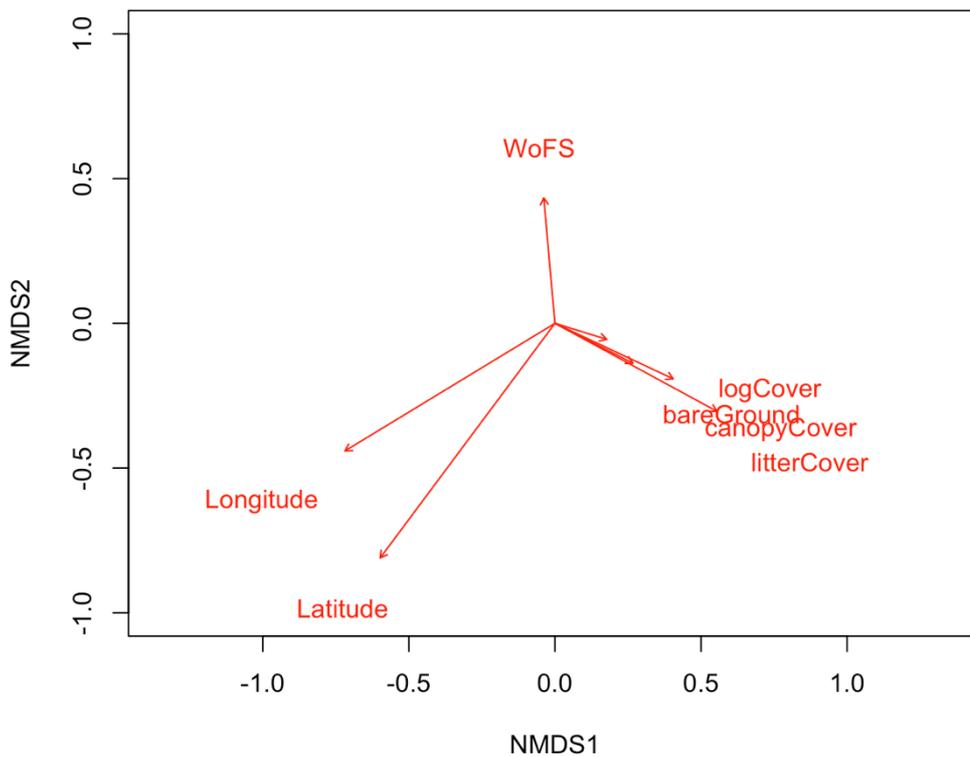
**Figure 23. nMDS ordination of vegetation community composition at Sample Points surveyed in each Trip between 2014-15 and 2017-8 across the four wetland Selected Areas in relation to hydrological conditions at the time of sampling (HydroState; Table 3). Stress = 0.2528022.**



**Figure 24. nMDS ordination of vegetation community composition at Sample Points surveyed in each Trip between 2014-15 and 2017-8 across the four wetland Selected Areas in relation to (top) mid-term flood regime (MTRF; Table 3) and (bottom) Commonwealth environmental watering regime (CEWR; Table 3). Stress = 0.2528022.**



**Figure 25. Boxplot showing dispersion amongst vegetation communities at Sample Points in each sampling year across wetland Selected Areas between 2014-15 and 2017-18 according to their assigned Commonwealth environmental watering regime during this period (CEWR; Table 3).**



**Figure 26. Environmental variables significantly correlating with the ordination of vegetation community composition at Sample Points surveyed in each Trip between 2014-15 and 2017-8 across the four wetland Selected Areas (see Figures 22 and 23).**

#### **4.5 Effects of Commonwealth environmental water on inundation of vegetation communities at a Basin scale between 2014-15 and 2017-18**

Commonwealth environmental water has inundated, or influenced inundation, of 35 ANAE ecosystem types over the four-year period of the LTIM project including 24 wetland ecosystem types and 11 floodplain ecosystem types (Table 6). Given the significant relationship between ANAE ecosystem type and vegetation community composition at monitored Selected Areas (Figure 22), it is very likely that vegetation diversity responses to watering will have differed between ecosystem types in unmonitored areas. Consequently, it can be expected that a greater diversity of ecosystem types inundated is likely to be reflected by a greater diversity of vegetation responses at a Basin scale.

Of the ecosystem types inundated, or influenced, by Commonwealth environmental water since 2014-15, 26 ecosystem types have received Commonwealth environmental water in every year of this period while three ecosystem types have only been watered in a single year. The diversity of ecosystem types watered has been remained relatively steady (i.e. 27-30) in all years except for 2016-17 when only 23 ecosystem types received Commonwealth environmental water. However, because of large natural floods during this year the diversity of aquatic ecosystems inundated is likely to have been much higher.

The vegetation communities that have had significant proportions of their area (i.e. > 10 %) inundated by Commonwealth environmental water in most years include temporary river red gum swamp (Pt1.1.2), permanent tall emergent marsh (Pp2.1.2), permanent wetland (Pp4.2), temporary sedge/grass/forb marsh (Pt2.2.2) and freshwater meadow (Pt2.3.2; Table 6).

**Table 6. Proportion of ANAE ecosystem types (by area or length) inundated or influence by Commonwealth environmental water in each sampling year of the LTIM project between 2014-15 and 2017-18 (Source: Brooks 2019).**

Australian National Aquatic Ecosystem (ANAE) wetland type	Total area (ha)	% receiving Cew			
		2014-15	2015-16	2016-17	2017-18
<b>Wetland ecosystems</b>					
Pt1.1.2: Temporary river red gum swamp	74 721	13.3	56.1	10.1	46.7
Pp2.1.2: Permanent tall emergent marsh	8005	43.1	51.9	0.0	43.1
Pp4.2: Permanent wetland	77 406	26.1	28.1	26.0	29.7
Psp4: Permanent saline wetland	2709	8.5	37.9	6.3	23.2
Pt4.1: Floodplain or riparian wetland	11 489	7.6	19.2	8.8	21.7
Pt1: Temporary swamp	3767	7.4	18.5	3.5	15.3
Lp1.1: Permanent lake	127 660	1.1	3.9	5.4	12.0
Pt2.2.2: Temporary sedge/grass/forb marsh	142 517	11.5	14.3	11.9	11.1
Pp2.3.2: Permanent grass marsh	1507	1.5	1.7	6.4	5.6
Pt2.1.2: Temporary tall emergent marsh	76 339	4.1	5.7	4.1	5.4
Pu1: Unspecified wetland	1763	0.0	0.0	0.0	5.4
Pp2.4.2: Permanent forb marsh	740	1.4	0.7	4.1	3.0
Pt2.3.2: Freshwater meadow	125 192	15.1	16.8	16.4	2.9
Pt4.2: Temporary wetland	22 916	<0.1	2.5	0.0	2.6
Pt3.1.2: Clay pan	138 725	2.3	2.7	1.2	1.2
Lst1.1: Temporary saline lake	27 897	0.0	0.5	0.0	1.1
Pt1.8.2: Temporary shrub swamp	234 419	0.7	3.2	0.9	0.9
Pt1.7.2: Temporary lignum swamp	49 965	1.1	7.0	24.9	0.9
Lt1.1: Temporary lake	459 375	0.6	1.7	0.5	0.8
Pp2.2.2: Permanent sedge/grass/forb marsh	3590	0.4	0.5	0.4	0.6
Pt1.2.2: Temporary black box swamp	60 272	1.8	10.4	0.4	0.4
Pt1.6.2: Temporary woodland swamp	216 625	<0.1	0.3	<0.1	0.2
Pst2.2: Temporary salt marsh	40 706	<0.1	1.6	<0.1	<0.1
Pst1.1: Temporary saline swamp	7942	1.2	0.0	0.0	0.0
<b>Floodplain ecosystems</b>					
F1.11: River cooba woodland riparian zone or floodplain	11 541	9.8	2.0	6.7	7.3
F1.2: River red gum forest riparian zone or floodplain	639 022	3.8	4.1	1.0	4.0
F1.4: River red gum woodland riparian zone or floodplain	325 221	1.1	0.4	0.4	1.5
F2.2: Lignum shrubland riparian zone or floodplain	143 886	3.8	1.5	0.8	1.0
F1.8: Black box woodland riparian zone or floodplain	779 639	0.3	0.7	0.1	0.2
F1.6: Black box forest riparian zone or floodplain	131 442	0.4	1.0	<0.1	0.2
F2.4: Shrubland riparian zone or floodplain	408 614	0.3	1.5	0.6	0.1
F1.10: Coolabah woodland and forest riparian zone or floodplain	1 215 726	0.3	<0.1	<0.1	0.1
F1.12: Woodland riparian zone or floodplain	318 686	<0.1	<0.1	<0.1	<0.1
F4: Unspecified riparian zone or floodplain	201 086	<0.1	<0.1	<0.1	<0.1
F3.2: Sedge/forb/grassland riparian zone or floodplain	833 102	0.0	0.0	<0.1	0.0

## 5 Synthesis of outcomes, contribution to achievement of Basin Plan objectives and adaptive management

### 5.1 Synthesis of outcomes

This section provides a synthesis of key findings of this evaluation in relation to the annual and cumulative evaluation questions addressed. A summary of contributions to Basin Plan objectives associated with vegetation diversity of Commonwealth environmental water in 2017-18 is provided in Table 7.

#### Annual evaluation

##### 1. *What did Commonwealth environmental water contribute to plant species diversity within and across monitored Selected Areas during 2017-18?*

Significant numbers of plant taxa recorded across all monitored Selected Areas in 2017-18 were only recorded from Sample Points that were inundated by Commonwealth environmental water delivered during 2017-18 including:

- 30 plant taxa (i.e. ~9 % of all plant taxa recorded across the Basin in 2017-18) from Sample Points inundated by Commonwealth environmental water in the Murrumbidgee river system;
- 30 taxa only recorded from the Goulburn River; and
- seven taxa only recorded from the Edward-Wakool river system.

##### 2. *What did Commonwealth environmental water contribute to vegetation community diversity within and across monitored Selected Areas during 2017-18 at local and landscape scales?*

Commonwealth environmental water was delivered to both riverine Selected Areas in 2017-18 for vegetation diversity outcomes. The Murrumbidgee river system was the only wetland Selected Area in which monitored locations were inundated by Commonwealth environmental water delivered in 2017-18 during the sampling period. A water action was delivered to the Gwydir river system during the year, but this did not result in any inundation of monitored Sample Points.

