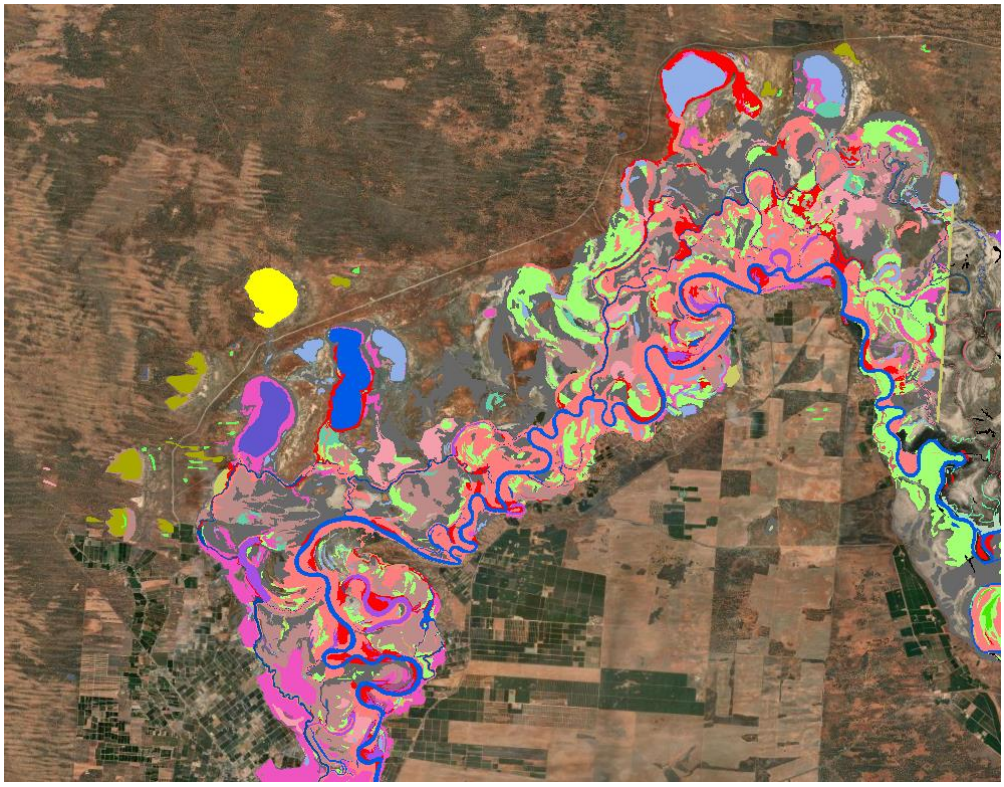
Australian Government
Commonwealth Environmental Water Office

LA TROBE UNIVERSITY

Murray–Darling Basin Long Term Intervention Monitoring Project

2018–19 Basin-scale evaluation of Commonwealth environmental water – Ecosystem Diversity

Contributors: Shane Brooks



May 2020

Final Report

CFE Publication 248

Murray–Darling Basin Long Term Intervention Monitoring Project 2018–19 Basin-scale evaluation of Commonwealth environmental water — Ecosystem Diversity

Report prepared for the Department of Agriculture, Water and the Environment, Commonwealth Environmental Water Office by La Trobe University, Centre for Freshwater Ecosystems.

Department of Department of Agriculture, Water and the Environment, Commonwealth Environmental Water Office
John Gorton Building
Parkes ACT 2600
Ph: (02) 6274 1111

For further information contact:

Nick Bond
Project Leader

Centre for Freshwater Ecosystems
(formerly Murray–Darling Freshwater Research Centre)
PO Box 821
Wodonga VIC 3689
Ph: (02) 6024 9640
Email: n.bond@latrobe.edu.au

Nikki Thurgate
Project Co-ordinator

(02) 6024 9647
n.thurgate@latrobe.edu.au

Web: https://www.latrobe.edu.au/freshwater-ecosystems/research/projects/ltim

Enquiries: cfe@latrobe.edu.au

Report Citation: Brooks S., (2020) Murray–Darling Basin Long Term Intervention Monitoring Project — 2018–19 Basin-scale evaluation of Commonwealth environmental water – Ecosystem Diversity. Report prepared for the Department of Agriculture, Water and the Environment, Commonwealth Environmental Water Office by La Trobe University, Centre for Freshwater Ecosystems, CFE Publication 248 May 2020 54p.

Cover Image: Australian National Aquatic Ecosystem mapping of the Chowilla floodplain, South Australia.

Traditional Owner acknowledgement:

La Trobe University Albury-Wodonga and Mildura campuses are located on the land of the Latje Latje and Wiradjuri peoples. The Research Centre undertakes work throughout the Murray–Darling Basin and acknowledge the traditional custodians of this land and water. We pay respect to Elders past, present and future.

Acknowledgements:

This project was undertaken using data collected for the Commonwealth Environmental Water Office Long Term Intervention Monitoring Project. The assistance provided by the Monitoring and Evaluation Providers into interpretation of data and report review is greatly appreciated. The author would also like to thank Commonwealth Environmental Water Office staff, State water agency staff, and LTIM Monitoring and Evaluation Providers who contributed to detailed mapping of inundation from watering actions that is a core input to this report. Thank you to the LTIM Hydrology team for compiling the annual inundation maps and to Bex Dunn (Geoscience Australia) for participating in our collaboration workshop and for providing background information and wetland inundation data from the Wetland Insight Tool.

Document history and status

Version	Date Issued	Reviewed by	Approved by	Revision type
1	31/03/20	CEWO		general
2	30/6/2020	S Brooks	N. Thurgate	final

Distribution of copies

Version	Quantity	Issued to
1	1 x word, 1 x pdf	CEWO

Contents

Summary of annual Basin-scale evaluation 2018–19

Key Basin-scale evaluation findings

- In 2018–19, there were approximately 92 475 ha of lakes and wetlands, 26 568 ha of floodplains and 14 379 km of rivers in the Basin upstream of the Lower Lakes that was supported by Commonwealth environmental water.
- Commonwealth environmental water supported another 103 335 ha of Lake Alexandrina and Lake Albert and their fringing wetlands and 23 802 ha of estuarine habitat in the Coorong and Murray Mouth.
- Commonwealth environmental water supported 58% of the different wetland ecosystem types and 83% of floodplain ecosystem types in the Basin in 2018–19.
- Many permanent wetlands and lakes were supported by the delivery of Commonwealth environmental water (30 118 ha excluding Lake Alexandrina and Albert or 115 374 ha when the lower lakes are included).
- Approximately 58% of the wetland areas (59 000 ha) and all floodplains (26 568 ha) that received Commonwealth environmental water were classed as temporary (intermittent) ecosystem types. These areas can be hot-spots for diversity if they support different suites of species in the dry and wet phases.
- As in previous years, Commonwealth environmental water contributed to all estuarine and river ecosystem types in the Basin during 2018–19 as environmental flows passed through to the Murray Mouth and Coorong.
- River red gum ecosystems dominated 44% of the area supported by Commonwealth environmental water in 2018–19. This is comprised of more than 33 000 ha of temporary river red gum swamp (45% of this ecosystem type in the Basin) and 19 000 ha of river red gum dominated floodplain (3% of this ecosystem type in the Basin). The largest extents of inundated red gum wetlands and floodplains occurred along the Murrumbidgee River, in the Barmah-Millewa forest and then further downstream along the Murray River into South Australia.
- Commonwealth environmental water also supported extensive areas of permanent wetlands (unknown vegetation) and permanent and temporary meadows and marshes (45 604 ha total) primarily in the Gwydir Wetlands and Macquarie Marshes.
- Sixteen of the 62 aquatic ecosystem types in the Basin (25%) did not receive any Commonwealth environmental water in 2018–19. These include permanently wet ecosystems (e.g. permanent springs, paperback swamps, peat bogs and fens, permanent lakes with aquatic macrophyte beds) and temporary saline wetlands and salt-pans that may not require additional water management. Many of these ecosystems also occur in unregulated catchments or above storages and may be outside the scope of Commonwealth environmental water delivery.

Key contribution to Basin Plan objectives

- 8.05 Protection and restoration of water-dependent ecosystems.
    - In 2018–19, Commonwealth environmental water supported 92 475 ha of lakes and wetlands, 26 568 ha of floodplains and 14 379 km of rivers in the Basin upstream of the Lower Lakes; an additional 103 335 ha of Lake Alexandrina and Lake Albert and their fringing wetlands and 23 802 ha of estuarine habitat in the Coorong and Murray Mouth.
    - 75% of the different water dependent ecosystem types in the Basin were represented in areas receiving Commonwealth environmental water.

Summary of multi-year Basin-scale evaluation outcomes 2014–19

Key Basin-scale evaluation findings

- A total of 68 ANAE ecosystem types are mapped in the Basin with 57 ecosystem types being supported by Commonwealth environmental water at least once during the past five years. Five of nine ecosystem types that did not receive Commonwealth environmental water in this period were not located on the Basin-wide Watering Strategy managed floodplain.
- During the five years of LTIM:
    - 28 291 ha of lakes were supported by Commonwealth environmental water.
    - 158 487 ha of palustrine wetlands from 24 ecosystem types were supported by Commonwealth environmental water; most commonly temporary river red gum swamp, temporary sedge/grass/forb marsh, permanent wetland, freshwater meadow and temporary lignum swamp.
    - 101 735 ha of ten different floodplain ecosystems were inundated by Commonwealth environmental water; dominated by river red gum forest riparian zone or floodplain but totalling only 2% of the floodplain area in the Basin.
    - 25 856 km of rivers and streams with flows containing Commonwealth environmental water, of which 91% were lowland rivers.
    - Commonwealth environmental water supported 103 335 ha of Lake Alexandrina and Lake Albert and their fringing wetlands and 23 802 ha of estuarine habitat in the Coorong and Murray Mouth in each of the five years.
- The broad pattern of watering across ecosystem types is similar across all the five years with 50% of ecosystem types supported to some extent by Commonwealth environmental water in all four years and 40% of ecosystem types not receiving any Commonwealth environmental water in any year over the same period. Gwydir wetlands, Macquarie Marshes, the Lowbidgee have received Commonwealth water in all years as has the Coorong, Lower Lakes and Murray mouth at the end of the system.
- The 2014–15 and 2016–17 water years did not include inundation of red gum swamps of the Barmah Millewa forest however these areas were supported by environmental water from NSW and Victoria.

Key contributions to Basin Plan objectives

- 8.05 Protection and restoration of water-dependent ecosystems is supported in principle for 288 513 ha of lakes, wetlands and floodplain and 25 856 km of waterways representing 57 ecosystem types (83 % of the ecosystem types currently mapped in the basin).

1 Preface

This report is a product of the Commonwealth Environmental Water Office (CEWO) Long-Term Intervention Monitoring (LTIM) project Basin-scale team. The evaluation is conducted at a whole-of-basin scale to assess the contribution of Commonwealth environmental water to Ecosystem Diversity in the Murray–Darling Basin. This report uses a draft revision to the 2017 Australian National Aquatic Ecosystem (ANAE) classification that includes improvements to the river line mapping and some additional riparian vegetation mapping in the northern part of the Basin. The 2017 ANAE update revised the ecosystem typology and substantially changed the number and extent of mapped aquatic ecosystems in areas that receive Commonwealth environmental water (Brooks 2017b). Results presented herein should not be compared to those in earlier Ecosystem Diversity reports from the first two years of the project that used the obsolete "interim" ANAE classification (Brooks 2016, 2017a). There may be some additional differences in this report when reporting on riverine ecosystems compared to the 2017–18 water year (Brooks 2019) due to recent improvements in the ANAE river line mapping.

The cumulative comparison across the full five-year duration of the LTIM project is achieved in this report by re-evaluating the contribution of Commonwealth environmental water delivered in each of the previous years of the LTIM project against the current ANAE classification. Further changes to the ANAE classification are expected as new and improved mapping and knowledge to classify ecosystem types becomes available. When this occurs, the cumulative evaluation of Ecosystem Diversity outcomes across years can be repeated against the revised classification to provide a consistent long-term perspective on the contribution of Commonwealth environmental water to Ecosystem Diversity.

Much of the introductory text and methods is repeated from previous LTIM Project Basin-scale Ecosystem Diversity evaluation reports to enable this report to stand alone for the convenience of the reader.