In the Murrumbidgee river system, Commonwealth environmental water delivered during 2017-18 appears to have maintained higher vegetation cover for a longer duration than occurred in drier wetlands. Wetlands that were watered but then dried out during the year also exhibited substantial increases in species richness as they dried before declining with further drying by the final sampling trip. In contrast, wetlands which experienced drier conditions throughout the year, mostly exhibited overall declines in plant species richness by up to around 50 %. Vegetation community composition in the Murrumbidgee rivers system was significantly related to short-term flood regimes during this year with wetlands experiencing wetter conditions supporting particularly distinctive vegetation communities at a landscape scale, characterized especially by the native perennial forb *Persicaria prostrata*.

At a Basin scale (i.e. across all monitored Selected Areas), vegetation community composition in monitored Sample Points was significantly influenced by both location (i.e. Selected Area) and ANAE ecosystem type. Sample Points that experienced wetter short-term flood regimes during this year supported particularly distinct vegetation communities at a Basin scale. These mainly comprised those wetlands in the Murrumbidgee river system that were inundated by Commonwealth environmental water delivered during this year. Consequently, Commonwealth environmental water delivered during 2017-18 is highly likely to have contributed to the diversity of vegetation communities present during the year at a Basin scale.

3. *What did Commonwealth environmental water likely contribute to vegetation community diversity in unmonitored areas during 2017-18?*

A total of 46 ANAE ecosystem types, comprising 23 wetland ecosystem types, 12 floodplain ecosystem types and 11 watercourse ecosystem types were inundated, or influenced by, Commonwealth environmental water during 2017-18. At a Basin scale, significant proportions (i.e. >20 %) of temporary red gum swamp (Pt1.1.2), permanent tall emergent marsh (Pt2.1.2), permanent wetland (Pp4.2), permanent saline wetland (Psp4) and floodplain or riparian wetland (Pt4.1) were influenced by Commonwealth environmental water during this year.

#### Cumulative (i.e. 1-4 year) evaluation

4. *What did Commonwealth environmental water contribute to plant species diversity within and across monitored Selected Areas between 2014-15 and 2017-18?*

A total of 626 plant taxa have been observed in the groundlayer vegetation of the six Selected Areas monitored for vegetation diversity under the LTIM project since 2014-15. Numbers of native plant species recorded have increased by approximately 4 % overall during this four-year period with 138 native plant taxa recorded in 2014-15, 82 in 2015-16, 56 in 2016-17 and 144 in 2017-18. In contrast, numbers of exotic plant species recorded have fallen by almost 22 % overall with 60 exotic plant taxa recorded in 2014-15, 40 in 2015-16, 32 in 2016-17 and 47 in 2017-18. Lower numbers of both native and exotic plant species in 2016-17 probably reflect the very wet conditions resulting from large natural floods during this year.

Approximately 2 % of all plant taxa recorded to date appear to be associated with particular hydrological / soil moisture conditions at the time of sampling. A similar proportion of plant taxa are associated with specific Commonwealth environmental watering regimes over the four year-period. In particular, *Typha* spp. and *Typha domingensis* have strong associations with wetter watering regimes over this period. By promoting the diversity of hydrological conditions in both the short- and longer-term, Commonwealth environmental water delivered since 2014-15 is therefore highly likely to have enhanced the diversity of plant species present in the Basin overall.

5. *What did Commonwealth environmental water contribute to vegetation community diversity within and across monitored Selected Areas between 2014-15 and 2017-18 at local and landscape scales?*

Total cover and species richness of vegetation communities have been highly variable within and between Selected Areas over these four years. In most cases, large natural flood events (i.e. in 2016-17) have dominated temporal patterns in these vegetation community metrics. Amongst the

wetland Selected Areas (excluding the Gwydir river system), total vegetation cover tended to rise dramatically following flooding in 2016-17 and has subsequently declined with drying. In contrast, species richness in these cases fell in response to flooding in 2016-17 with rapid increases in species numbers occurring with subsequent drying. These sharp changes in vegetation cover and species richness in response to natural flooding in 2016-17 appear to have been dampened in the Murrumbidgee river system in wetlands that have received Commonwealth environmental water more regularly during the four years. In contrast, wetlands in the Murrumbidgee river system that have experienced drier watering regimes over this period display an overall decline in species richness over the four years. Commonwealth environmental water delivered since 2014-15, therefore appears to have been particularly important in maintaining both plant species diversity and vegetation community diversity in the Murrumbidgee river system over multiple time scales.

In the Gwydir river system, species numbers have gradually declined in Sample Points that have received more Commonwealth environmental water over the four years, but this may largely reflect declines in exotic taxa over this period.

Amongst the riverine Selected Areas, there has been an overall increase in vegetation cover of approximately 10 % on river banks of the Goulburn River over the four years while species richness has fluctuated seasonally but declined overall, reflecting drier conditions early in this period which likely promoted establishment of plant species followed by reductions in plant cover and species due to high natural flows in 2016-17. Patterns in vegetation cover and species richness in the Edward-Wakool river system have been highly variable over the four-year period.

Patterns in exotic plant cover over the four-year period have varied between Selected Areas. Amongst the two riverine Selected Areas, exotic plant cover has fluctuated seasonally in the Goulburn River while being relatively stable over the longer-term. In contrast, there has been a gradual rise in exotic plant cover in several Sample Points in the Edward-Wakool river system. A gradual increase in exotic plant cover over the four year is also evident in the Junction of the Warrego and Darling rivers, the Lachlan river system and the Murrumbidgee river system but this trend does not appear to be affected by the watering regimes of Sample Points over this period. In the Gwydir river system, Commonwealth environmental water appears to have contributed to reducing exotic plant cover overall as Sample Points with wetter watering regimes exhibit relatively low, stable exotic plant cover throughout much of the four years while that in drier Sample Points has been considerably more variable.

Vegetation community composition across the Basin (i.e. across all Selected Areas) between 2014-15 and 2017-18 has been significantly influenced by year, Selected Area and ANAE ecosystem type. At a Basin scale, River cooba woodland riparian zone or floodplain (F1.11), Woodland riparian zone or floodplain (F1.12), Temporary sedge/grass/forb marsh (Pt2.2.2) and Permanent grass marsh (Pt2.3.2) ecosystem types appear to support particularly distinctive vegetation communities. The composition of vegetation communities at Sample Points also varies significantly at a Basin scale in relation to both current and antecedent hydrological conditions over the short- to longer-term, reflecting a broad gradient from drier to wetter samples. In particular, vegetation community composition in samples is significantly associated with Commonwealth environmental watering regimes over the four years. Intermediate watering regimes have generated the greatest diversity of

vegetation communities overall. Consequently, Commonwealth environmental water has almost certainly contributed to the diversity of vegetation communities at a Basin scale during this period.

6. *What did Commonwealth environmental water likely contribute to vegetation community diversity in unmonitored areas between 2014-15 and 2017-18?*

Thirty-five ANAE ecosystem types have been inundated, or influenced by, Commonwealth environmental water during the four-year period of the LTIM project, including 24 wetland ecosystem types and 11 floodplain ecosystem types. Twenty-six ecosystem types have received Commonwealth environmental water annually while three ecosystem types have only been watered in a single year. The number of ecosystem types watered in each year has been relatively equal (27-30) except in 2016-17 when Commonwealth environmental water only inundated, or influenced, 23 ecosystem types. In most years, temporary river red gum swamp (Pt1.1.2), permanent tall emergent marsh (Pp2.12), permanent wetland (Pp4.2), temporary sedge/grass/forb marsh (Pt2.2.2) and freshwater meadow (Pt2.3.2) have had significant proportions (> 10 %) of their area within the Basin only inundated, or influenced by, Commonwealth environmental water.

## 5.2 Key messages for adaptive management

*All Commonwealth environmental water actions are likely to enhance plant species diversity at the Basin scale at any particular time.*

The presence of plant species across the Basin's wetlands, floodplains and riverine ecosystems is highly variable in time and space. Very few plant taxa have been recorded at multiple Selected Areas in any one year of the LTIM project to date with most taxa present at any particular time with very limited distributions, even within Selected Areas. Because many plant taxa are favoured by waterlogged and damp conditions, any Commonwealth environmental water delivered is therefore very likely to enhance plant diversity at a Basin scale at any particular time because different plant taxa will respond to wetting in different locations. In 2017-18, for example, Commonwealth environmental water delivered solely to the Murrumbidgee Selected Area is likely to have influenced the establishment, growth and reproduction of approximately 9 % of plant taxa recorded across all Selected Areas in this year.

*All Commonwealth environmental water actions are likely to enhance vegetation community diversity at the Basin scale at any particular time.*

The composition and structure of vegetation communities across the Basin's wetlands, floodplains and riverine ecosystems are highly variable in time and space. Vegetation community composition is strongly influenced by hydrological regimes in both the short- and long term. All Commonwealth environmental water delivered is therefore likely to enhance vegetation community diversity at Selected Area and Basin scales at any particular time because different vegetation communities will be influenced by wetting in different locations. Furthermore, different vegetation communities will exhibit different responses to wetting. In general, the most species rich vegetation communities occur in wetlands under damp conditions following the recession of floodwaters. The composition of wetlands that experience regular, frequent watering, however, are particularly distinctive at a Basin

scale. Delivery of Commonwealth environmental water should consider maintaining a diversity of wetlands with both types of watering regimes throughout the Basin.

*Vegetation diversity across multiple scales is enhanced by environmental watering that generates a dynamic mosaic of wetting and drying regimes.*

Because different plant species and vegetation communities respond differently to watering regimes over multiple time scales, the diversity of both plant species and vegetation communities will be enhanced at Area and Basin scales by delivery of Commonwealth environmental water that generates a diversity of hydrologic regimes within and between wetlands. Continuous wetting is very likely to reduce the diversity of plant species at a wetland scale and, if this is conducted at the expense of sporadic wetting of other wetlands, may also reduce the diversity of vegetation communities at a landscape scale. Within any wetland landscape, however, it may be desirable to maintain both semi-permanent wetland vegetation communities and responsive intermittently flooded wetland communities. Consideration might therefore be given to determining if aquatic vegetation communities in permanent and semi-permanent wetlands can be maintained without delivery of environmental water in occasional years so that this might instead be delivered to other wetlands which have experienced longer durations of drying, beyond the stage during which the establishment and growth of amphibious and terrestrial plant taxa are still favoured. Such intermittent wetting may promote the capacity of these wetlands to respond to wetting over the longer-term by reducing exotic plant cover and supporting replenishment of soil seed banks.

*Large natural floods have an overriding influence on vegetation dynamics.*

Vegetation dynamics at most Selected Areas have been strongly influenced in the medium term (i.e. 1-4 years) by large natural flood events which still seem to be affecting trajectories of many vegetation communities. Expected outcomes for Commonwealth environmental water actions must therefore account for such antecedent conditions. There is some evidence to suggest that the effects of large natural flood events may be dampened in wetlands that receive regular, frequent environmental water.