2 Introduction

Biological diversity describes the variety of living organisms and ecosystems on Earth. The concept of biodiversity is often understood in terms of numbers of species of microbes, plants and animals but increasingly the definition is expanded to include other forms of natural variation such as genetic diversity, ecosystem diversity and diversity of ecosystem function (Figure 1). Conservation biology is often focused on protecting and restoring ecosystems on the basis that this also preserves the communities and species within them in addition to critical ecosystem functions and services that ecosystems may provide to us (Cadotte *et al.* 2011; Pollock *et al.* 2017).

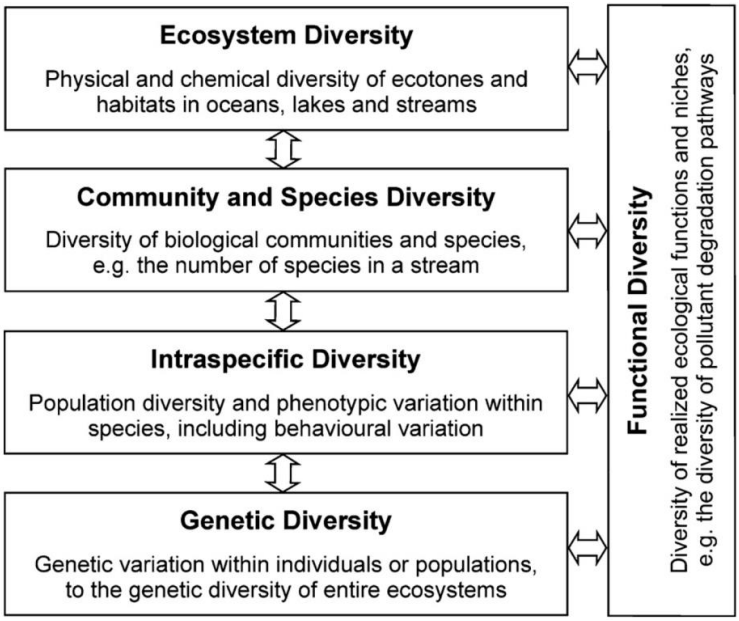


Figure 1. Hierarchical levels of biodiversity in aquatic ecosystems (Geist 2011)

There is increasing recognition globally that conserving biodiversity is critically important to maintain the functioning of natural ecosystems and for the sustainability of resources and ecosystem services on which human survival depends. Australia has joined 196 other countries as signatories to the United Nations Convention on Biological Diversity (1993, https://www.cbd.int) which provides guidance and impetus for conserving biodiversity and promoting sustainable development and sharing of genetic resources. The *Murray–Darling Basin Plan* (Commonwealth of Australia 2012) is consistent with these objectives as it balances the need for sustainable water resource use with the environmental imperative to protect and restore biodiversity that is dependent on those same water resources.

Managed delivery of Commonwealth environmental water to aquatic ecosystems in the Basin supports water-dependent flora and fauna and provides the physical and chemical conditions that determine how those ecosystems function (Junk *et al.* 1989; Poff 1997; Thorp *et al.* 2006). Over decadal time scales, environmental water has potential to influence physical landscape diversity through geomorphological processes (Figure 2). In practice, however, the frequency and volumes of Commonwealth environmental water that are delivered are constrained by storage volumes, infrastructure, and land use to volumes that augment natural hydrology without radically altering the hydrological regime. Large changes to the distribution and abundance of ecosystem types in the Basin are not expected within the duration of the LTIM project (5 years).

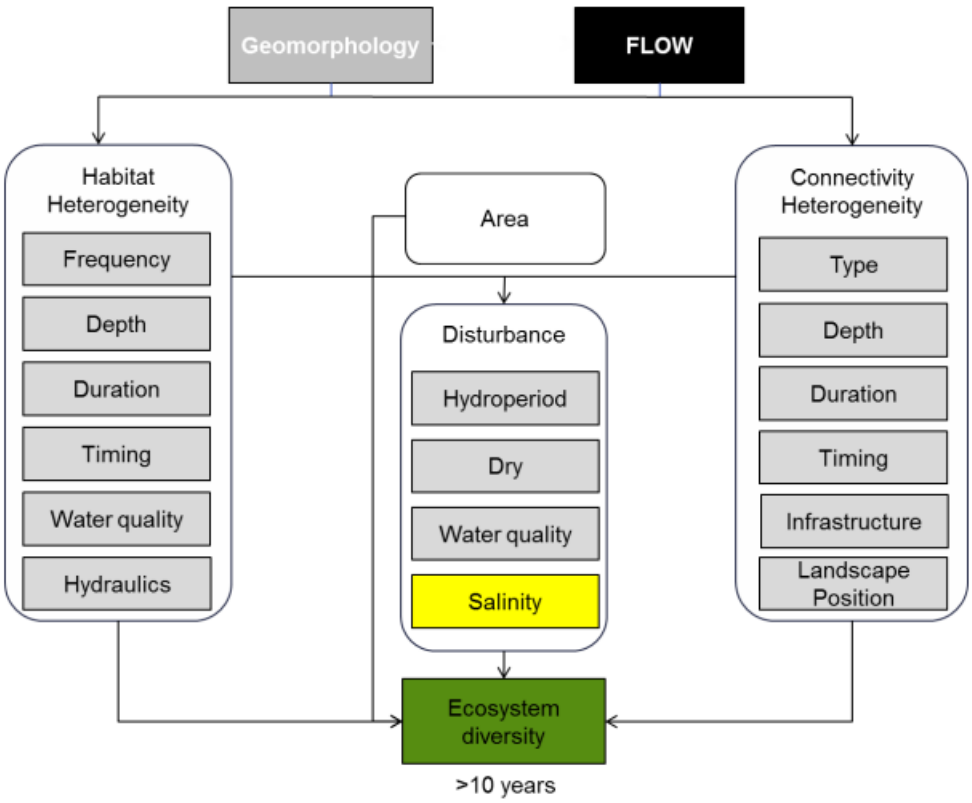


Figure 2. Cause-and-effect diagram depicting the influence of flow on landscape ecosystem diversity (MDFRC 2013).

This evaluation catalogues the different ecosystem types in the Basin that received Commonwealth environmental water during the 2018–19 water year and over the five-year duration of the project. Evaluating the extent to which water-dependent ecosystem types have been supported by Commonwealth environmental water contributes to assessing the contribution of Commonwealth environmental water to Basin Plan biodiversity objectives as outlined in the Commonwealth Environmental Water Outcomes Framework (CEWH 2013).

3 Method

Ecosystem types in the Basin are defined using the interim ANAE Classification Framework (Aquatic Ecosystems Task Group 2012). The framework provides a consistent ecosystem type classification that can inform cross-jurisdictional adaptive management of aquatic ecosystems (Figure 3).

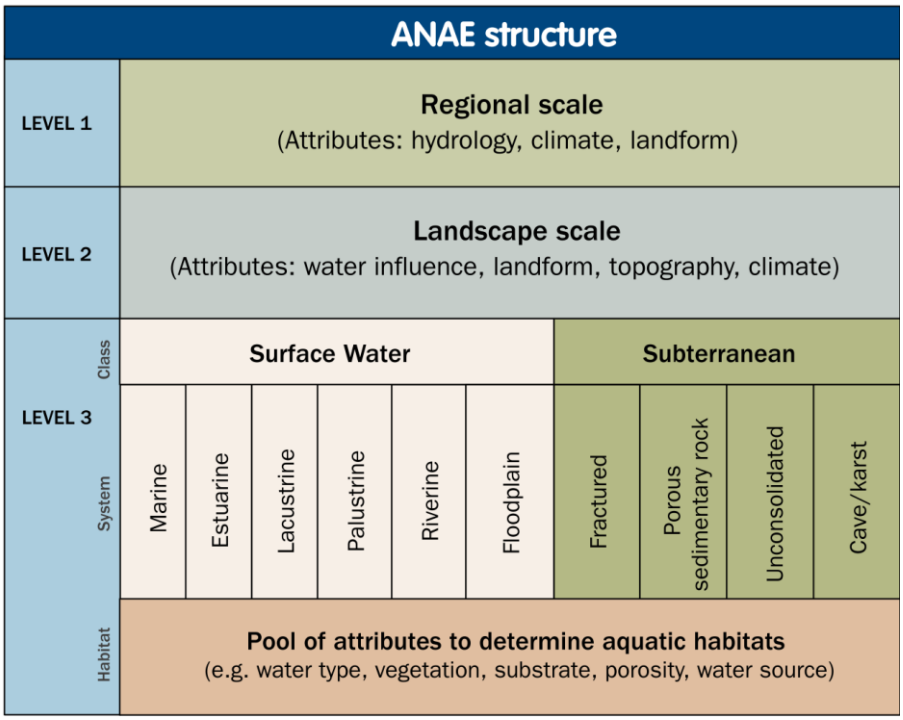


Figure 3. Structure and levels of the Interim Australian National Aquatic Ecosystem Classification Framework (Aquatic Ecosystems Task Group 2012).

The ANAE classification framework was applied to the best available jurisdictional mapping for Basin wetlands, floodplains and rivers by Brooks et al. (2014) to produce the interim Murray–Darling Basin Aquatic Ecosystem Classification data set. With subsequent updates (Brooks 2017b), this data set provides the LTIM project with relevant and contemporary ecosystem type definitions and mapping of their distribution throughout the Basin.

Overlaying the ANAE ecosystem map with the distribution of Commonwealth environmental water that was delivered in the Basin can then identify which ecosystem types received Commonwealth environmental water to answer the following short-term (one-year) and long-term (five-year) Basin-scale evaluation question:

1. What did Commonwealth environmental water contribute to ecosystem diversity?

3.1 Data

Data inputs to the evaluation of ecosystem diversity include:

The Murray–Darling Basin ANAE data set (Brooks *et al.* 2014; Brooks 2017b) (Figure 4). In 2017 the ANAE classification of the Basin underwent a substantial revision designed to improve the accuracy and currency of aquatic ecosystem mapping and to integrate all ecosystem types into a single aquatic ecosystem map for the Basin (Brooks 2017b). Additional changes were made in 2018 to further refine the classification of floodplains and to add new mapping for floodplains in Queensland to improve consistency of mapping across state borders (Figure 5).

As a result of all the changes to the ecosystem mapping, the Ecosystem Diversity evaluation results presented in this report are not comparable to those presented in the first two years of the LTIM project (Brooks 2016, 2017a). A cumulative comparison across the full duration of the LTIM project was made in 2018 and 2019 using the revised classification and is extended to include the 2018–19 water year below (Section 5).

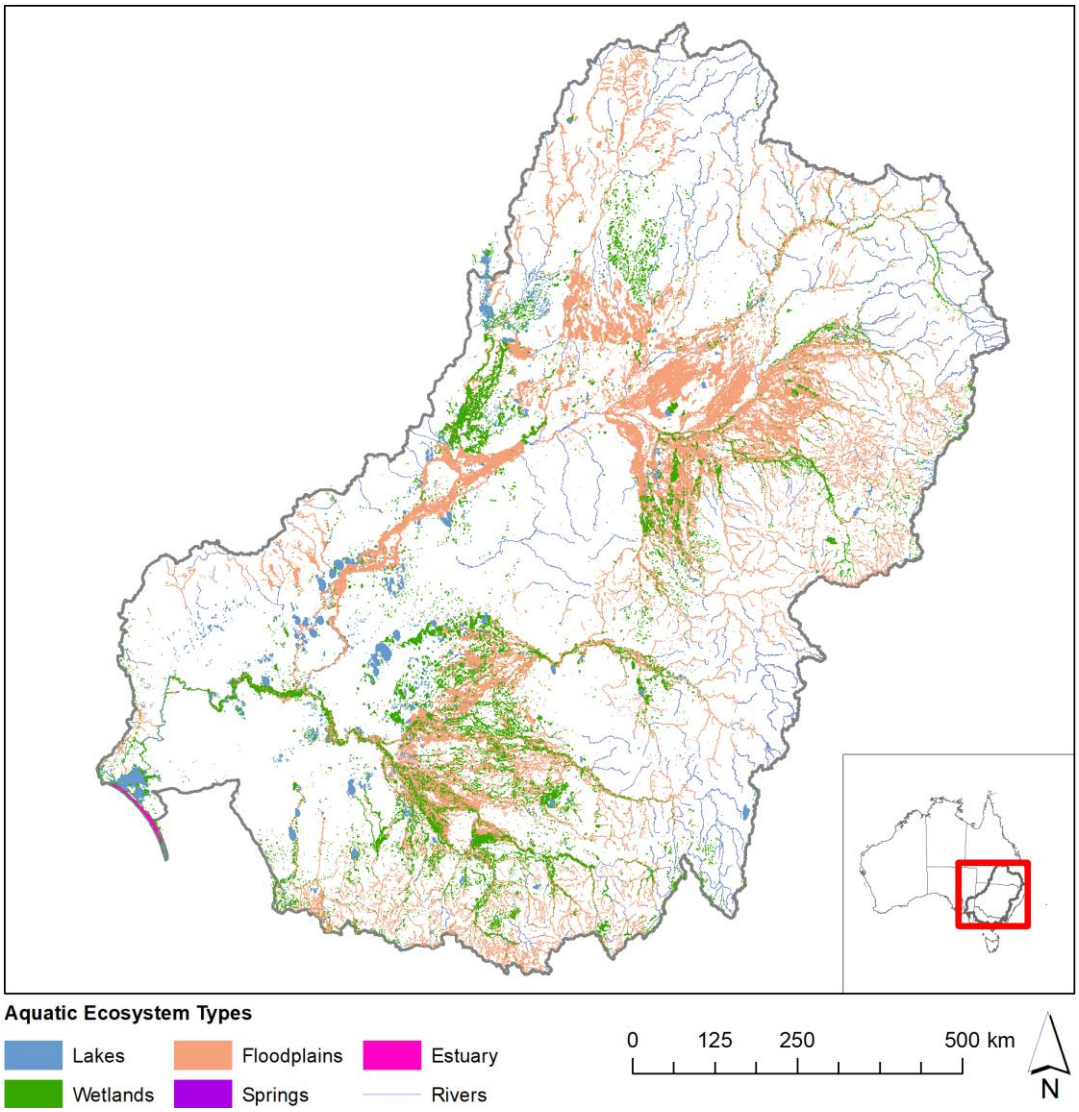


Figure 4. Aquatic ecosystems of the Murray–Darling Basin (ANAE 2018 mapping).

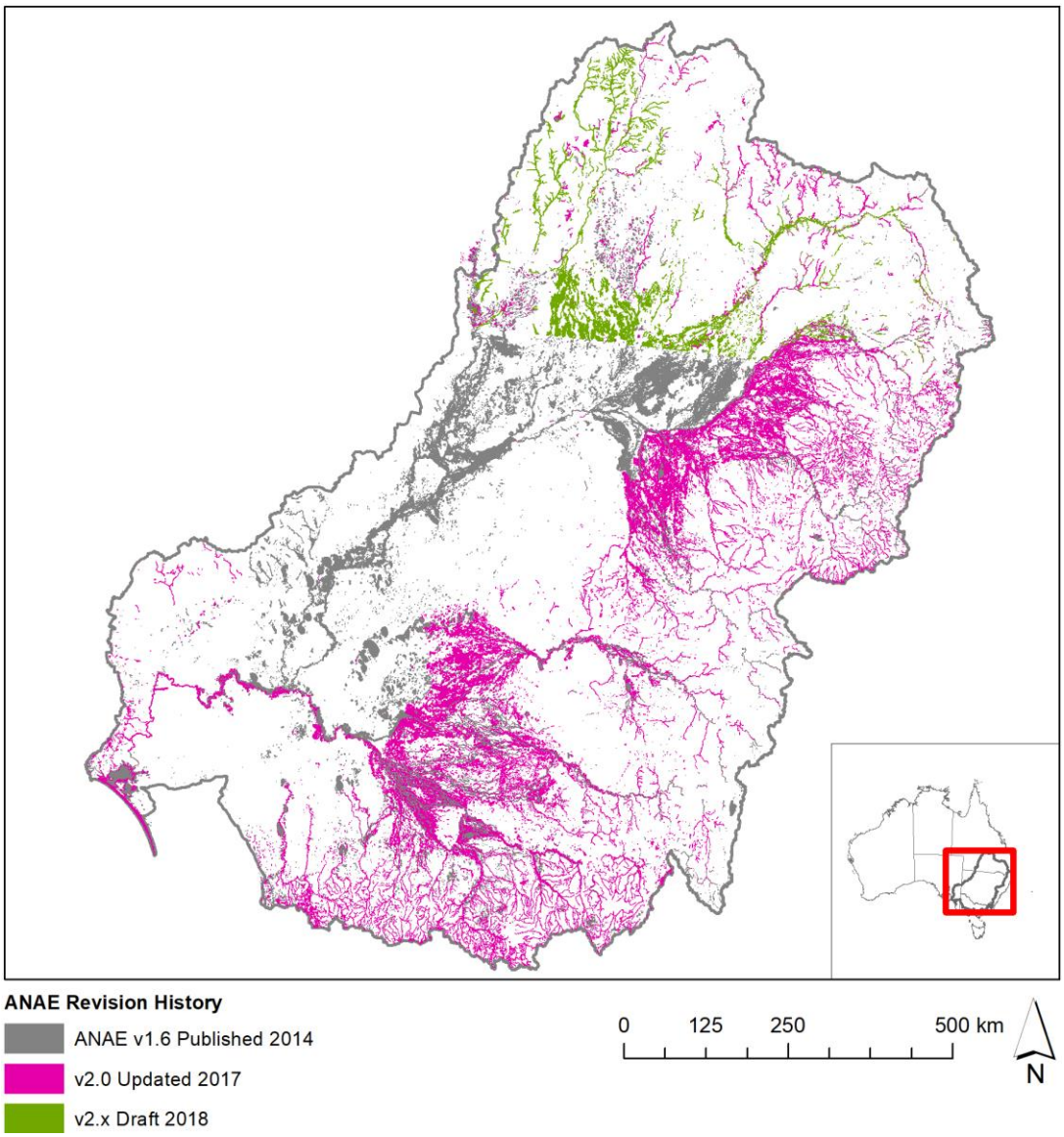


Figure 5. Revision history for the ANAE mapping in the Basin.

Commonwealth environmental water Inundation 2018–19 — a spatial representation of watering extent for Commonwealth environmental water delivered in the 2018–19 water year (Stewardson & Guarino 2020) (Figure 6). Commonwealth environmental water may include other environmental water (e.g. from State agencies) in a combined delivery and the extent mapped is the combined extent.

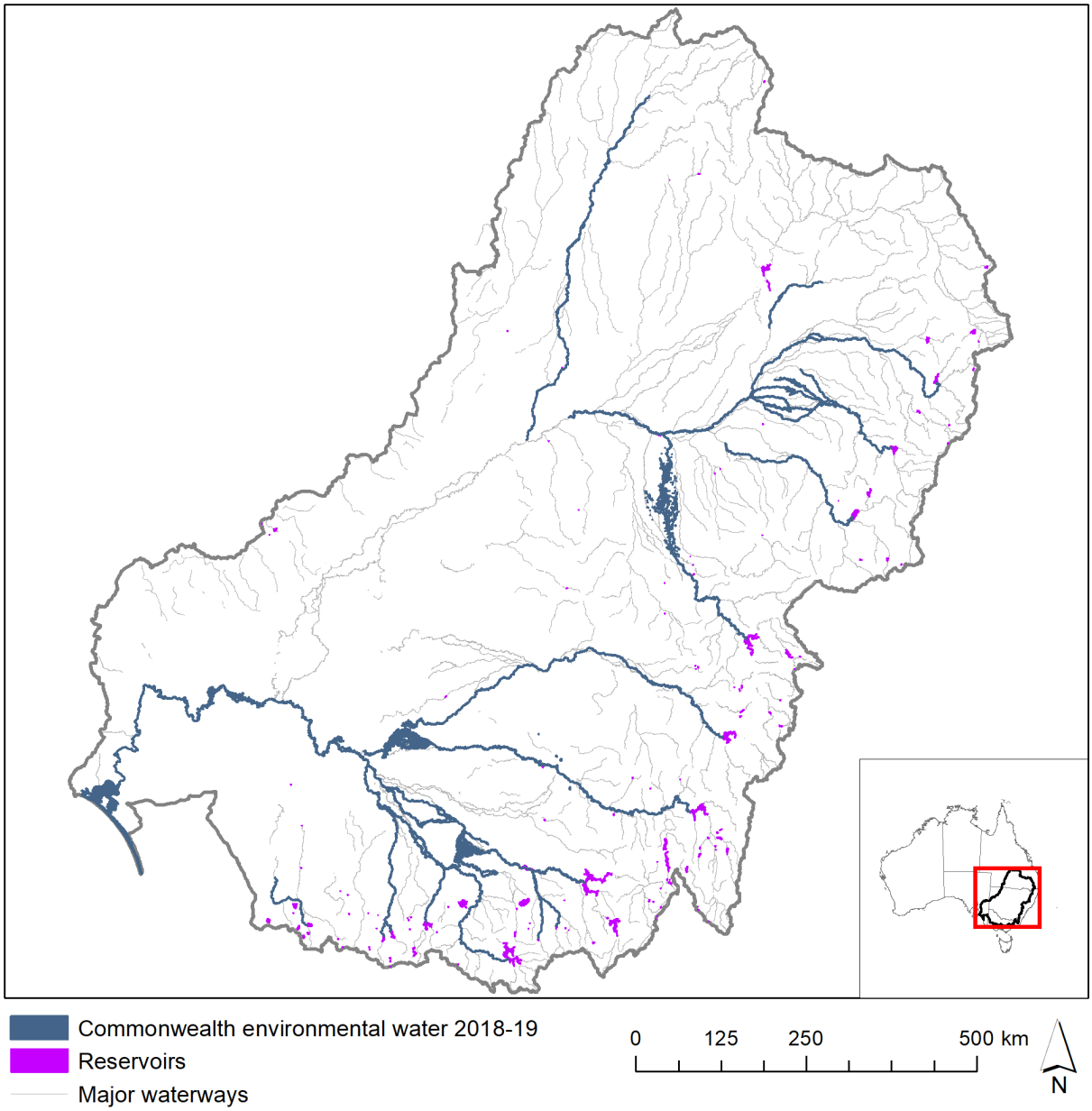


Figure 6. Commonwealth environmental water 2018–19.

LTIM valleys — a spatial layer developed for the LTIM project that subdivides the Basin into the major river valleys (Figure 7). These boundaries were derived from the Sustainable Rivers Audit (SRA) catchment boundaries with a modification to separate the Edward-Wakool Catchment from the Central Murray. The boundaries were adjusted slightly to improve the assignment of wetlands near valley boundaries to the watersheds in which managers and Commonwealth environmental water accounting allocate them. Mostly these changes affect the Central Murray area with a widening along the Murray River corridor to encompass fringing wetlands and the Gunbower and Barmah forests, and southern expansion of the Murrumbidgee valley to include Yanco Creek within the Murrumbidgee valley.