*Exotic plant cover appears to be increasing throughout the Basin.*

Data collected under the LTIM project suggests that exotic plant cover is likely to be gradually increasing in most Selected Areas throughout the Basin. This trend does not, however, appear to be influenced by watering regimes although there is also good evidence suggesting that in some cases, e.g. the Gwydir river system, frequent delivery of Commonwealth environmental water can reduce the cover of exotic plant taxa and maintain this at relatively low levels.

**Table 7. Contribution of CEWO watering in 2017-18 to Basin Plan objectives associated with vegetation diversity.**

Basin Plan objectives	Basin Outcomes		5-year Expected Outcomes	1-year Expected Outcomes	Measured 1-year outcomes 2017-18	Measured 1-4-year outcomes 2014-18	Predicted 1-5-year outcomes
Biodiversity (Basin Plan S. 8.05)	Species diversity	Plants	Establishment, growth, spread and reproduction of hydrophilic taxa	Greater plant species diversity	A significant proportion of native species, including numerous aquatic forbs, grasses and sedges/rushes, only present in areas inundated by Commonwealth environmental water.	Some taxa significantly associated with Commonwealth environmental watering regimes over 4-year period.	Presence of some species in extant vegetation likely to be dependent on inundation by Commonwealth environmental water inundation at Selected Area and Basin scales.
			Mortality, reduced establishment and spread of xeric taxa			Overall increase in richness of native species across Selected Areas. Overall decline in richness of exotic species across Selected Areas.	Continued increase in richness of native species across Selected Areas.
	Ecosystem diversity	Vegetation	Increased richness and productivity of wetland vegetation communities	Greater vegetation diversity	Greater vegetation cover in wetlands inundated by Commonwealth environmental water in the Murrumbidgee river system. Significant increases in species richness in wetlands inundated by Commonwealth environmental water during subsequent draw down phase. Distinctive vegetation communities generated by inundation by Commonwealth environmental water.	Enhanced diversity of vegetation communities at Basin scale in response to delivery of Commonwealth environmental water.	Enhanced diversity of vegetation communities at Basin scale in response to delivery of Commonwealth environmental water.
			Shifts in composition of floodplain and wetland vegetation communities				
			Increased heterogeneity of vegetation			Greater diversity of vegetation communities at Basin scale generated by delivery of	Consistently increased heterogeneity of vegetation at landscape scales.

Basin Plan objectives	Basin Outcomes		5-year Expected Outcomes	1-year Expected Outcomes	Measured 1-year outcomes 2017–18	Measured 1-4-year outcomes 2014–18	Predicted 1-5-year outcomes
			communities at landscape scales		Commonwealth environmental water.		
Resilience (Basin Plan S. 8.07)	Ecosystem resilience	Vegetation	Enhanced resilience to drought among plant taxa benefitting from Commonwealth environmental water	Greater resilience of plant species to drought	<i>Not assessed in this year's evaluation.</i>		
			Enhanced resilience to drought among vegetation assemblages benefitting from Commonwealth environmental water	Greater vegetation resilience to drought		Evidence that wetting during 2014-15 influenced vegetation response to drying in 2015-16.	Vegetation communities influenced by Commonwealth environmental water will have greater resilience to drought over next 1–5 years and should exhibit greater responses to further wetting.

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**Appendix A. Watering actions contributed to by Commonwealth environmental water in 2017–18 with Expected Outcomes related to vegetation diversity**

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-MBG-09	10068-06	Murrumbidgee: Yarradda Lagoon	178	177.64	20/11/17	25/11/17	Wetland	Consolidate and maintain native vegetation condition and water quality in Yarradda Lagoon.
1718-GLB-08	10064	Goulburn: Lower Goulburn River	49989	91943.00	22/6/18	30/6/18	Fresh	Contribute to a winter fresh to provide vegetation and maintain macroinvertebrate habitat.
1718-GLB-01	10064	Goulburn: Lower Goulburn River	112232	142489.00	1/7/17	24/7/17	Fresh	Contribute to a winter fresh to provide vegetation.
1718-GLB-03	10064	Goulburn: Lower Goulburn River	3487	29065.00	8/10/17	19/11/17	Baseflow	Contribute to baseflows to maintain water quality and provide suitable habitat and food resources for native fish and macroinvertebrate and to water bank vegetation.
1718-GLB-05	10064	Goulburn: Lower Goulburn River	852	8315.00	27/11/17	5/12/17	Baseflow	Contribute to baseflows to maintain water quality and provide suitable habitat and food resources for native fish and macroinvertebrate and to water bank vegetation.
1718-GLB-07	10064	Goulburn: Lower Goulburn River	5560	287127.00	19/12/17	9/1/18	Baseflow	Contribute to baseflows to maintain water quality and provide suitable habitat and food resources for native fish and macroinvertebrate and to water bank vegetation.

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-BRK-04	10041-03	Lower Broken Creek and fringing wetlands	6873	13879.00	3/10/17	15/11/17	Baseflow, Fresh	Contribute to flushing flows between August and November to remove large Azolla blooms.
1718-BRK-02	10041-03	Lower Broken Creek and fringing wetlands	1121	4077.00	18/8/17	31/8/17	Fresh	Contribute to higher baseflows between August and November to minimise Azolla growth. Contribute to flushing flows between August and November to remove large Azolla blooms.
1718-GLB-02	10064	Goulburn: Lower Goulburn River	74205	99204.00	16/9/17	11/10/17	Fresh	Contribute to long-duration freshes in spring to water bank vegetation, provide soil moisture to banks and benches, distribute seed and allow plants to flower and seed for later germination and distribution.
1718-CMP-01	10003-05	Campaspe River Catchment	6218	15906.00	13/11/17	28/11/17	Fresh	Contribute to winter low flows to maintain: river red gum; native fish and macroinvertebrate populations; and emergent vegetation.
1718-CLM-01	10065-04	Lower Murray: Coorong, Lower Lakes and Murray Mouth	326320	326320.00	1/7/17	30/9/17	Fresh	Deliver Commonwealth environmental water into the Coorong via a hydrological regime that: Potentially reduces peak salinity in the Coorong in summer-autumn to reduce the risk of irreversible damage to <i>Ruppia tuberosa</i> .

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-CLM-02	10065-04	Lower Murray: Coorong, Lower Lakes and Murray Mouth	354807	354807.00	1/10/17	31/1/18	Fresh	Deliver Commonwealth environmental water into the Coorong via a hydrological regime that: Potentially reduces peak salinity in the Coorong in summer-autumn to reduce the risk of irreversible damage to <i>Ruppia tuberosa</i> .
1718-CLM-04	10065-04	Lower Murray: Coorong, Lower Lakes and Murray Mouth	9331	9331.00	1/6/18	30/6/18	Baseflow	Deliver Commonwealth environmental water into the Coorong via a hydrological regime that: Potentially reduces peak salinity in the Coorong in summer-autumn to reduce the risk of irreversible damage to <i>Ruppia tuberosa</i> .
1718-LWM-21	10058-01	Lower Murray: Renmark Wetlands Site 8	158	157.50	9/4/18	31/5/18	Wetland	Halt the decline and possible death of mature long lived plant species. Maintain existing regeneration and provide opportunities for future regeneration events of long lived plants.
1718-LWM-23	10058-01	Lower Murray: Renmark Wetlands Site 14	53	52.70	1/8/17	28/5/18	Wetland	Halt the decline and possible death of mature long lived plant species. Maintain existing regeneration and provide opportunities for future regeneration events of long lived plants.

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-LWM-24	10058-01	Lower Murray: Renmark Wetlands Site 15	22	21.50	1/7/17	10/10/17	Wetland	Halt the decline and possible death of mature long lived plant species. Maintain existing regeneration and provide opportunities for future regeneration events of long lived plants.
1718-LWM-28	10065-09	Lower Murray: Rilli Reach	9	8.67	1/9/17	1/6/18	Wetland	Improve condition of mature river red gum, black box woodlands and lignum shrublands across the Murray Valley floodplains. Support survival and growth of regenerated sapling trees from the 2011-12 floods. Support maintenance of lignum and chenopod shrubland communities.
1718-LWM-29	10065-09	Lower Murray: Calperum Station	3894	3894.29	15/10/17	20/12/17	Wetland	Improve condition of mature river red gum, black box woodlands and lignum shrublands across the Murray Valley floodplains. Support survival and growth of regenerated sapling trees from the 2011-12 floods. Support maintenance of lignum and chenopod shrubland communities.
1718-LWM-30	10065-09	Lower Murray: Riversleigh Lagoon	650	649.85	1/10/17	1/6/18	Wetland	Improve condition of mature river red gum, black box woodlands and lignum shrublands across the Murray Valley floodplains. Support survival and growth of

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
								regenerated sapling trees from the 2011-12 floods. Support maintenance of lignum and chenopod shrubland communities.
1718-LWM-34	10065-09	Lower Murray: Clarke's Floodplain	13	13.27	22/3/18	24/5/18	Wetland	Improve condition of mature river red gum, black box woodlands and lignum shrublands across the Murray Valley floodplains. Support survival and growth of regenerated sapling trees from the 2011-12 floods. Support maintenance of lignum and chenopod shrubland communities.
1718-LWM-35	10065-09	Lower Murray: Pike River	19	18.67	1/4/18	27/4/18	Wetland	Improve condition of mature river red gum, black box woodlands and lignum shrublands across the Murray Valley floodplains. Support survival and growth of regenerated sapling trees from the 2011-12 floods. Support maintenance of lignum and chenopod shrubland communities.
1718-LWM-36	10065-09	Lower Murray: Ramco River Terrace	5	4.50	1/4/18	1/6/18	Wetland	Improve condition of mature river red gum, black box woodlands and lignum shrublands across the Murray Valley floodplains. Support survival and growth of regenerated sapling trees from the 2011-12 floods.

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
								Support maintenance of lignum and chenopod shrubland communities.
1718-LWM-37	10065-09	Lower Murray: Greenways Landing	20	20.00	1/4/18	30/4/18	Wetland	Improve condition of mature river red gum, black box woodlands and lignum shrublands across the Murray Valley floodplains. Support survival and growth of regenerated sapling trees from the 2011-12 floods. Support maintenance of lignum and chenopod shrubland communities.
1718-MCQ-02	10067-01	Macquarie River: Mid-Macquarie River and Macquarie Marshes	50660	134377.00	15/8/17	12/11/17	Fresh, Wetland	Inundate up to 20,000 ha of the Macquarie Marshes (pink zone) to support the recruitment of semi-permanent wetland vegetation (northern, southern and eastern marshes). Improve condition and resilience of plant and seedbank resilience of permanence and semi-permanent wetland vegetation (e.g. reeds, watercouch and mixed marshes). Support recovery of the north marsh reedbed during the second year after fire.
1718-MBG-03	10062-02	Murrumbidgee: Yarradda Lagon	326	826.00	4/7/17	24/7/17	Wetland	Maintain and improve the condition of wetland vegetation.

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-MBG-04	10062-03	Murrumbidgee: Gooragool Lagoon	1426	1426.00	18/7/17	11/8/17	Wetland	Maintain and improve the condition of wetland vegetation.
1718-LWM-20	10058-01	Lower Murray: Renmark Wetlands Site 5	48	47.80	26/3/18	27/5/18	Wetland	Maintain existing regeneration and provide opportunities for future regeneration events of long lived plant species.
1718-LWM-01	10065-07	Lower Murray: Wingillie Station	1459	1459.00	28/9/17	20/4/18	Wetland	Maintain extent and condition of inundation dependant vegetation.
1718-LWM-02	10065-07	Lower Murray: Lucerne Day	82	82.00	28/9/17	11/10/17	Wetland	Maintain extent and condition of inundation dependant vegetation.
1718-LWM-26	10065-06	Lower Murray: Bookmark Creek	448	448.00	1/7/17	30/6/18	Wetland	Maintain health of adult River red gum, black box and lignum.
1718-EWK-01	10070-01	Edward Wakool: Yallakool Wakool System	16452	16452.00	1/9/17	1/5/18	Fresh	Maintain health of riparian and in-channel aquatic native vegetation communities.
1718-EWK-03	10070-03	Edward Wakool: Colligen-Neimur	13832	13832.00	1/9/17	1/5/18	Fresh	Maintain health of riparian and in-channel aquatic native vegetation communities.
1718-EWK-02	10070-01	Edward Wakool: Tuppall Creek	1641	3282.00	21/8/17	10/11/17	Baseflow	Maintain health of riparian and in-channel aquatic native vegetation communities. Improve the condition of the fringing vegetation community including river red gums and black box.

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-EWK-04	10070-04	Edward Wakool: Tuppal Creek	933	3712.00	29/3/18	5/5/18	Baseflow	Maintain health of riparian and in-channel aquatic native vegetation communities. Improve the condition of the fringing vegetation community including river red gums and black box.
1718-EWK-05	10054-11	Edward Wakool: Yallakool Wakool System	7915	7915.00	1/7/17	30/8/17	Baseflow	Maintain health of riparian and in-channel aquatic native vegetation communities. Instream aquatic plant regeneration post 2016 flood.
1718-EWK-06	10054-12	Edward Wakool: Colligen-Neimur	6370	6370.00	1/7/17	30/8/17	Baseflow	Maintain health of riparian and in-channel aquatic native vegetation communities. Instream aquatic plant regeneration post 2016 flood.
1718-MBG-12	10068-09	Murrumbidgee: Tuckerbill Swamp	600	600.00	9/4/18	16/4/18	Wetland	Maintain the ecological character of this Ramsar site which requires environmental water to maintain vegetation condition, and in-particular critical habitat for the critically endangered (EPBC Act) Australasian bittern, supporting a range waterbirds, native fish, frogs and turtles.
1718-WIM-01	10007-01	Wimmera River	2734	9196.00	12/2/18	30/6/18	Baseflow	Maintain the extent and improve condition of vegetation.

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-WIM-02	10007-01	Mt William Creek	374	748.00	9/4/18	18/4/18	Fresh	Maintain the extent and improve condition of vegetation.
1718-MBG-01	10034-13	Murrumbidgee: Nimmie-Caira	1738	1738.00	15/12/17	18/12/17	Baseflow	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.
1718-MBG-05	10068-02	Murrumbidgee: North Redbank	5528	5528.00	9/10/17	19/10/17	Wetland	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.
1718-MBG-07	10068-04	Murrumbidgee: Coonancoocabil Lagoon	900	900.00	11/12/17	2/1/18	Wetland	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.
1718-MBG-08	10068-05	Murrumbidgee: Oak Creek	620	620.00	28/12/17	2/1/18	Wetland	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.
1718-MBG-11	10068-08	Murrumbidgee: Sandy Creek	400	400.00	17/2/18	23/4/18	Wetland	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.
1718-MBG-13	10068-10	Murrumbidgee: Nimmie-Caira	5000	13850.00	15/4/18	28/5/18	Wetland	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-MBG-14	10068-11	Murrumbidgee: Gooragool Lagoon	750	1500.00	1/6/18	30/6/18	Wetland	Maintain water quality and riparian vegetation, and contribute to the ecological health and resilience of the wetlands and creek systems.
1718-CNM-04	10065-01	Central Murray: River Murray	289606	289606.00	1/7/17	31/12/17	Fresh, Overbank	Maintaining the extent and condition of riparian and in-channel vegetation by: a) Increasing periods of growth for non-woody vegetation communities (e.g. Moira grass) that closely fringe or occur within the River Murray channel, anabranches and low elevation floodplain wetlands. b) Maintaining the extent and condition of inundation dependent river red gum, black box, lignum and non-woody vegetation within low-lying areas of floodplain, with scale of contribution subject to seasonal conditions.
1718-LWM-04	10065-01	Lower Murray: Lock 7	409	-27.00	22/2/18	31/5/18	Baseflow	Maintaining the extent and condition of riparian and in-channel vegetation by: Enabling recruitment of trees and supporting growth of understory species within river red gum, black box and coolibah communities on floodplains that receive overbank flooding during 2016.

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-LWM-06	10065-01	Lower Murray: Lock 8	409	-220.00	22/2/18	31/5/18	Baseflow	Maintaining the extent and condition of riparian and in-channel vegetation by: Enabling recruitment of trees and supporting growth of understorey species within river red gum, black box and coolibah communities on floodplains that receive overbank flooding during 2016.
1718-LWM-08	10065-01	Lower Murray: Lock 9	409	-1419.00	22/2/18	30/5/18	Baseflow	Maintaining the extent and condition of riparian and in-channel vegetation by: Enabling recruitment of trees and supporting growth of understorey species within river red gum, black box and coolibah communities on floodplains that receive overbank flooding during 2016.
1718-CLM-03	10065-04	Lower Murray: Coorong, Lower Lakes and Murray Mouth	203279	203279.00	1/2/18	31/5/18	Baseflow	Maintaining the extent and condition of riparian and in-channel vegetation by: Increasing periods of growth for non-woody vegetation communities that closely fringe or occur within the River Murray channel, anabranches and low elevation floodplain wetlands. Deliver Commonwealth environmental water into the Coorong via a hydrological regime that:

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
								<p>in dry conditions, aims to maximise estuarine habitat by prolonging barrage releases to support water levels and improve water quality in the north lagoon, in order to:</p> <p>Potentially reduces peak salinity in the Coorong in summer-autumn to reduce the risk of irreversible damage to <i>Ruppia tuberosa</i>.</p> <p>Environmental water delivered to the Lower Lakes is expected to also support the following outcomes:</p> <p>Maintenance of the health of fringing vegetation.</p>
1718-LWM-03	10065-01	Lower Murray: Lock 7	409	1569.00	8/9/17	10/12/17	Overbank	<p>Maintaining the extent and condition of riparian and in-channel vegetation by:</p> <p>Increasing periods of growth for non-woody vegetation communities that closely fringe or occur within the River Murray channel, anabranches and low elevation floodplain wetlands.</p> <p>Enabling recruitment of trees and supporting growth of understorey species within river red gum, black box and coolibah communities on floodplains that receive overbank flooding during 2016.</p>

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-LWM-05	10065-01	Lower Murray: Lock 8	409	1315.00	10/9/17	6/12/17	Overbank	Maintaining the extent and condition of riparian and in-channel vegetation by: Increasing periods of growth for non-woody vegetation communities that closely fringe or occur within the River Murray channel, anabranches and low elevation floodplain wetlands. Enabling recruitment of trees and supporting growth of understorey species within river red gum, black box and coolibah communities on floodplains that receive overbank flooding during 2016.
1718-LWM-07	10065-01	Lower Murray: Lock 9	409	483.00	30/8/17	9/10/17	Overbank	Maintaining the extent and condition of riparian and in-channel vegetation by: Increasing periods of growth for non-woody vegetation communities that closely fringe or occur within the River Murray channel, anabranches and low elevation floodplain wetlands. Enabling recruitment of trees and supporting growth of understorey species within river red gum, black box and coolibah communities on floodplains that receive overbank flooding during 2016.

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-LWM-09	10065-01	Lower Murray: Lock 15	409	1815.00	5/9/17	26/11/17	Overbank	Maintaining the extent and condition of riparian and in-channel vegetation by: Increasing periods of growth for non-woody vegetation communities that closely fringe or occur within the River Murray channel, anabranches and low elevation floodplain wetlands. Enabling recruitment of trees and supporting growth of understorey species within river red gum, black box and coolibah communities on floodplains that receive overbank flooding during 2016.
1718-LWM-12	10065-06	Lower Murray: Lock 2	335				Overbank	Maintaining the extent and condition of riparian and in-channel vegetation by: Increasing periods of growth for non-woody vegetation communities that closely fringe or occur within the River Murray channel, anabranches and low elevation floodplain wetlands. Enabling recruitment of trees and supporting growth of understorey species within river red gum, black box and coolibah communities on floodplains that receive overbank flooding during 2016.