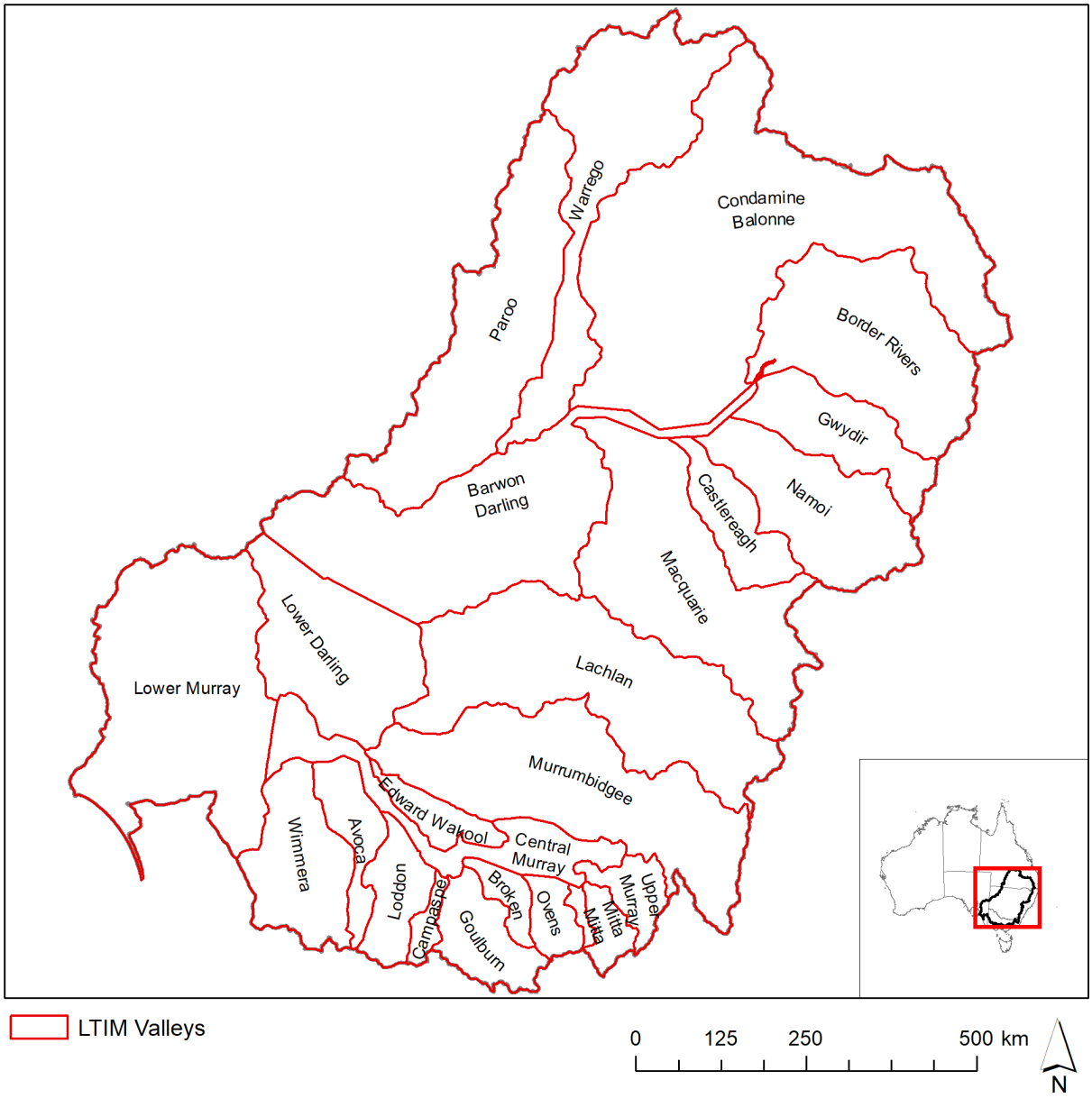


Figure 7. Valley boundaries within the Murray–Darling Basin used in this evaluation.

Geofabric v3 River Lines — River lines are mapped using the new Australian Geofabric v3 Network river lines (BOM 2019). This newly released beta product is still under development however the river line mapping is complete and provides more accurate and more consistent mapping for rivers than is available in the spatial maps compiled from jurisdiction data in the ANAE data set. The Basin ANAE waterway mapping compiles state data that varies in resolution from 1:25 000 to 1:250 000 (equivalent to 25m to

250m accuracy) The Geofabric v3 Network Streams were generated from a 1 second DEM (30m) resolution consistently for the entire Basin. The consistent resolution is important because river length measurement is highly dependent on the level of detail in the mapping with higher resolution mapping capturing more twists and turns in the river that increase the measured river length along the flow path between two points. The ANAE river typology and attributes were assigned to the nearest Geofabric v3 Network Streams in GIS for the purpose of this evaluation. It is expected that the ANAE classification of the Basin data set will formally adopt this new mapping in the near future.

3.2 Approach

As in previous years, two different approaches were used to quantify the area of different ecosystem types that received Commonwealth environmental water:

1. Area inundated by Commonwealth environmental water = the sum of only the inundated areas of each wetland type, excluding the areas of wetlands that were not inundated.
2. Area influenced by Commonwealth environmental water = the sum of the all wetland areas that received water even if the inundation mapping showed that only a portion of the wetland was inundated.

The area *inundated* by Commonwealth environmental water is a 'literal' definition that represents the minimum contribution of Commonwealth environmental water in the landscape. The area *influenced* by Commonwealth environmental water acknowledges that aquatic ecosystems are complex interconnected systems and delivering water to part of a wetland contributes benefits to the entire wetland system. For example, filling a wetland depression may raise local water tables and benefit fringing vegetation, or provide feeding habitat for waterbirds that roost elsewhere in the wetland vegetation that was not inundated.

For lakes and palustrine wetlands, the total area *influenced* by Commonwealth environmental water is the appropriate measure of the contribution of Commonwealth environmental water to ecosystem diversity because water entering one part of a wetland depression is likely to raise water levels or the local water table across the extent.

For floodplains, the area *inundated* by Commonwealth environmental water is used to measure the contribution of Commonwealth environmental water to ecosystem diversity. This more conservative measure is used for floodplains because floodplains occur as broad continuous expanses and the ecosystem response is generally limited to the wetted area. Depressional wetlands and channels that hold or convey water through floodplains are considered as separate entities.

GIS methodologies for calculating these areas are provided attached in Appendix 1.

The spatial representation of watering extent for Commonwealth environmental water delivered in 2018–19 includes all watering actions that resulted in inundation beyond the river channel (Stewardson & Guarino 2020). River reaches that received in-channel pulses, freshes and passing flows are also identified (Figure 6); however, the river channel inundation mapping is not of sufficient resolution to identify inundation of river banks and fringing habitats along the channels.

Commonwealth environmental water reaching the end of the system contributes to the maintenance of the Coorong, Lake Alexandrina, Lake Albert and the Murray Mouth ecosystems. Reliable inundation models for this area do not exist at this time so the extent of inundation is estimated from the mapped extent of the Coorong, Lake Alexandrina, Lake Albert and the Murray Mouth. This estimate is considered reliable because the lakes are managed for a relatively constant water level of 0.5 to 0.8m AHD by regulating outflows through the barrages. Below the barrages, water levels in the Murray Mouth and Coorong are maintained near sea level.

4 Basin-scale evaluation 2018–19

4.1 Key findings

In the 2018–19 water year:

- In 2018–19, there were approximately 92 475 ha of lakes and wetlands, 26 568 ha of floodplains and 14 379 km of rivers in the Basin upstream of the Lower Lakes that was supported by Commonwealth environmental water.
- Commonwealth environmental water supported another 103 335 ha of Lake Alexandrina and Lake Albert and their fringing wetlands and 23 802 ha of estuarine habitat in the Coorong and Murray Mouth.
- Commonwealth environmental water supported 58% of the different wetland ecosystem types and 83% of floodplain ecosystem types in the Basin in 2018–19.
- Many permanent wetlands and lakes were supported by the delivery of Commonwealth environmental water (30 118 ha excluding Lake Alexandrina and Albert or 115 374 ha when the lower lakes are included).
- Approximately 58% of the wetland areas (59 000 ha) and all floodplains (26 568 ha) that received Commonwealth environmental water were classed as temporary (intermittent) ecosystem types. These areas can be hot-spots for diversity if they support different suites of species in the dry and wet phases.
- As in previous years, Commonwealth environmental water contributed to all estuarine and river ecosystem types in the Basin during 2018–19 as environmental flows passed through to the Murray Mouth and Coorong.
- River red gum ecosystems dominated 44% of the area supported by Commonwealth environmental water in 2018–19. This is comprised of more than 33 000 ha of temporary river red gum swamp (45% of this ecosystem type in the Basin) and 19 000 ha of river red gum dominated floodplain (3% of this ecosystem type in the Basin). The largest extents of inundated red gum wetlands and floodplains occurred along the Murrumbidgee River, in the Barmah-Millewa forest and then further downstream along the Murray River into South Australia.
- Commonwealth environmental water also supported extensive areas of permanent wetlands (unknown vegetation) and permanent and temporary meadows and marshes (45 604 ha total) primarily in the Gwydir Wetlands and Macquarie Marshes.
- Sixteen of the 62 aquatic ecosystem types in the Basin (25%) did not receive any Commonwealth environmental water in 2018–19. These include permanently wet ecosystems (e.g. permanent springs, paperback swamps, peat bogs and fens, permanent lakes with aquatic macrophyte beds) and temporary saline wetlands and salt-pans that may not require additional water management. Many of these ecosystems also occur in unregulated catchments or above storages and may be outside the scope of Commonwealth environmental water delivery.

4.2 Contribution of Commonwealth environmental water towards Ecosystem Diversity in 2018–19

LTIM inundation mapping (Figure 6) collapses the maximum wetted extent of all watering actions during 2018–19 that included Commonwealth environmental water. Therefore this evaluation is not able to consider the details of individual watering events and is ignorant of the specific timing and duration of Commonwealth environmental water in different areas of the landscape. The area inundated in each valley, and the length of river channels influenced by Commonwealth environmental water is presented in Table 1.

Watering actions targeting floodplains and floodplain wetlands occurred in 6 of the 25 valleys of the Basin (Table 1) with the small amount of floodplain inundation recorded in the Edward–Wakool being the northern extension of inundation of the Barmah-Millewa Forest in the Central Murray valley. Commonwealth environmental water was used more extensively for in-channel delivery in 17 of the 25 valleys (refer Stewardson & Guarino 2020 for details of specific watering actions).

Table 1. Major categories of aquatic ecosystems in each LTIM catchment inundated or influenced by Commonwealth environmental water (Cew) in 2018–19.

Catchment name	LTIM Selected Area	Lakes and wetland area influenced by Cew (ha)	Floodplain inundated by Cew (ha)	Length of waterways containing Cew (km)
Avoca		-	-	-
Barwon Darling		-	-	833
Border Rivers		-	-	819
Broken		-	-	172
Campaspe		-	-	117
Castlereagh		-	-	-
Central Murray		30 606	4135	2196
Condamine Balonne		-	-	-
Edward–Wakool	Edward–Wakool river system	3	33	970
Goulburn	Goulburn River	-	-	395
Gwydir	Gwydir river system	7096	3238	1132
Kiewa		-	-	-
Lachlan	Lachlan river system	4054	1183	1363
Loddon		-	-	365
Lower Darling		-	-	-
Lower Murray*	Lower Murray River*	7270	766	1123
Lower Murray (Coorong Lakes Alexandrina and Albert and Murray Mouth)		Fresh: 103 335 Estuarine: 23 802	22	-
Macquarie		32237	3208	1054
Mitta Mitta		-	-	-
Murrumbidgee	Murrumbidgee river system	11 209	13 983	1626
Namoi		-	-	506
Ovens		-	-	320
Paroo		-	-	-
Upper Murray		-	-	-
Warrego	Junction of the Warrego and Darling rivers	-	-	1208
Wimmera		-	-	180
Total		**219 612**	**26 568**	**14 379**

*** excludes the Coorong, Lakes Alexandrina and Albert and the Murray Mouth.**

Commonwealth environmental watering actions contributed to the inundation of 92 475 ha of lakes and wetlands, 26 568 ha of floodplains and 14 379 km of rivers in the Basin upstream of the Lower Lakes. This includes a wide range of ecosystem types within the Basin that included 58% of the different wetland types (Table 2) and 83% of the different floodplain ecosystem types (Table 3), and all (100%) of the river channel (Table 4) and estuarine ecosystem types in the Coorong and Murray Mouth (Table 5).

The contribution of Commonwealth environmental water to Ecosystem Diversity in the Coorong and Lakes Alexandrina and Albert and the Murray Mouth are presented separately in (Table 5) for two reasons: to prevent the large areas of Lakes Alexandrina and Albert (82 500 ha) from masking finer scale patterns of inundation of lakes in the rest of the Lower Murray valley; and the constant managed water levels of the Lakes inundating the same ecosystems each year may hinder evaluation of more variable inter-annual differences in the use of Commonwealth environmental water in other areas of the Basin.

A more detailed breakdown by valley is provided in Appendix 3 (wetlands and estuarine ecosystems), Appendix 4 (floodplains) and Appendix 5 (river channels).

Table 2. Contribution of Commonwealth environmental water to ecosystem diversity of lakes and wetlands at the basin-scale. Ecosystem types are sorted by the area influenced by Commonwealth environmental water.

Australian National Aquatic Ecosystem (ANAE) wetland type	Total ex Coorong and Lower Lakes	Inundated*		Influenced*	
	area (ha)	Area (ha)	% of total	Area (ha)	% of total
Pt1.1.2: Temporary river red gum swamp	74 721	9359	12.5	33 432	44.7
Pp4.2: Permanent wetland	77 314	8558	11.1	21 885	28.3
Pt2.2.2: Temporary sedge/grass/forb marsh	139 937	5724	4.1	15 476	11.1
Pp2.1.2: Permanent tall emergent marsh	8005	649	8.1	4156	51.9
Pt2.1.2: Temporary tall emergent marsh	70 837	2747	3.9	4030	5.7
Lp1.1: Permanent lake	127 388	2914	2.3	3389	2.7
Pt4.1: Floodplain or riparian wetland	11 214	83	0.7	2082	18.6
Pt1.8.2: Temporary shrub swamp	234 412	776	0.3	1507	0.6
Lt1.1: Temporary lake	459 359	157	<0.1	1291	0.3
Pt3.1.2: Clay pan	130 927	384	0.3	1143	0.9
Pt2.3.2: Freshwater meadow	125 165	323	0.3	932	0.7
Pt1: Temporary swamp	3767	507	13.5	675	17.9
Psp4: Permanent saline wetland	2093	534	25.5	639	30.5
Pt4.2: Temporary wetland	22 888	313	1.4	586	2.6
Pt1.6.2: Temporary woodland swamp	216 625	370	0.2	579	0.3
Pst1.1: Temporary saline swamp	7157	54	0.8	316	4.4
Pt1.2.2: Temporary black box swamp	60 272	94	0.2	294	0.5
Pp2.3.2: Permanent grass marsh	1507	10	0.7	25	1.7
Pp2.2.2: Permanent sedge/grass/forb marsh	3590	17	0.5	17	0.5
Pst2.2: Temporary salt marsh	40 335	3	<0.1	8	<0.1
Pt1.7.2: Temporary lignum swamp	49 962	0	0.0	8	<0.1
Pp2.4.2: Permanent forb marsh	740	2	0.3	7	0.9
Lp1.2: Permanent lake with aquatic bed	2067	0	0.0	0	0.0
Lsp1.1: Permanent saline lake	9419	0	0.0	0	0.0
Lsp1.2: Permanent saline lake with aquatic bed	181	0	0.0	0	0.0
Lst1.1: Temporary saline lake	27 897	0	0.0	0	0.0
Lst1.2: Temporary saline lake with aquatic bed	2238	0	0.0	0	0.0
Lt1.2: Temporary lake with aquatic bed	9052	0	0.0	0	0.0
Pp1.1.2: Permanent paperbark swamp	1	0	0.0	0	0.0
Pp3: Peat bog or fen marsh	4425	0	0.0	0	0.0
Pps5: Permanent spring	130	0	0.0	0	0.0
Psp1.1: Saline paperbark swamp	31	0	0.0	0	0.0
Psp2.1: Permanent salt marsh	246	0	0.0	0	0.0
Pst3.2: Salt pan or salt flat	3249	0	0.0	0	0.0
Pst4: Temporary saline wetland	6180	0	0.0	0	0.0
Pt1.3.2: Temporary coolibah swamp	8271	0	0.0	0	0.0
Pt1.5.2: Temporary paperbark swamp	412	0	0.0	0	0.0
Pu1: Unspecified wetland	1763	0	0.0	0	0.0

* Area inundated/influenced by Commonwealth environmental water: see Section 3.2 for definitions.

Table 3. Contribution of Commonwealth environmental water to ecosystem diversity of floodplains at the Basin-scale, sorted by the area inundated.

Australian National Aquatic Ecosystem (ANAE) floodplain type	Total area (ha)	Inundated* area (ha)	% of total
F1.2: River red gum forest riparian zone or floodplain	639 022	19 092	3.0
F1.10: Coolibah woodland and forest riparian zone or floodplain	1 215 726	2300	0.2
F2.2: Lignum shrubland riparian zone or floodplain	143 880	1538	1.1
F1.4: River red gum woodland riparian zone or floodplain	325 221	1247	0.4
F1.11: River cooba woodland riparian zone or floodplain	11 541	1137	9.9
F2.4: Shrubland riparian zone or floodplain	408 019	485	0.1
F1.8: Black box woodland riparian zone or floodplain	779 639	432	<0.1
F1.6: Black box forest riparian zone or floodplain	131 442	256	0.2
F1.12: Woodland riparian zone or floodplain	318 645	57	<0.1
F4: Unspecified riparian zone or floodplain	201 086	3	<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

* Area inundated/influenced by Commonwealth environmental water: see Section 3.2 for definitions.

Table 4. Contribution of Commonwealth environmental water to ecosystem diversity within river channels of the Basin sorted by the length of channel inundated by Commonwealth environmental water.

Australian National Aquatic Ecosystem (ANAE) waterway type	Total	Inundated*	
	Length (km)	Length (km)	% of total
Rp1.4: Permanent lowland stream	40 133	10 143	25.3
Rt1.4: Temporary lowland stream	198 551	3179	1.6
Rp1.2: Permanent transitional zone stream	15 962	484	3.0
Rp1.1: Permanent high energy upland stream	39 421	453	1.1
Rp1.3: Permanent low energy upland stream	633	266	42.0
Rp1: Permanent stream	360	167	46.4
Rt1.2: Temporary transitional zone stream	91 873	84	<0.1
Rt1: Temporary stream	156	79	50.6
Rt1.3: Temporary low energy upland stream	2783	49	1.8
Rt1.1: Temporary high energy upland stream	96 565	31	<0.1
Rw1: Permanent river (landform unknown)	271	14	5.2
Ru1: Unspecified river (landform unknown)	293	9	3.1

* Area inundated/influenced by Commonwealth environmental water: see Section 3.2 for definitions.

Table 5. Ecosystem types in the Coorong Lower Lakes and Murray Mouth that are influenced or inundated (Floodplains only) by Commonwealth environmental water. Ecosystem types are sorted by the area inundated/influenced by Commonwealth environmental water.

Australian National Aquatic Ecosystem (ANAE) wetland type	Total	Inundated*	
	area (ha)	Area (ha)	% of total
Lp1.1: Permanent lake	82 303	82 303	100.0
Ewd1.3.2: Coastal lagoon	18 912	18 912	100.0
Pt3.1.2: Clay pan	7798	7783	99.8
Pt2.1.2: Temporary tall emergent marsh	5502	5502	100.0
Pt2.2.2: Temporary sedge/grass/forb marsh	2580	2580	100.0
Lsp1.1: Permanent saline lake	2242	2242	100.0
Etd1.3.3: Tide dominated estuary	2234	2234	100.0
Ewd1.2.4: Intertidal mudflat or sand bar	918	918	100.0
Pst1.1: Temporary saline swamp	786	786	100.0
Etd1.2.2: Tide dominated mudflats and sandbar	628	628	100.0
Psp4: Permanent saline wetland	616	616	100.0
Ewd1.2.3: Intertidal saltmarsh	478	478	100.0
Pst4: Temporary saline wetland	451	451	100.0
Pst2.2: Temporary salt marsh	371	371	100.0
Etd1.2.1: Tide dominated saltmarsh	321	321	100.0
Ewd1.2.5: Intertidal rocky shoreline	284	284	100.0
Pt4.1: Floodplain or riparian wetland	275	275	100.0
Psp1.1: Saline paperbark swamp	132	132	100.0
Pst3.2: Salt pan or salt flat	121	121	100.0
Pp4.2: Permanent wetland	92	92	100.0
Pt4.2: Temporary wetland	28	28	100.0
Pt2.3.2: Freshwater meadow	27	27	100.0
F2.4: Shrubland riparian zone or floodplain	595	20	3.4
Etd1.2.3: Tide dominated forest	19	19	100.0
Lt1.1: Temporary lake	16	16	100.0
Etd1.1.1: Tide dominated rocky shoreline	7	7	100.0
Pt1.8.2: Temporary shrub swamp	7	7	100.0
Pt1.7.2: Temporary lignum swamp	3	3	100.0
Psp2.1: Permanent salt marsh	3	3	100.0
F1.12: Woodland riparian zone or floodplain	40	2	5.0
F2.2: Lignum shrubland riparian zone or floodplain	6	1	16.7

* Area inundated/influenced by Commonwealth environmental water: see Section 3.2 for definitions.

5 Cumulative Basin-scale evaluation 2014–19

5.1 Key findings

- A total of 68 ANAE ecosystem types are mapped in the Basin with 57 ecosystem types being supported by Commonwealth environmental water at least once during the past five years. Five of nine ecosystem types that did not receive Commonwealth environmental water in this period were not located on the Basin-wide Watering Strategy managed floodplain.
- During the five years of LTIM:
    - 28 291 ha of lakes were supported by Commonwealth environmental water.
    - 158 487 ha of palustrine wetlands from 24 ecosystem types were supported by Commonwealth environmental water; most commonly temporary river red gum swamp, temporary sedge/grass/forb marsh, permanent wetland, freshwater meadow and temporary lignum swamp.
    - 101 735 ha of ten different floodplain ecosystems were inundated by Commonwealth environmental water; dominated by river red gum forest riparian zone or floodplain but totalling only 2% of the floodplain area in the Basin.
    - 25 856 km of rivers and streams with flows containing Commonwealth environmental water, of which 91% were lowland rivers.
- The broad pattern of watering across ecosystem types is similar across all the five years with 50% of ecosystem types supported to some extent by Commonwealth environmental water in all four years and 40% of ecosystem types not receiving any Commonwealth environmental water in any year over the same period. Gwydir wetlands, Macquarie Marshes, the Lowbidgee have received Commonwealth water in all years as has the Coorong, Lower Lakes and Murray mouth at the end of the system.
- The 2014–15 and 2016–17 water years did not include inundation of red gum swamps of the Barmah Millewa forest however these areas were supported by environmental water from NSW and Victoria.

5.2 Contribution of Commonwealth environmental water towards Ecosystem Diversity 2014–2019

This cumulative evaluation qualitatively compares the distribution of Commonwealth environmental water among aquatic ecosystem types in the Basin over the duration of the LTIM project from July 2014 to June 2019. The inter-annual comparisons of watering extents presented should be viewed as indicative only as there are some differences in the way inundation extents were mapped in each year. The 2014–15 inundation likely over-estimates the extent of Commonwealth environmental water in the Macquarie Marshes, Gwydir wetlands and Lower Murrumbidgee (Lowbidgee) due to poor discrimination of Commonwealth environmental water from other water in satellite imagery. Improvements to the hydrological data assembly process increased the accuracy and confidence in the inundation mapping from 2015–16 onwards.

The Basin Plan (Commonwealth of Australia 2012) Section 8.05 (3b) states "*An objective is to protect and restore biodiversity that is dependent on Basin water resources by ensuring that representative populations and communities of native biota are protected and, if necessary, restored.*"

This objective can be extended to ecosystem types to evaluate whether ecosystem types supported by Commonwealth environmental water are representative of those types found within the Basin. It is important to consider that Commonwealth environmental water is only one instrument among many working towards achieving Basin Plan objectives. There are many rain-fed aquatic ecosystems that may be out of scope for water management as they are located too far from water sources and/or lack channels or

infrastructure to support water management. The current best estimate of the area of the Basin that is in scope for environmental water management is the Basin-wide watering strategy managed floodplain (MDBA 2014, 2019). The managed floodplain (Figure 8) maps the area where floodplain vegetation can be influenced with the 2075 GL of environmental water under the Basin Plan (MDBA 2019). It includes actively managed areas that can receive environmental water via large headwater storages or via The Murray–Darling Basin Authority's The Living Murray 'environmental works' sites on the River Murray floodplain, and passively managed areas that receive environmental water via flow rules in water resource plans or via natural events.

This evaluation therefore considers whether the ecosystem diversity supported by Commonwealth environmental water is representative of the whole Basin, or representative of the subset of ecosystems that intersect the Basin-wide watering strategy managed floodplain (Figure 8).