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-LWM-14	10065-06	Lower Murray: Lock 5	1266	1265.50			Overbank	Maintaining the extent and condition of riparian and in-channel vegetation by: Increasing periods of growth for non-woody vegetation communities that closely fringe or occur within the River Murray channel, anabranches and low elevation floodplain wetlands. Enabling recruitment of trees and supporting growth of understorey species within river red gum, black box and coolibah communities on floodplains that receive overbank flooding during 2016.
1718-GLB-06	10064	Goulburn: Lower Goulburn River	6112	97639.00	2/12/17	22/12/17	Bankfull	Protect fish, water bug and vegetation habitat and bank condition.
1718-LWM-15	10045-02	Lower Murray: Banrock Station - Heron's Bend	24	23.50	11/12/17	27/12/17	Wetland	Protect the extent and condition of native riparian vegetation communities and provide reproduction and recruitment opportunities. Improve cover and condition of understorey vegetation including lignum. Enhance survival of seedlings arising from 2011 flood event. Improve the condition of the associated Red Gum woodland vegetation communities that are

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
								hosting one of the few colonies of Regent Parrot in South Australia.
1718-LWM-16	10045-02	Lower Murray: Banrock Station - Banrock Bend	24	24.40	11/12/17	27/12/17	Wetland	Protect the extent and condition of native riparian vegetation communities and provide reproduction and recruitment opportunities. Improve cover and condition of understorey vegetation including lignum. Enhance survival of seedlings arising from 2011 flood event. Improve the condition of the associated Red Gum woodland vegetation communities that are hosting one of the few colonies of Regent Parrot in South Australia.
1718-LWM-17	10045-02	Lower Murray: Banrock Station - Wigley Reach Depression	396	395.50	11/12/17	10/2/18	Wetland	Protect the extent and condition of native riparian vegetation communities and provide reproduction and recruitment opportunities. Improve cover and condition of understorey vegetation including lignum. Enhance survival of seedlings arising from 2011 flood event. Improve the condition of the associated Red Gum woodland vegetation communities that are

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
								hosting one of the few colonies of Regent Parrot in South Australia.
1718-LWM-18	10045-02	Lower Murray: Banrock Station - Eastern Lagoon	1429	1428.70	11/12/17	23/5/18	Wetland	Protect the extent and condition of native riparian vegetation communities and provide reproduction and recruitment opportunities. Improve cover and condition of understorey vegetation including lignum. Enhance survival of seedlings arising from 2011 flood event. Improve the condition of the associated Red Gum woodland vegetation communities that are hosting one of the few colonies of Regent Parrot in South Australia.
1718-LWM-19	10045-02	Lower Murray: Banrock Station - Herons & Banrock's Bend flats	132	131.90	16/5/18	13/6/18	Wetland	Protect the extent and condition of native riparian vegetation communities and provide reproduction and recruitment opportunities. Improve cover and condition of understorey vegetation including lignum. Enhance survival of seedlings arising from 2011 flood event. Improve the condition of the associated Red Gum woodland vegetation communities that are

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
								hosting one of the few colonies of Regent Parrot in South Australia.
1718-BRK-08	10042-03	Upper Broken Creek and Moodie Swamp	498	600.00	18/4/18	7/6/18	Fresh, Wetland	Provide a more natural flooding regime to ensure the success of bird breeding events (incl Brolga) and to provide growth conditions for water dependant vegetation.
1718-CNM-05	10065-08	Central Murray: Barham Lake	102	102.00	23/1/18	23/3/18	Wetland	Provide habitat for other water dependent species, including fringing vegetation.
1718-CNM-03	10065-03	Central Murray: Hattah Lakes	32145	111933.00	3/7/17	31/10/17	Wetland	Support growth, improve condition and recruitment opportunities for black box ( <i>Eucalyptus largiflorens</i> ) woodland at higher elevations. Support the ongoing reestablishment of water dependant vegetation in wetlands and waterways, and maintenance of river red gum ( <i>Eucalyptus camaldulensis</i> ) forests and woodlands.
1718-MBG-02	10062-01	Murrumbidgee: Mid-Murrumbidgee wetlands	159283	236205.00	24/7/17	1/9/17	Fresh, Wetland	Support reproduction and improved condition of vegetation, waterbirds, native fish and other biota.
1718-NAM-01	10066-01	Namoi: Lower Namoi River	4100	4100.00	12/3/18	15/5/18	Baseflow	Support riparian vegetation.

Basin-scale Evaluation Water Action Reference	Water Action Number (WAR)	Surface water region: asset	Commonwealth environmental water volume (ML)	Total water action volume (ML)	Start Date	End Date	Flow component	Expected ecological outcome <sup>1</sup>
1718-GWY-01	10069-01	Gwydir: Gwydir Wetlands	4000	8000.00	19/12/17	17/1/18	Wetland	Support vegetation survival, condition and reproduction.

<sup>1</sup> As reported by CEWO.

## Appendix B. Plant taxa recorded in the LTIM project from monitored Selected Areas in each sampling year between 2014-15 and 2017-18

Note: \* indicates exotic species

Plant group	Species	2014-15	2015-16	2016-17	2017-18
Annual forbs	<i>Amaranthus macrocarpus</i>	1	0	0	0
	<i>Ammannia multiflora</i>	1	1	1	1
	<i>Anagallis arvensis*</i>	0	1	1	0
	<i>Arabidella nasturtium</i>	1	0	0	0
	<i>Arctotheca calendula*</i>	1	1	0	1
	<i>Argemone ochroleuca*</i>	1	1	1	1
	<i>Bergia trimeria</i>	0	0	1	1
	<i>Bidens pilosa*</i>	1	1	0	0
	<i>Brachyscome goniocarpa</i>	1	0	0	1
	<i>Brassica tournefortii*</i>	1	1	0	0
	<i>Bulbine semibarbata</i>	1	1	1	1
	<i>Callitriche</i>	0	0	0	1
	<i>Callitriche sonderi</i>	0	0	1	0
	<i>Callitriche umbonata</i>	1	1	0	1
	<i>Calocephalus sonderi</i>	0	0	0	1
	<i>Calotis hispidula</i>	1	1	1	1
	<i>Capsella bursa-pastoris*</i>	1	1	1	0
	<i>Cardamine hirsuta*</i>	1	0	0	0
	<i>Carduus pycnocephalus*</i>	1	0	0	0
	<i>Carduus*</i>	0	0	1	0
	<i>Carrichtera annua*</i>	1	1	1	1
	<i>Carthamus lanatus*</i>	1	0	1	0
	<i>Centaurea calcitrapa*</i>	0	0	1	1
	<i>Centaureum tenuiflorum*</i>	1	0	0	0
	<i>Centipeda minima</i>	1	1	1	0
	<i>Chenopodium melanocarpum</i>	1	1	1	0
	<i>Chenopodium pumilio</i>	1	1	0	0
	<i>Citrullus lanatus*</i>	1	0	1	1
	<i>Cotula australis</i>	1	1	0	1
	<i>Cotula bipinnata</i>	0	0	1	0
	<i>Craspedia variabilis</i>	0	0	0	1
	<i>Crassula</i>	0	0	0	1
	<i>Crassula decumbens</i>	0	1	0	0
	<i>Crassula helmsii</i>	1	0	1	0
	<i>Cucumis melo</i>	0	0	1	0
	<i>Cucumis myriocarpus*</i>	1	1	1	1

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Cuscuta</i>	1	0	0	0
	<i>Cuscuta australis</i>	0	0	1	0
	<i>Cyclospermum leptophyllum*</i>	1	1	1	1
	<i>Damasonium minus</i>	1	1	1	1
	<i>Daucus glochidiatus</i>	0	1	1	1
	<i>Dentella minutissima</i>	0	0	1	1
	<i>Echium plantagineum*</i>	1	1	1	1
	<i>Eclipta platyglossa</i>	1	1	1	1
	<i>Elatine gratioloides</i>	1	1	1	1
	<i>Emex australis*</i>	0	1	0	0
	<i>Epaltes australis</i>	1	1	1	1
	<i>Erodium botrys*</i>	0	1	0	0
	<i>Erodium malacoides*</i>	1	0	0	1
	<i>Eryngium paludosum</i>	0	0	1	0
	<i>Eryngium rostratum</i>	0	1	0	0
	<i>Euchiton sphaericus</i>	1	1	1	1
	<i>Euphorbia australis</i>	1	0	0	0
	<i>Fumaria capreolata*</i>	1	1	0	1
	<i>Fumaria*</i>	1	1	1	1
	<i>Galium aparine*</i>	1	1	1	1
	<i>Galium murale*</i>	0	1	1	0
	<i>Geococcus pusillus</i>	1	0	0	0
	<i>Glinus lotoides</i>	1	1	1	1
	<i>Gnaphalium luteoalbum</i>	0	1	1	1
	<i>Gnaphalium polycaulon*</i>	0	1	0	0
	<i>Gnaphalium sphaericum</i>	1	0	0	1
	<i>Goodenia cycloptera</i>	1	0	0	0
	<i>Goodenia heteromera</i>	1	1	1	1
	<i>Harmsiodoxa blennodioides</i>	1	0	0	0
	<i>Hedypnois rhagadioloides*</i>	0	0	1	0
	<i>Helichrysum luteoalbum</i>	0	1	1	0
	<i>Heliotropium curassavicum*</i>	1	1	1	1
	<i>Heliotropium europaeum*</i>	1	1	1	1
	<i>Heliotropium supinum*</i>	1	0	1	1
	<i>Helminthotheca echioides*</i>	1	1	1	0
	<i>Hibiscus trionum</i>	1	1	0	1
	<i>Hydrocotyle trachycarpa</i>	1	0	0	0
	<i>Hypochaeris glabra*</i>	0	0	1	0
	<i>Ixiolaena</i>	0	1	0	0
	<i>Lactuca saligna*</i>	0	1	1	1

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Lactuca serriola</i> *	1	1	1	1
	<i>Lactuca</i> *	0	1	0	0
	<i>Lamium amplexicaule</i> *	1	0	0	1
	<i>Leiocarpa</i>	0	0	1	0
	<i>Lepidium africanum</i> *	0	0	0	1
	<i>Lepidium bonariense</i> *	1	1	1	0
	<i>Lepidium campestre</i> *	0	1	1	0
	<i>Lepidium hyssopifolium</i>	1	0	1	1
	<i>Ludwigia octovalvis</i>	1	1	1	1
	<i>Lythrum</i>	0	0	0	1
	<i>Lythrum hyssopifolia</i>	1	1	1	1
	<i>Malva parviflora</i> *	1	1	0	1
	<i>Malvastrum americanum</i> *	1	0	0	0
	<i>Medicago arabica</i> *	0	0	1	0
	<i>Medicago lupulina</i> *	1	0	0	0
	<i>Medicago minima</i> *	1	0	0	0
	<i>Medicago polymorpha</i> *	1	1	1	1
	<i>Medicago praecox</i> *	1	1	0	0
	<i>Medicago truncatula</i> *	1	0	0	0
	<i>Medicago</i> *	1	1	1	1
	<i>Melilotus indicus</i> *	0	1	1	0
	<i>Myosurus australis</i>	1	1	1	1
	<i>Nicotiana velutina</i>	0	1	1	1
	<i>Osteocarpum acropterum</i>	1	0	0	0
	<i>Ottelia ovalifolia</i>	1	1	1	1
	<i>Oxalis corniculata</i> *	1	1	1	1
	<i>Oxalis exilis</i>	1	1	1	1
	<i>Oxalis pes-caprae</i> *	1	0	0	0
	<i>Persicaria hydropiper</i>	1	0	1	1
	<i>Petrorhagia nanteuilii</i> *	0	0	1	0
	<i>Phyllanthus fuernrohrii</i>	0	0	0	1
	<i>Phyllanthus lacunarius</i>	1	1	1	1
	<i>Physalis ixocarpa</i> *	0	0	0	1
	<i>Physalis minima</i> *	0	1	1	0
	<i>Physalis</i> *	0	1	1	1
	<i>Picris angustifolia</i> *	0	1	0	1
	<i>Plantago cunninghamii</i>	1	0	1	1
	<i>Plantago debilis</i>	0	1	1	0
	<i>Plantago lanceolata</i> *	1	1	1	1
	<i>Polycarpon tetraphyllum</i> *	1	0	0	0