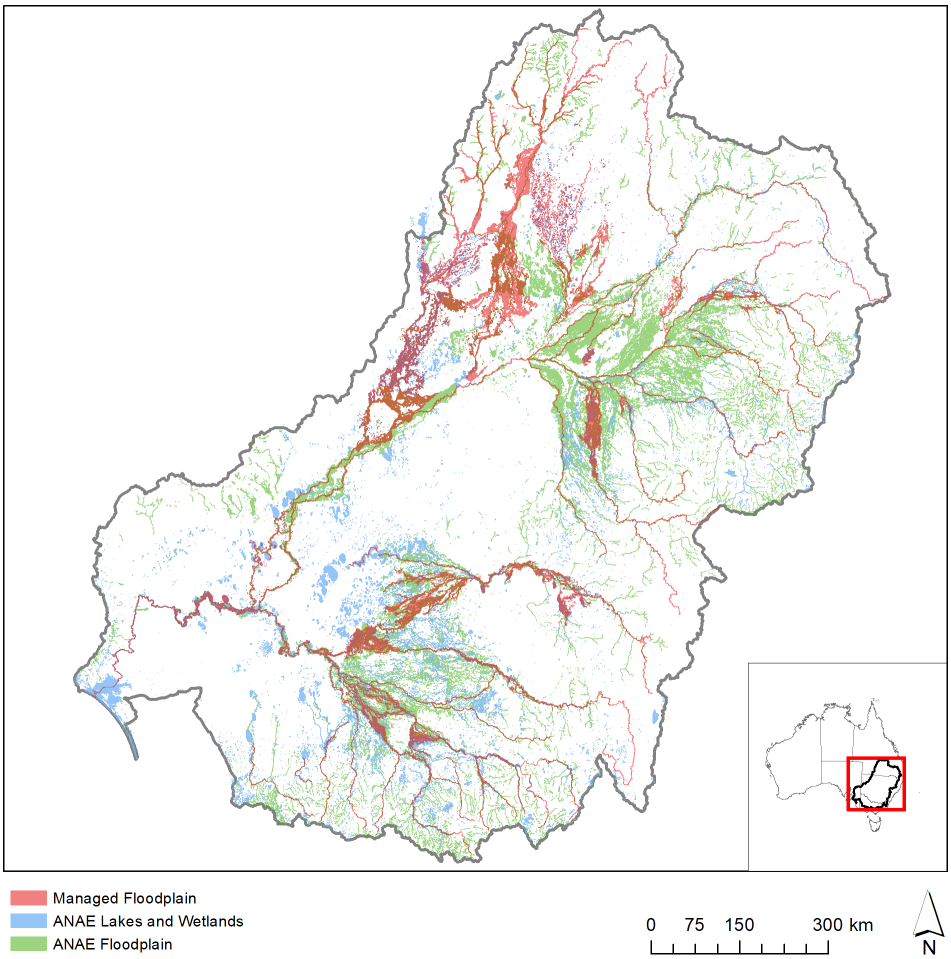


Figure 8. Spatial extent of the Basin-wide watering strategy managed floodplain compared to the extent of ANAE wetland and floodplain ecosystem types.

5.2.1 Lake Ecosystems

Thirty-one percent of the combined area of Basin lakes occurs on the managed floodplain where seven of the eight ANAE lake ecosystem types are represented (Figure 9). The managed floodplain contains a higher proportion of permanent lakes (34% vs 20% in the Basin) perhaps because floodplain lakes are more frequently topped up from rivers via channel and floodplain connections. Commonwealth environmental water was consistently delivered to only two fresh water lake types (temporary and permanent lakes) (Table 6) which comprise 92% of the lake area in the Basin and on the managed floodplain (Figure 9). The distribution of Commonwealth environmental water favoured the maintenance of permanent lakes (relative to their representation in the landscape) over temporary lakes in four out of the five LTIM years (Figure 10). This is consistent with the hydrological needs of these systems. Four of the five lake types that did not receive Commonwealth environmental water were ecosystem types that are classified by the presence of submerged aquatic macrophytes covering large extents of the lake bed ("aquatic bed" in the ANAE type name). Submerged aquatic vegetation may indicate a naturally dependable water supply that perhaps has not been in need of additional support from environmental water to date. Further investigation of individual lakes is required to determine whether Commonwealth environmental water should prioritise these systems higher, or whether their water needs are being met by natural rainfall and groundwater.

An increase in lake inundation is seen in 2017–18 when weir pool manipulations of Loch 8 and Loch 9 on the Murray River pushed Commonwealth environmental water into Lake Victoria (10738 ha).

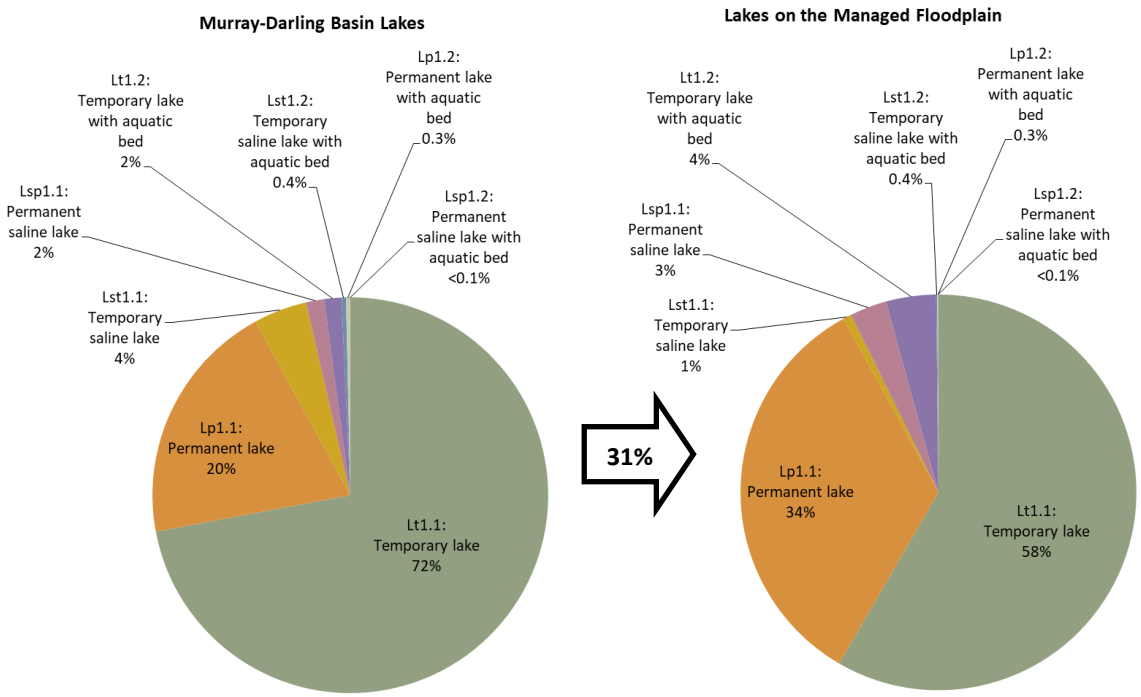


Figure 9. Comparison of the proportional representation of ANAE lake ecosystem types in the Basin to the subset (31%) that occurs on the managed floodplain that is potentially in scope for Commonwealth environmental water management.

Table 6. Comparison of the contribution of Commonwealth environmental water to ecosystem diversity of lakes from 2014–19. Ecosystem types that have received Commonwealth environmental water in every year of the LTIM project are shaded blue. Ecosystem types that have not received Commonwealth environmental water during the period of LTIM are shaded red.

Australian National Aquatic Ecosystem (ANAE) wetland type	Total area in Basin (ha)	Area on Managed Floodplain (ha)	Area receiving Commonwealth environmental water (ha)				
			Y1 '14-'15	Y2 '15-'16	Y3 '16-'17	Y4 '17-'18	Y5 '18-'19
Lt1.1: Temporary lake	459 359	116 742	2593	4505	2485	3730	1291
Lp1.1: Permanent lake	127 388	67 334	1440	4755	6840	15292	3389
Lst1.1: Temporary saline lake	27 897	1349	0	0	0	307	0
Lsp1.1: Permanent saline lake	9419	6039	0	0	0	0	0
Lt1.2: Temporary lake with aquatic bed	9052	8177	0	0	0	0	0
Lst1.2: Temporary saline lake with aquatic bed	2238	180	0	0	0	0	0
Lp1.2: Permanent lake with aquatic bed	2067	196	0	0	0	0	0
Lsp1.2: Permanent saline lake with aquatic bed	181	0	0	0	0	0	0
TOTAL	**637 601**	**200 017**	**4 033**	**9 260**	**9 325**	**19 329**	**4 680**

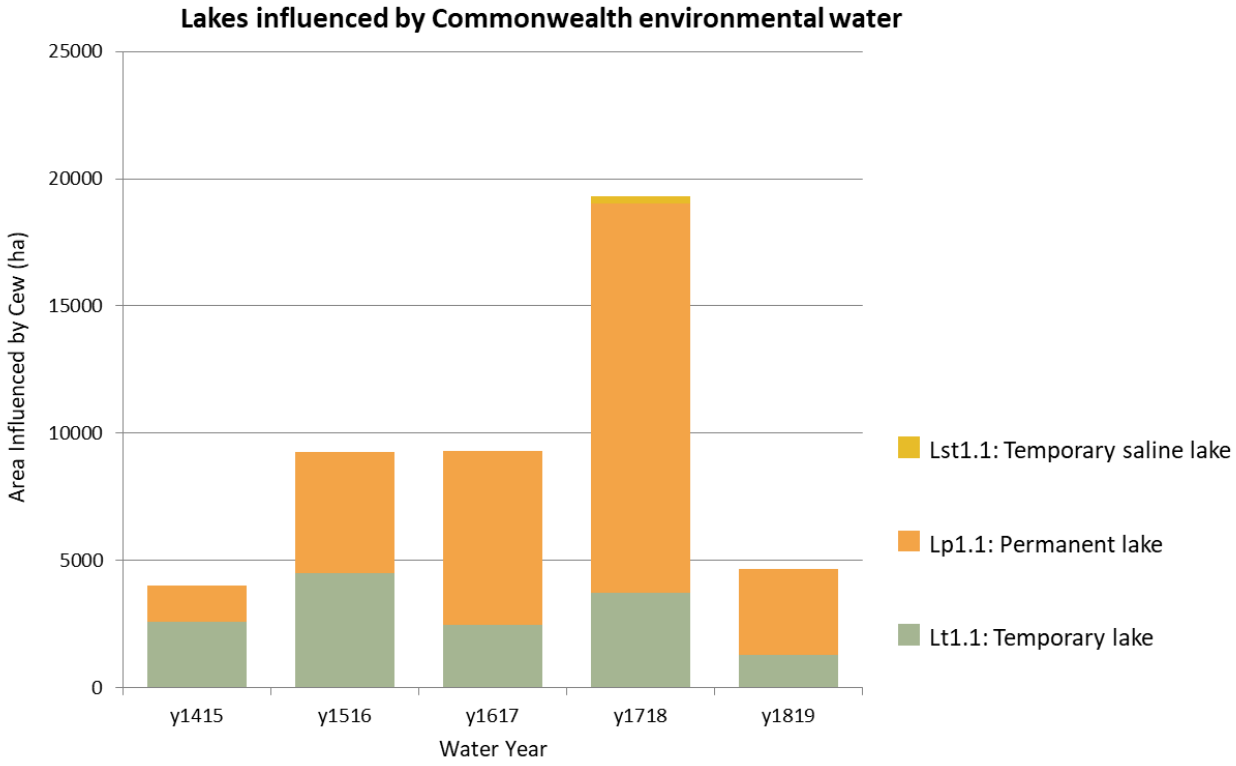


Figure 10. The extent of lake ecosystem types supported by Commonwealth environmental water in each year of the LTIM project.

Over the five years of LTIM Commonwealth environmental water supported 28 291 ha of lake ecosystems. Only two small unnamed lakes received Commonwealth environmental water in all 5 years totalling just 17 ha (Table 7). Seventy percent of the lake ecosystem that received Commonwealth environmental water did so once (Table 7), with the majority in 2017–18 as a result of the northern connectivity flows and topping up of Lake Victoria. The relatively small area of lake ecosystem supported by Commonwealth environmental water annually may reflects a combination of lower water requirements (lakes are typically deeper than wetlands and hold water for longer) and above-average rainfall in 2016–17 (Stewardson & Guarino 2020) that helped maintain lake levels in the Basin naturally. Additionally, a number of lakes in internationally significant Ramsar sites (Hattah Lakes, Kerang Lakes and Barmah Lake) were supported by Victoria and The Living Murray environmental water reserves in years when Commonwealth environmental water was not delivered to these sites (Hale *et al.* 2020).

Table 7. Total area of lakes influenced by Commonwealth environmental water at differing frequencies during the five years of the LTIM project (2014–19).