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Polygonum arenastrum*</i>	1	1	1	1
	<i>Polygonum aviculare*</i>	1	1	1	1
	<i>Polygonum plebeium</i>	1	1	1	1
	<i>Portulaca oleracea</i>	1	1	1	1
	<i>Pseudognaphalium luteoalbum</i>	1	1	1	1
	<i>Pycnosorus chrysanthus</i>	1	0	0	1
	<i>Ranunculus pentandrus</i>	0	1	1	1
	<i>Ranunculus pumilio</i>	1	1	1	1
	<i>Ranunculus sceleratus*</i>	1	1	0	0
	<i>Ranunculus sessiliflorus</i>	1	0	1	0
	<i>Raphanus raphanistrum*</i>	1	1	0	1
	<i>Rapistrum rugosum*</i>	1	1	1	1
	<i>Rhodanthe</i>	0	0	0	1
	<i>Rhodanthe corymbiflora</i>	0	1	1	1
	<i>Rhodanthe floribunda</i>	0	1	0	0
	<i>Rhodanthe stricta</i>	0	1	0	0
	<i>Rorippa eustylis</i>	1	1	1	1
	<i>Rorippa palustris*</i>	1	0	1	1
	<i>Rumex crystallinus</i>	1	1	1	1
	<i>Schenkia australis</i>	0	1	0	1
	<i>Scleroblitum atriplicinum</i>	1	1	1	1
	<i>Senecio glossanthus</i>	1	1	1	0
	<i>Senecio hispidulus</i>	1	0	0	0
	<i>Senecio lautus</i>	0	1	0	0
	<i>Senecio pinnatifolius</i>	0	1	0	0
	<i>Senecio quadridentatus</i>	1	1	1	1
	<i>Senecio runcinifolius</i>	1	1	1	1
	<i>Sesbania cannabina</i>	1	1	1	1
	<i>Sigesbeckia australiensis</i>	0	0	1	0
	<i>Sisymbrium erysimoides*</i>	1	1	1	1
	<i>Sisymbrium irio*</i>	1	1	1	1
	<i>Sisymbrium officinale*</i>	0	1	0	0
	<i>Soliva anthemifolia</i>	1	1	0	0
	<i>Sonchus asper*</i>	1	1	0	1
	<i>Sonchus oleraceus*</i>	1	1	1	1
	<i>Spergularia marina</i>	0	0	1	1
	<i>Spirodela polyrhiza</i>	1	0	0	0
	<i>Spirodela punctata</i>	1	0	0	0
	<i>Stellaria media*</i>	1	1	1	0
	<i>Tetragonia</i>	0	0	1	1

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Tetragonia eremaea</i>	0	1	1	1
	<i>Tetragonia tetragonoides</i>	1	1	1	1
	<i>Trianthema triquetra</i>	1	0	0	0
	<i>Tribulus terrestris</i> *	1	0	1	0
	<i>Trifolium angustifolium</i> *	1	1	0	0
	<i>Trifolium arvense</i> *	1	1	0	0
	<i>Trifolium campestre</i> *	1	1	0	0
	<i>Trifolium glomeratum</i> *	0	1	0	0
	<i>Trifolium subterraneum</i> *	1	0	0	0
	<i>Trifolium tomentosum</i> *	1	0	0	0
	<i>Trigonella suavissima</i>	0	1	1	0
	<i>Urtica urens</i> *	1	0	1	0
	<i>Vellereophyton dealbatum</i> *	0	0	0	1
	<i>Verbena supina</i> *	1	1	1	1
	<i>Verbesina encelioides</i> *	0	0	1	1
	<i>Veronica peregrina</i> *	0	1	1	1
	<i>Vicia</i> *	0	1	0	0
	<i>Wahlenbergia gracilentia</i>	1	0	1	1
	<i>Zaleya galericulata</i>	0	1	0	0
Annual grasses	<i>Agrostis parviflora</i>	0	1	0	0
	<i>Avena barbata</i> *	0	1	0	0
	<i>Avena</i> *	1	1	1	0
	<i>Brachyachne ciliaris</i>	0	0	1	0
	<i>Bromus diandrus</i> *	1	1	0	1
	<i>Cenchrus ciliaris</i> *	1	0	0	0
	<i>Diplachne fusca</i> *	1	1	1	0
	<i>Echinochloa colona</i> *	1	1	1	1
	<i>Echinochloa crus-galli</i> *	1	1	1	1
	<i>Echinochloa crus-pavonis</i> *	0	0	0	1
	<i>Echinochloa inundata</i>	1	0	0	0
	<i>Ehrharta longiflora</i> *	0	1	0	0
	<i>Eleusine indica</i> *	0	0	0	1
	<i>Eragrostis elongata</i>	1	1	1	1
	<i>Eragrostis parviflora</i>	1	0	0	0
	<i>Hordeum leporinum</i> *	1	1	1	1
	<i>Lachnagrostis filiformis</i>	1	1	1	1
	<i>Lolium loliaceum</i> *	0	1	0	0
	<i>Lolium perenne</i> *	1	0	1	1
	<i>Lolium rigidum</i> *	1	1	0	1
	<i>Lolium</i> *	1	1	1	1

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Phalaris aquatica</i> *	0	0	1	0
	<i>Phalaris paradoxa</i> *	0	1	1	1
	<i>Phalaris</i> *	0	0	1	1
	<i>Poa annua</i> *	0	1	0	0
	<i>Poa infirma</i> *	1	0	0	0
	<i>Polypogon monspeliensis</i> *	1	1	1	1
	<i>Schismus barbatus</i> *	0	0	1	1
	<i>Sporobolus caroli</i>	1	1	0	0
	<i>Tragus australianus</i>	1	0	0	0
	<i>Vulpia bromoides</i> *	1	0	0	0
Annual sedges/rushes	<i>Cyperus difformis</i>	1	1	1	1
	<i>Cyperus pygmaeus</i>	0	0	1	1
	<i>Isolepis australiensis</i>	0	0	0	1
Annual shrubs and sub-shrubs	<i>Abutilon theophrasti</i> *	1	1	1	1
	<i>Aeschynomene indica</i>	1	1	1	1
	<i>Alternanthera denticulata</i>	1	1	1	1
	<i>Alternanthera nodiflora</i>	1	1	0	1
	<i>Aster subulatus</i> *	1	1	1	1
	<i>Atriplex lindleyi</i>	1	0	0	0
	<i>Atriplex muelleri</i>	1	0	0	0
	<i>Atriplex suberecta</i>	0	1	0	1
	<i>Centaurea melitensis</i> *	1	1	1	1
	<i>Chenopodium album</i> *	1	1	1	1
	<i>Chenopodium murale</i>	1	1	1	1
	<i>Cirsium vulgare</i> *	1	1	1	1
	<i>Conyza albida</i> *	0	1	0	1
	<i>Conyza bonariensis</i> *	1	1	1	1
	<i>Conyza sumatrensis</i> *	0	1	1	1
	<i>Cullen cinereum</i>	1	0	1	1
	<i>Dissocarpus paradoxus</i>	1	0	0	0
	<i>Dysphania pumilio</i>	1	1	1	1
	<i>Einadia polygonoides</i>	1	1	1	0
	<i>Einadia trigonos</i>	0	0	1	1
	<i>Erigeron bonariense</i> *	0	1	1	1
	<i>Erigeron sumatrensis</i> *	1	1	0	0
	<i>Persicaria lapathifolia</i>	1	1	1	1
	<i>Persicaria orientalis</i>	1	1	0	1
	<i>Physalis angulata</i> *	1	0	0	0
	<i>Salsola australis</i>	1	1	1	1
	<i>Salsola kali</i>	1	1	1	1

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Sclerolaena brachyptera</i>	1	1	1	1
	<i>Sida rhombifolia</i>	1	1	0	0
	<i>Xanthium occidentale</i> *	1	1	1	1
	<i>Xanthium pungens</i> *	1	0	0	0
	<i>Xanthium spinosum</i> *	1	1	1	1
	<i>Zygophyllum</i>	1	0	0	1
	<i>Zygophyllum apiculatum</i>	1	1	1	1
Mistletoe	<i>Amyema miquelii</i>	1	0	0	0
	<i>Amyema quandang</i>	1	0	1	0
	<i>Lysiana</i>	1	0	0	1
Perennial forbs	<i>Acetosella +B2:B624vulgaris</i> *	0	0	1	0
	<i>Acroptilon repens</i> *	0	1	0	0
	<i>Asperula conferta</i>	1	1	1	0
	<i>Asperula gemella</i>	1	1	1	1
	<i>Asperula geminifolia</i>	1	1	1	1
	<i>Azolla</i>	0	0	1	0
	<i>Azolla filiculoides</i>	1	1	1	1
	<i>Berula erecta</i> *	0	0	1	0
	<i>Boerhavia dominii</i>	1	1	1	1
	<i>Brachyscome basaltica</i>	1	1	1	1
	<i>Brachyscome ciliaris</i>	0	1	0	0
	<i>Brachyscome dentata</i>	0	1	1	0
	<i>Brachyscome melanocarpa</i>	0	1	1	0
	<i>Brachyscome papillosa</i>	0	1	1	1
	<i>Bulbine bulbosa</i>	0	1	1	0
	<i>Calotis cuneata</i>	0	0	1	0
	<i>Calotis cuneifolia</i>	0	1	1	0
	<i>Calotis erinacea</i>	1	1	0	0
	<i>Calotis lappulacea</i>	0	1	1	0
	<i>Calotis latiuscula</i>	0	0	1	1
	<i>Calotis scabiosifolia</i>	1	1	1	1
	<i>Calotis scapigera</i>	1	1	1	1
	<i>Carpobrotus</i>	0	1	0	0
	<i>Centipeda cunninghamii</i>	1	1	1	1
	<i>Centipeda thespidioides</i>	0	1	1	0
	<i>Chamaesyce dallachyana</i>	1	1	0	1
	<i>Chamaesyce drummondii</i>	1	1	1	1
	<i>Chenopodium</i>	1	1	1	0
	<i>Chenopodium ambrosioides</i>	1	0	0	0
	<i>Chenopodium anidiophyllum</i>	1	1	0	0

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Chondrilla juncea*</i>	1	0	0	0
	<i>Chrysocephalum apiculatum</i>	0	1	0	0
	<i>Cichorium intybus*</i>	1	0	0	1
	<i>Convolvulus</i>	1	0	0	1
	<i>Convolvulus arvensis*</i>	0	0	1	1
	<i>Convolvulus erubescens</i>	1	1	0	0
	<i>Convolvulus graminetinus</i>	1	0	1	0
	<i>Coronidium rutidolepis</i>	0	1	0	0
	<i>Craspedia</i>	0	1	0	0
	<i>Crinum flaccidum</i>	1	1	0	0
	<i>Cullen tenax</i>	1	0	1	0
	<i>Cynoglossum australe</i>	0	1	1	0
	<i>Cynoglossum suaveolens</i>	0	0	1	0
	<i>Dichondra</i>	0	1	0	0
	<i>Dichondra repens</i>	1	1	0	1
	<i>Eichhornia crassipes*</i>	1	1	0	0
	<i>Euchiton</i>	1	1	1	0
	<i>Euchiton involucratus</i>	1	0	1	1
	<i>Euphorbia dallachyana</i>	1	0	0	0
	<i>Euphorbia drummondii</i>	1	1	1	1
	<i>Euphorbia planiticola</i>	0	0	1	0
	<i>Galium gaudichaudii</i>	1	1	1	1
	<i>Gaura*</i>	1	0	0	0
	<i>Geranium solanderi</i>	1	1	0	1
	<i>Glossostigma elatinoides</i>	1	0	0	0
	<i>Glycine tabacina</i>	0	0	1	0
	<i>Goodenia fascicularis</i>	0	1	1	1
	<i>Goodenia glauca</i>	1	0	1	1
	<i>Goodenia pinnatifida</i>	0	1	1	0
	<i>Gratiola</i>	0	1	1	1
	<i>Gratiola pedunculata</i>	0	1	0	0
	<i>Haloragis aspera</i>	1	1	1	0
	<i>Haloragis glauca</i>	1	1	1	1
	<i>Haloragis heterophylla</i>	1	1	1	1
	<i>Hypericum gramineum</i>	0	0	1	0
	<i>Hypochaeris microcephala*</i>	1	1	1	0
	<i>Hypochaeris radicata*</i>	1	1	1	1
	<i>Kickxia elatine*</i>	0	0	1	1
	<i>Kickxia sieberi*</i>	1	1	0	0
	<i>Lemna</i>	1	1	1	1

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Lemna disperma</i>	1	1	0	0
	<i>Lemna minor</i>	0	1	1	0
	<i>Leontodon saxatilis</i> *	0	1	0	0
	<i>Lepidium pseudohyssopifolium</i>	1	0	1	0
	<i>Limosella australis</i>	1	0	1	1
	<i>Lobelia concolor</i>	1	0	0	0
	<i>Lobelia darlingensis</i>	0	0	0	1
	<i>Lobelia purpurascens</i>	0	1	1	0
	<i>Lotus cruentus</i>	0	1	0	0
	<i>Ludwigia peploides</i>	1	1	1	1
	<i>Lysimachia</i> *	1	1	0	0
	<i>Lythrum salicaria</i>	0	0	1	0
	<i>Malva</i> *	1	1	0	1
	<i>Marrubium vulgare</i> *	1	1	1	1
	<i>Marsilea</i>	1	1	1	1
	<i>Marsilea costulifera</i>	1	1	1	1
	<i>Marsilea drummondii</i>	1	1	1	1
	<i>Marsilea hirsuta</i>	1	1	1	1
	<i>Mentha</i>	1	1	0	0
	<i>Mentha australis</i>	1	1	1	1
	<i>Mimulus gracilis</i>	1	1	1	1
	<i>Minuria denticulata</i>	0	1	0	0
	<i>Minuria integerrima</i>	0	0	1	0
	<i>Modiola caroliniana</i> *	1	0	1	0
	<i>Myriophyllum crispatum</i>	1	1	1	0
	<i>Myriophyllum papillosum</i>	1	1	1	1
	<i>Myriophyllum propinquum</i>	0	1	0	0
	<i>Myriophyllum verrucosum</i>	1	1	1	1
	<i>Nymphoides crenata</i>	1	1	1	1
	<i>Onopordum acanthium</i> *	0	1	0	1
	<i>Oxalis chnoodes</i>	0	1	0	0
	<i>Oxalis perennans</i>	1	1	1	1
	<i>Oxalis thompsoniae</i>	1	1	0	0
	<i>Persicaria decipiens</i>	1	1	1	1
	<i>Persicaria prostrata</i>	1	1	1	1
	<i>Phyla canescens</i> *	1	1	1	1
	<i>Phyla nodiflora</i> *	1	1	1	1
	<i>Pluchea dentex</i>	1	0	0	0
	<i>Polymeria pusilla</i>	1	0	0	0
	<i>Potamogeton</i>	0	0	1	0

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Potamogeton crispus</i>	0	0	1	1
	<i>Potamogeton tricarinatus</i>	1	1	1	1
	<i>Pratia</i>	1	0	0	0
	<i>Pratia concolor</i>	1	1	1	1
	<i>Psilocaulon tenue</i>	1	1	1	0
	<i>Ranunculus</i>	0	1	0	0
	<i>Ranunculus inundatus</i>	0	0	0	1
	<i>Ranunculus undosus</i>	1	1	1	1
	<i>Romulea rosea*</i>	0	0	0	1
	<i>Rorippa laciniata</i>	0	0	1	0
	<i>Rumex brownii</i>	1	1	1	1
	<i>Rumex crispus*</i>	1	1	1	0
	<i>Rumex tenax</i>	1	1	1	1
	<i>Sagittaria montevidensis</i>	1	1	0	0
	<i>Solanum ellipticum</i>	1	0	0	0
	<i>Solanum esuriale</i>	1	1	1	1
	<i>Spergularia rubra*</i>	0	1	0	0
	<i>Stellaria angustifolia</i>	1	1	1	1
	<i>Stemodia florulenta</i>	1	1	1	1
	<i>Swainsona</i>	0	1	1	1
	<i>Swainsona procumbens</i>	0	1	0	0
	<i>Taraxacum</i>	1	0	0	0
	<i>Taraxacum officinale*</i>	0	0	1	1
	<i>Teucrium racemosum</i>	1	1	1	1
	<i>Tragopogon porrifolius*</i>	1	0	1	0
	<i>Triglochin</i>	0	0	1	0
	<i>Triglochin dubia</i>	1	1	1	0
	<i>Triglochin procera</i>	1	1	1	1
	<i>Urtica incisa*</i>	0	0	1	1
	<i>Utricularia gibba</i>	1	1	1	1
	<i>Vallisneria australis</i>	0	1	0	0
	<i>Vallisneria gigantea</i>	1	1	1	1
	<i>Velleia paradoxa</i>	1	0	0	0
	<i>Verbascum thapsus*</i>	0	0	0	1
	<i>Verbascum*</i>	1	0	0	0
	<i>Verbena gaudichaudii</i>	1	1	1	1
	<i>Verbena officinalis*</i>	1	1	1	1
	<i>Veronica catenata*</i>	0	1	0	0
	<i>Veronica gracilis</i>	1	0	0	0
	<i>Vittadinia</i>	1	1	0	0

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Vittadinia cuneata</i>	1	1	1	1
	<i>Wahlenbergia communis</i>	1	1	1	0
	<i>Wahlenbergia fluminalis</i>	1	1	1	1
	<i>Wahlenbergia gracilis</i>	1	1	1	1
	<i>Wurmbea dioica</i>	1	0	0	0
Perennial grasses	<i>Alopecurus geniculatus*</i>	0	1	1	0
	<i>Amphibromus nervosus</i>	1	1	1	0
	<i>Anthosachne kingiana</i>	1	0	0	0
	<i>Anthosachne scabra</i>	0	1	0	0
	<i>Austrodanthonia</i>	1	1	1	1
	<i>Austrodanthonia caespitosa</i>	0	1	0	0
	<i>Austrostipa</i>	0	1	1	0
	<i>Cynodon dactylon*</i>	1	1	1	1
	<i>Danthonia</i>	1	0	0	0
	<i>Deyeuxia</i>	0	0	1	0
	<i>Dichanthium sericeum</i>	1	0	0	0
	<i>Digitaria ammophila</i>	1	0	0	0
	<i>Enteropogon acicularis</i>	0	0	1	0
	<i>Eragrostis australasica</i>	1	1	0	1
	<i>Eragrostis brownii</i>	0	1	0	0
	<i>Eragrostis leptostachya</i>	1	0	0	0
	<i>Eragrostis setifolia</i>	0	1	0	1
	<i>Eriochloa crebra</i>	1	0	0	0
	<i>Eriochloa procera</i>	1	0	0	0
	<i>Glyceria</i>	1	0	0	0
	<i>Holcus*</i>	0	1	0	0
	<i>Leptochloa</i>	1	0	0	0
	<i>Panicum</i>	1	0	1	0
	<i>Panicum coloratum*</i>	1	1	1	1
	<i>Panicum decompositum</i>	1	1	0	0
	<i>Panicum effusum</i>	1	1	0	1
	<i>Paspalidium constrictum</i>	1	0	0	0
	<i>Paspalidium jubiflorum</i>	1	1	1	1
	<i>Paspalum dilatatum*</i>	0	1	1	1
	<i>Paspalum distichum</i>	1	1	1	1
	<i>Pennisetum clandestinum*</i>	1	0	0	0
	<i>Phalaris minor*</i>	0	1	1	1
	<i>Phragmites australis</i>	0	0	1	1
	<i>Piptatherum miliaceum*</i>	1	1	0	0
	<i>Poa</i>	1	1	1	0