Australian National Aquatic Ecosystem (ANAE) wetland type	1in5	2in5	3in5	4in5	5in5	Total (All years)
Lp1.1: Permanent lake	17 801	155	2059	2000	2	**22 017**
Lt1.1: Temporary lake	1533	1991	1853	287	15	**5679**
Lsp1.1: Permanent saline lake	214	74	0	0	0	**288**
Lst1.1: Temporary saline lake	307	0	0	0	0	**307**
Lt1.2: Temporary lake with aquatic bed	0	0	0	0	0	**0**
Lst1.2: Temporary saline lake with aquatic bed	0	0	0	0	0	**0**
Lp1.2: Permanent lake with aquatic bed	0	0	0	0	0	**0**
Lsp1.2: Permanent saline lake with aquatic bed	0	0	0	0	0	**0**
TOTAL	**19 855**	**2220**	**3912**	**2287**	**17**	**28 291**

5.2.2 Wetland Ecosystems (Palustrine)

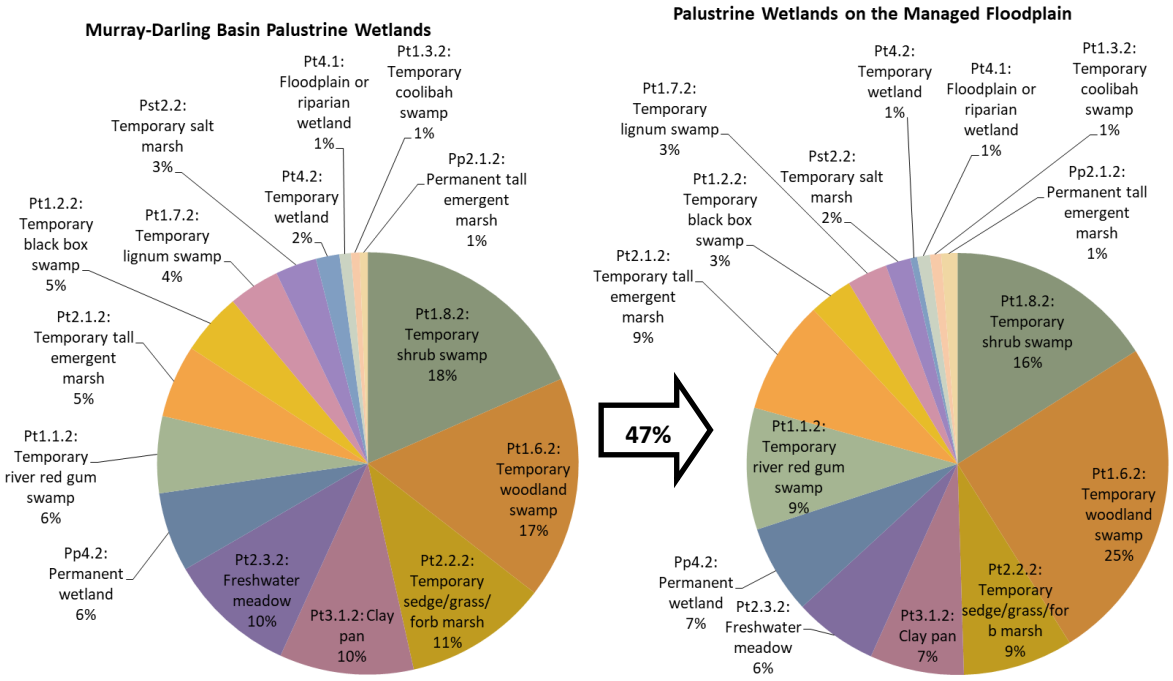


Figure 11. Comparison of the proportional representation of ANAE wetland (palustrine) ecosystem types in the Basin to the subset (47%) that occurs on the managed floodplain that is potentially in scope for Commonwealth environmental water management. For clarity only the 15 most common wetland types are represented that together occupy 99% of the Basin wetland area. There are an additional 15 rare wetland types not shown that make up the remaining 1% (refer Table 8).

There are 30 ANAE palustrine wetland types in the Basin with 15 of the most common representing 99% of the total wetland area in the Basin. The managed floodplain contains 47% of the Basin wetland area. This is made up of the same 15 common types in similar proportion to the whole of the Basin (Figure 11).

Over the five years of LTIM project, Commonwealth environmental water supported 158 487 ha of palustrine wetlands of 22 different ANAE wetland types. Sixteen wetland types received Commonwealth environmental water in each of the five years with another six types supported more irregularly (Table 8). Most commonly, water is delivered to permanent wetlands, freshwater meadows and temporary grass/sedge/forb marshes. These wetland types are common in the Gwydir wetlands and Macquarie Marshes. Both locations are priority assets in the Basin that have been supported by Commonwealth environmental water annually to maintain their Ramsar values (refer LTIM Biodiveristy report, Hale *et al.* 2020). Temporary river red gum swamps are also commonly recipients of Commonwealth environmental water (7517 to 34 910 ha each year totalling 72 810 ha supported by Commonwealth environmental water over the five years). This ecosystem type is common on the managed floodplain predominantly along watercourses. Eight wetland types did not receive any Commonwealth environmental water during the period 2014–19. These include salt flats and salt marsh for which delivery of fresh water is likely inappropriate (Table 8), and very wet ecosystems (e.g. permanent springs, paperback swamps, peat bogs and fens) that may not require additional support/protection from environmental water management.

Table 8. Comparison of the contribution of Commonwealth environmental water to ecosystem diversity of palustrine wetlands in the basin from 2014–19. Ecosystem types that have received Commonwealth environmental water in every year of the LTIM project are shaded blue. Ecosystem types that have not received Commonwealth environmental water during the period of LTIM are shaded red.

Australian National Aquatic Ecosystem (ANAE) wetland type	Total area in Basin (ha)	Area on Managed Floodplain (ha)	Area receiving Commonwealth environmental water (ha)				
			Y1 '14-'15	Y2 '15-'16	Y3 '16-'17	Y4 '17-'18	Y5 '18-'19
Pt1.8.2: Temporary shrub swamp	234 412	96 598	1552	2567	2122	2218	1507
Pt1.6.2: Temporary woodland swamp	216 625	151 170	99	417	186	494	579
Pt2.2.2: Temporary sedge/grass/forb marsh	139 937	50 902	17 018	9773	16 917	15 776	15 476
Pt3.1.2: Clay pan	130 927	43 524	3048	3673	1698	1654	1143
Pt2.3.2: Freshwater meadow	125 165	38 747	18 960	1401	20 508	3620	932
Pp4.2: Permanent wetland	77 314	41 111	20 267	21 044	20 095	23 018	21 885
Pt1.1.2: Temporary river red gum swamp	74 721	56 254	9940	28 052	7517	34 910	33 432
Pt2.1.2: Temporary tall emergent marsh	70 837	52 720	3100	3509	3116	4154	4030
Pt1.2.2: Temporary black box swamp	60 272	20 173	1069	1260	228	239	294
Pt1.7.2: Temporary lignum swamp	49 962	18 681	522	33	12 427	446	8
Pst2.2: Temporary salt marsh	40 335	11 575	19	8	1	4	8
Pt4.2: Temporary wetland	22 888	3111	0	578	0	602	586
Pt4.1: Floodplain or riparian wetland	11 214	5944	1118	2469	1008	2495	2082
Pt1.3.2: Temporary coolibah swamp	8271	5146	2	0	0	0	0
Pp2.1.2: Permanent tall emergent marsh	8005	7496	3449	4156	0	3451	4156
Pst1.1: Temporary saline swamp	7157	9	94	0	0	0	316
Pst4: Temporary saline wetland	6180	50	0	0	0	0	0
Pp3: Peat bog or fen marsh	4425	173	0	0	0	0	0
Pt1: Temporary swamp	3767	2822	280	690	132	576	675
Pp2.2.2: Permanent sedge/grass/forb marsh	3590	176	15	15	15	21	17
Pst3.2: Salt pan or salt flat	3249	253	0	0	0	0	0
Psp4: Permanent saline wetland	2093	1222	231	811	172	629	639
Pu1: Unspecified wetland	1763	130	0	0	0	95	0
Pp2.3.2: Permanent grass marsh	1507	248	23	25	96	85	25
Pp2.4.2: Permanent forb marsh	740	146	10	0	30	22	7
Pt1.5.2: Temporary paperbark swamp	412	0	0	0	0	0	0
Psp2.1: Permanent salt marsh	246	0	0	0	0	0	0
Pps5: Permanent spring	130	3	0	0	0	0	0
Psp1.1: Saline paperbark swamp	31	0	0	0	0	0	0
Pp1.1.2: Permanent paperbark swamp	1	1	0	0	0	0	0
TOTAL	**1 306 176**	**608 385**	**80 816**	**80 481**	**86 268**	**94 509**	**87 797**

The proportion of wetland types supported by Commonwealth environmental water is remarkably similar among the years of the LTIM project (Figure 12). The major differences among years are the result of:

1. increased watering of freshwater meadows in 2014-15 and 2016-17 when water was delivered from the Warrego River to the western floodplain at Toorale,
2. increased watering of temporary river redgum in swamp in 2015–16, 2017–18 and 2018–19 when Commonwealth environmental water was used to flood the red gum dominated Barmah-Millewa Forest,
3. increased watering of temporary lignum swamp in 2016–17 when Commonwealth environmental water was delivered to Narran lakes.

Temporary woodland swamps comprise 11% of the Basin wetlands and are the most extensive wetland type on the managed floodplain (151 000 ha) however only a small proportion has received Commonwealth environmental water in the last five years (99 ha-579 ha). This is an arid-land wetland type that is found most commonly the Paroo River and Condamine-Balonne and in other valleys located away from the river channels.

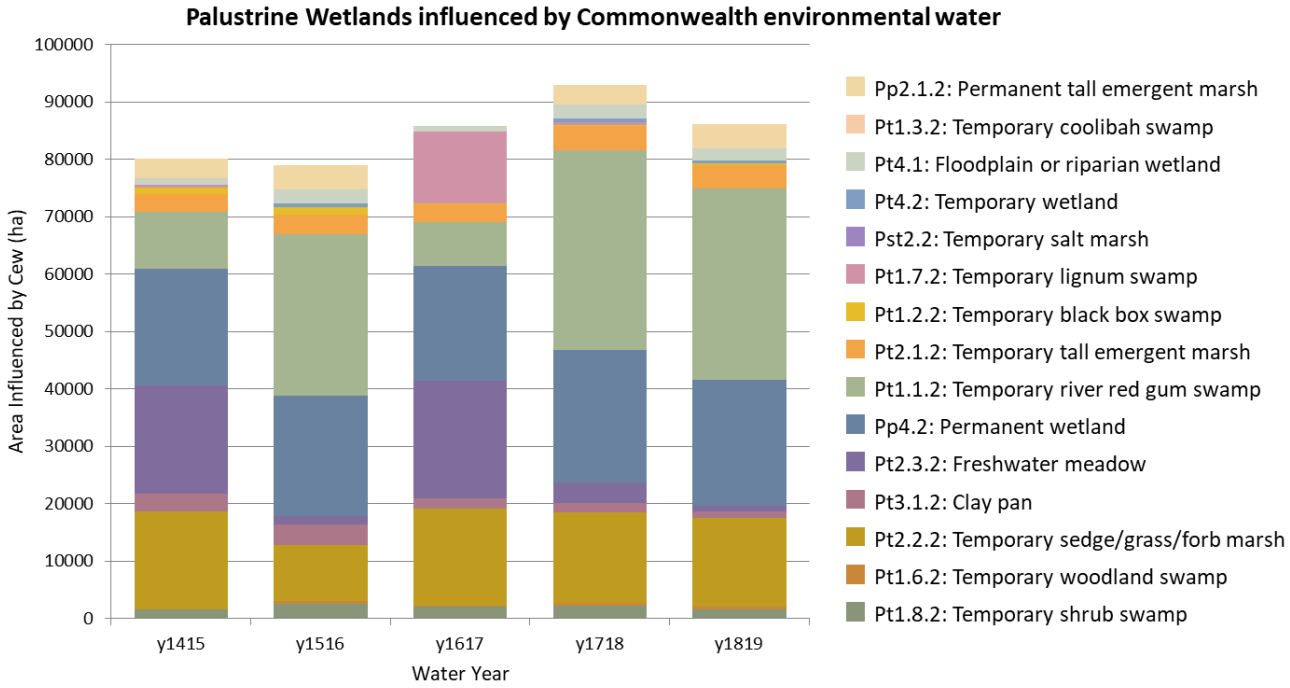


Figure 12. The extent of palustrine wetland ecosystem types supported by Commonwealth environmental water in each year of the LTIM project.