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Poa fordeana</i>	0	0	1	1
	<i>Poa labillardierei</i>	1	1	1	1
	<i>Pseudoraphis spinescens</i>	1	1	1	1
	<i>Rytidosperma</i>	1	0	1	1
	<i>Rytidosperma caespitosum</i>	0	0	1	0
	<i>Sorghum halepense*</i>	0	0	0	1
	<i>Sporobolus creber</i>	1	0	0	0
	<i>Sporobolus mitchellii</i>	1	0	1	1
	<i>Themeda triandra</i>	1	1	1	1
	<i>Walwhalleya proluta</i>	0	1	1	0
Perennial sedges/rushes	<i>Bolboschoenus fluviatilis</i>	1	1	1	1
	<i>Carex</i>	1	1	1	1
	<i>Carex appressa</i>	1	1	1	1
	<i>Carex inversa</i>	1	0	0	0
	<i>Carex tereticaulis</i>	1	1	1	1
	<i>Cyperus alterniflorus*</i>	0	0	0	1
	<i>Cyperus bifax</i>	1	0	1	1
	<i>Cyperus eragrostis*</i>	1	1	1	1
	<i>Cyperus exaltatus</i>	1	1	1	1
	<i>Cyperus gymnocaulos</i>	1	1	1	1
	<i>Eleocharis acuta</i>	1	1	1	1
	<i>Eleocharis pallens</i>	1	1	1	1
	<i>Eleocharis plana</i>	1	1	1	1
	<i>Eleocharis pusilla</i>	1	1	1	1
	<i>Eleocharis sphacelata</i>	1	1	1	1
	<i>Juncus amabilis</i>	1	1	1	1
	<i>Juncus aridicola</i>	1	1	1	1
	<i>Juncus flavidus</i>	1	1	1	1
	<i>Juncus ingens</i>	1	0	0	0
	<i>Juncus subsecundus</i>	0	1	0	0
	<i>Juncus tenuis*</i>	0	1	0	0
	<i>Juncus usitatus</i>	1	1	1	1
	<i>Typha</i>	1	1	1	1
<i>Typha domingensis</i>	1	1	1	1	
Perennial shrubs and sub-shrubs	<i>Abutilon otoparpum</i>	1	0	0	0
	<i>Abutilon oxycarpum</i>	1	0	0	0
	<i>Atriplex</i>	1	1	1	1
	<i>Atriplex angulata</i>	0	1	1	0
	<i>Atriplex leptocarpa</i>	1	1	1	1
	<i>Atriplex nummularia</i>	1	1	1	1

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Atriplex pseudocampanulata</i>	0	1	0	1
	<i>Atriplex semibaccata</i>	1	1	1	1
	<i>Atriplex vesicaria</i>	1	1	1	1
	<i>Bassia</i>	0	1	0	0
	<i>Bassia decurrens</i>	1	1	0	1
	<i>Chenopodium curvispicatum</i>	1	0	0	0
	<i>Chenopodium nitrariaceum</i>	1	1	1	1
	<i>Dodonaea viscosa</i>	1	1	1	1
	<i>Duma florulenta</i>	1	1	1	1
	<i>Dysphania ambrosioides*</i>	1	1	1	0
	<i>Einadia</i>	1	0	0	1
	<i>Einadia hastata</i>	1	1	0	0
	<i>Einadia nutans</i>	1	1	1	1
	<i>Enchylaena</i>	0	0	1	0
	<i>Enchylaena tomentosa</i>	1	1	1	1
	<i>Eremophila desertii</i>	0	0	0	1
	<i>Euphorbia stevenii</i>	0	0	1	0
	<i>Euphorbia terracina*</i>	1	0	0	0
	<i>Glycyrrhiza acanthocarpa</i>	0	1	0	1
	<i>Hibiscus sturtii</i>	0	1	0	0
	<i>Lycium ferocissimum*</i>	1	1	1	1
	<i>Lysiana subfalcata</i>	0	0	0	1
	<i>Maireana</i>	1	1	1	1
	<i>Maireana aphylla</i>	1	1	1	1
	<i>Maireana appressa</i>	1	0	0	0
	<i>Maireana brevifolia</i>	1	1	1	1
	<i>Maireana decalvans</i>	1	1	0	0
	<i>Maireana enchylaenoides</i>	0	0	0	1
	<i>Maireana pyramidata</i>	0	0	1	0
	<i>Maireana trichoptera</i>	0	1	0	0
	<i>Maireana triptera</i>	1	0	0	0
	<i>Malva preissiana</i>	0	1	1	0
	<i>Nitraria billardiarei</i>	0	0	0	1
	<i>Radyera farragei</i>	1	0	0	0
	<i>Rhagodia spinescens</i>	1	1	1	1
	<i>Sclerolaena</i>	1	0	0	0
	<i>Sclerolaena bicornis</i>	1	0	0	1
	<i>Sclerolaena birchii</i>	1	1	1	1
	<i>Sclerolaena calcarata</i>	0	1	1	0
	<i>Sclerolaena constricta</i>	0	0	1	0

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Sclerolaena convexula</i>	1	0	0	0
	<i>Sclerolaena cuneata</i>	1	0	0	0
	<i>Sclerolaena diacantha</i>	0	1	1	1
	<i>Sclerolaena divaricata</i>	1	1	1	1
	<i>Sclerolaena intricata</i>	1	0	1	1
	<i>Sclerolaena muricata</i>	1	1	1	1
	<i>Sclerolaena parviflora</i>	0	1	0	0
	<i>Sclerolaena stelligera</i>	1	0	1	1
	<i>Sclerolaena tricuspis</i>	1	1	1	1
	<i>Senecio cunninghamii</i>	1	1	1	1
	<i>Senecio magnificus</i>	1	1	0	1
	<i>Sida corrugata</i>	1	1	1	1
	<i>Sida cunninghamii</i>	1	0	1	0
	<i>Sida fibulifera</i>	1	0	0	0
	<i>Sida glauca</i>	1	0	0	0
	<i>Sida intricata</i>	1	0	0	0
	<i>Sida trichopoda</i>	1	1	0	0
	<i>Solanum nigrum*</i>	1	1	1	1
	<i>Solanum simile</i>	0	1	0	0
	<i>Tecticornia†triandra</i>	1	0	0	0
	<i>Vachellia farnesiana</i>	1	1	1	1
	<i>Verbascum virgatum*</i>	0	0	0	1
	<i>Vittadinia gracilis</i>	1	1	0	0
Trees Variable	<i>Acacia dealbata</i>	1	1	1	1
	<i>Acacia stenophylla</i>	1	1	1	1
	<i>Acacia victoriae</i>	0	1	0	1
	<i>Callistemon sieberi</i>	0	0	1	0
	<i>Casuarina cristata</i>	1	0	0	0
	<i>Eucalyptus</i>	0	1	1	1
	<i>Eucalyptus camaldulensis</i>	1	1	1	1
	<i>Eucalyptus coolabah</i>	1	1	1	1
	<i>Eucalyptus largiflorens</i>	1	1	1	1
	<i>Eucalyptus populnea</i>	0	1	1	0
	<i>Myoporum montanum</i>	0	0	1	1
	<i>Calotis</i>	1	0	0	1
	<i>Chamaesyce</i>	0	1	0	0
	<i>Dysphania</i>	0	0	1	1
	<i>Epilobium</i>	0	1	0	0
	<i>Euphorbia</i>	0	0	1	0
	<i>Fabaceae</i>	1	0	1	0

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Hypericum</i>	0	1	1	1
Variable forbs	<i>Abutilon</i>	1	1	0	0
	<i>Asteraceae</i>	1	1	1	1
	<i>Boerhavia</i>	0	1	0	1
	<i>Brachyscome</i>	1	1	1	1
	<i>Brassica*</i>	0	1	0	0
	<i>Brassicaceae</i>	1	1	1	0
	<i>Bulbine</i>	0	0	1	1
	<i>Caryophyllaceae</i>	1	0	0	0
	<i>Centipeda</i>	0	0	1	1
	<i>Cucumis*</i>	0	0	1	1
	<i>Cynoglossum</i>	0	0	1	0
	<i>Daucus</i>	0	1	0	0
	<i>Galium</i>	1	0	1	0
	<i>Gamochaeta*</i>	0	1	0	0
	<i>Geraniaceae</i>	1	0	0	0
	<i>Glinus</i>	0	0	1	0
	<i>Gnaphalium</i>	1	0	1	1
	<i>Goodenia</i>	1	1	0	0
	<i>Haloragis</i>	1	0	1	0
	<i>Heliotropium*</i>	0	0	1	1
	<i>Lepidium</i>	1	1	1	1
	<i>Leptorhynchos squamatus</i>	0	1	0	0
	<i>Limosella</i>	0	1	0	1
	<i>Malvaceae*</i>	0	1	1	1
	<i>Malvastrum</i>	0	0	1	0
	<i>Melilotus*</i>	1	0	0	0
	<i>Myriophyllum</i>	1	1	1	1
	<i>Oxalis</i>	1	1	1	1
	<i>Persicaria</i>	1	1	1	1
	<i>Phyllanthus</i>	0	1	0	0
	<i>Plantago*</i>	0	1	0	1
	<i>Polycarpaea</i>	0	0	0	1
	<i>Polygonum*</i>	1	1	1	1
	<i>Rorippa</i>	0	1	0	1
<i>Rumex</i>	1	1	1	1	
<i>Senecio</i>	1	1	1	1	
<i>Silene*</i>	0	0	1	0	
<i>Sisymbrium*</i>	1	1	1	1	
<i>Solanaceae</i>	0	1	1	0	

Plant group	Species	2014-15	2015-16	2016-17	2017-18
	<i>Solanum</i>	0	1	1	1
	<i>Sonchus</i>	1	1	1	0
	<i>Trifolium*</i>	1	1	0	0
	<i>Verbena</i>	0	1	0	1
	<i>Wahlenbergia</i>	1	1	1	1
Variable grasses	<i>Bromus*</i>	0	1	1	1
	<i>Chloris</i>	1	0	0	0
	<i>Digitaria</i>	1	0	0	0
	<i>Eragrostis</i>	1	1	1	0
	<i>Hordeum*</i>	1	1	1	0
	<i>Paspalidium</i>	1	0	1	0
	<i>Pennisetum</i>	0	1	0	0
	<i>Poaceae</i>	1	1	1	1
	<i>Urochloa</i>	1	0	0	0
Variable sedges/rushes	<i>Cyperaceae</i>	1	0	1	1
	<i>Cyperus</i>	1	1	1	1
	<i>Eleocharis</i>	1	1	1	1
	<i>Isolepis</i>	1	0	1	1
	<i>Juncaceae</i>	0	1	0	1
	<i>Juncus</i>	1	1	1	1
	<i>Scirpus</i>	0	1	0	0
Variable shrubs and sub-shrubs	<i>Alternanthera</i>	1	1	1	1
	<i>Conyza*</i>	1	1	1	1
	<i>Erigeron</i>	1	1	0	1
	<i>Sida</i>	1	1	1	1