Many wetland areas received repeated inundation by Commonwealth environmental water over multiple years (Table 9). In total, 158 487 ha of wetlands were supported by Commonwealth environmental water from 2014-19. There are 30 259 ha of wetlands that have been supported by Commonwealth environmental water in every year of the project, with the majority located in the Macquarie Marshes and Gwydir Wetlands. A further 15 230 ha of wetlands have been supported by Commonwealth environmental water in four of the last five years (Table 9). 18 062 ha (60%) of the area that is inundated annually is classified as permanent wetland. The remaining 40% includes 7079 ha of temporary sedge/grass/forb marsh, 2130 ha of temporary tall emergent marsh and 1767 ha of temporary river red gum swamp for which ongoing annual inundation may be inappropriate. For example, refer to Figure 13 which shows a side-by-side comparison of the distribution of ANAE ecosystem types and watering frequencies in the Macquarie Marshes. Continued regular watering may convert naturally intermittent ecosystems into more

permanent wetland types and promote drought sensitive species that increase the dependency on ongoing environmental water management. For example, regular water may allow the encroachment of reed beds into areas previously dominated by sedges and/or redgum.

In the Macquarie marshes, the temporary tall emergent marsh may be seasonally inundated with a dry phase in late summer despite annual watering. It is also possible that some of the tall emergent marshes are misclassified permanently wet ecosystems. An update to the ANAE classification planned for late 2020 will further examine the use of wetness indices derived from satellite data (Dunn *et al.* 2019) to improve the classification of hydrological regime that is used to distinguish "temporary" and "permanent" ecosystem types.

The large area of temporary lignum swamp supported by Commonwealth environmental water delivered to Narran lakes in 2016–17 represents 40% of the wetland area watered just once in the five years. Watering of the Western Floodplain at Toorale (freshwater meadow) in 2014–15 and 2016–17 is 43% of the 45 937 ha of wetlands that were supported by Commonwealth environmental water twice during LTIM (Table 9). It is expected that improvements to the ANAE mapping expected in late 2020 will re-map much of the western floodplain as a floodplain ecosystem type and require these results to be recast.

Table 9. Total area of palustrine wetland ecosystems influenced by Commonwealth environmental water at differing frequencies during the five years of the LTIM project (2014–19).

Australian National Aquatic Ecosystem (ANAE) wetland type	1in5	2in5	3in5	4in5	5in5	Total (All years)
Pt1.1.2: Temporary river red gum swamp	2951	1287	23 161	7239	1767	**36 405**
Pt2.2.2: Temporary sedge/grass/forb marsh	4050	8968	3440	1611	7079	**25 148**
Pp4.2: Permanent wetland	2635	1116	2293	1016	17902	**24 962**
Pt2.3.2: Freshwater meadow	1249	19 692	810	108	34	**21 893**
Pt1.7.2: Temporary lignum swamp	13 082	7	8	0	0	**13 097**
Pt3.1.2: Clay pan	4157	2165	985	183	44	**7534**
Pt2.1.2: Temporary tall emergent marsh	563	2054	1198	930	2130	**6875**
Pt4.2: Temporary wetland	29	4277	576	0	0	**4882**
Pp2.1.2: Permanent tall emergent marsh	1	705	11	3449	0	**4166**
Pt1.8.2: Temporary shrub swamp	1875	1044	17	88	1087	**4111**
Pt4.1: Floodplain or riparian wetland	381	1522	898	537	0	**3338**
Pt1.2.2: Temporary black box swamp	657	795	91	0	55	**1598**
Pst1.1: Temporary saline swamp	1	1388	41	0	0	**1430**
Pt1: Temporary swamp	267	381	377	33	1	**1059**
Psp4: Permanent saline wetland	147	91	452	27	138	**855**
Pt1.6.2: Temporary woodland swamp	81	182	416	0	0	**679**
Pp2.3.2: Permanent grass marsh	14	86	2	0	9	**111**
Pu1: Unspecified wetland	95	0	0	0	0	**95**
Pst4: Temporary saline wetland	3	82	0	0	0	**85**
Pst3.2: Salt pan or salt flat	1	48	0	0	0	**49**
Pst2.2: Temporary salt marsh	2	42	0	4	0	**48**
Pp2.4.2: Permanent forb marsh	26	3	11	3	0	**43**
Pp2.2.2: Permanent sedge/grass/forb marsh	5	2	0	2	13	**22**
Pt1.3.2: Temporary coolibah swamp	2	0	0	0	0	**2**
Pp3: Peat bog or fen marsh	0	0	0	0	0	**0**
Pt1.5.2: Temporary paperbark swamp	0	0	0	0	0	**0**
Psp2.1: Permanent salt marsh	0	0	0	0	0	**0**
Pps5: Permanent spring	0	0	0	0	0	**0**
Psp1.1: Saline paperbark swamp	0	0	0	0	0	**0**
Pp1.1.2: Permanent paperbark swamp	0	0	0	0	0	**0**
TOTAL	**32 274**	**45 937**	**34 787**	**15 230**	**30 259**	**158 487**

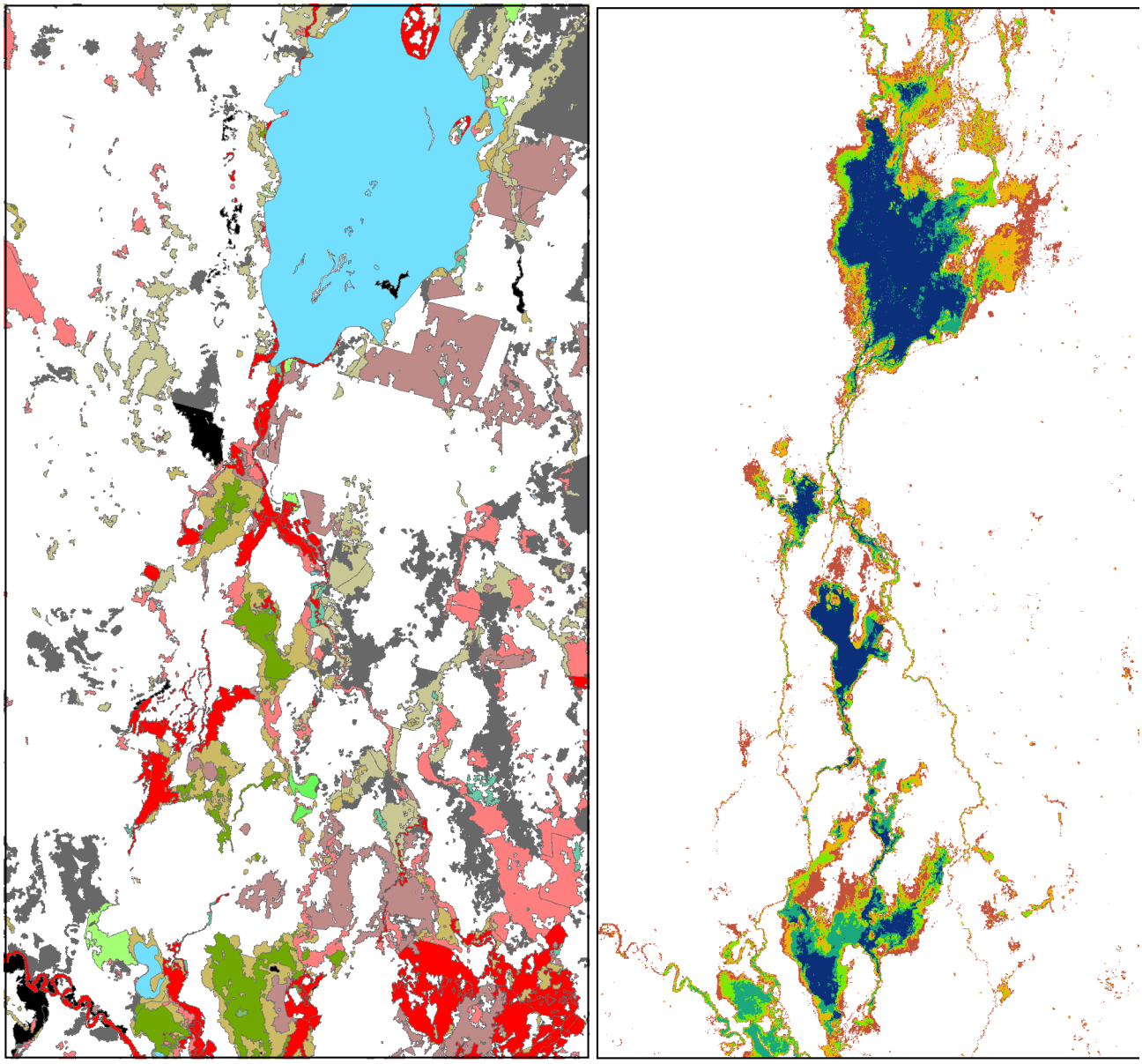


Figure 13. Side-by-side comparison of wetland and floodplain ecosystem mapping in the Macquarie Marshes with the inundation frequency by Commonwealth environmental water (Cew) in the 5 years of the LTIM project to 2019.

5.2.3 Floodplain Ecosystems

Approximately 28% of floodplains in the basin align with the Basin-wide watering strategy managed floodplain (Figure 14) and there is a high degree of congruence in the proportional representation of floodplain types on the managed floodplain vs at the Basin-scale.

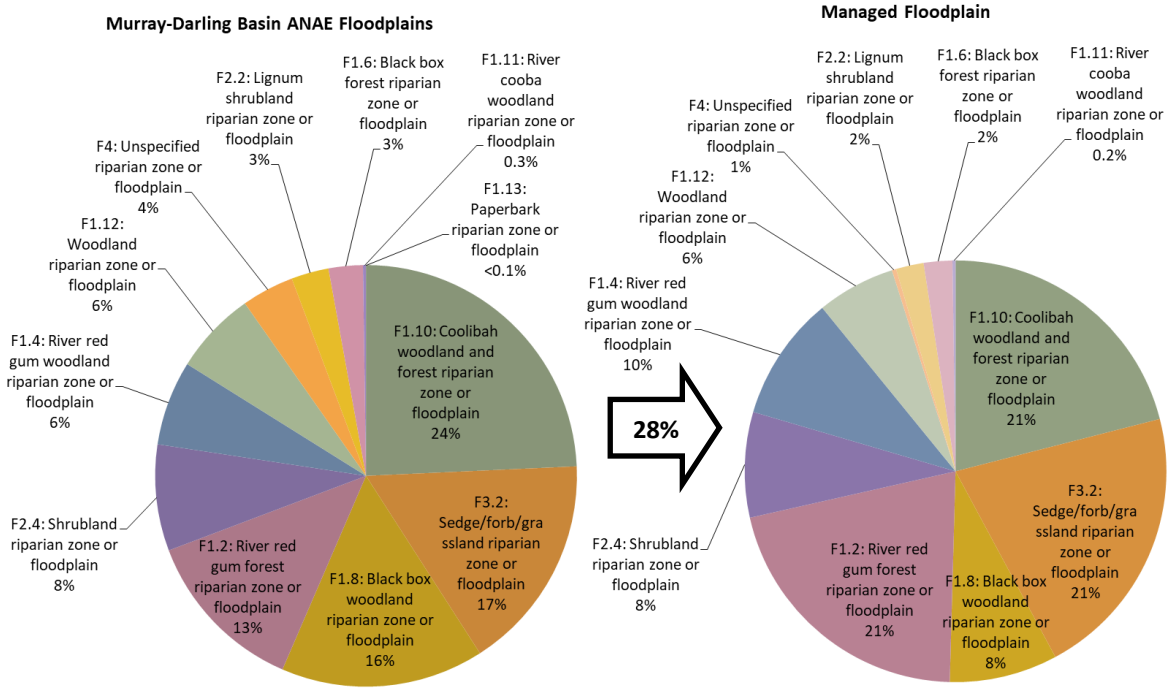


Figure 14. Comparison of the proportional representation of ANAE floodplain ecosystem types in the Basin to the subset (28%) that occurs on the managed floodplain that is potentially in scope for Commonwealth environmental water management.

The rare paperbark riparian zone or floodplain type only occurs along small area of the Namoi River in NSW and the Wimmera River in Victoria (17 ha total). Both areas are not on the managed floodplain and they have not received Commonwealth environmental water during the period of LTIM (Table 10). Sedge/forb/grassland riparian zone or floodplain is the second most common floodplain type in the Basin (833 102 ha) but it almost exclusively distributed in the unregulated Paroo River valley and Condamine Balonne with only a small area (32 ha) receiving Commonwealth environmental water when water was delivered to Narran lakes in 2016–17 (Table 10).

On average, only 1.2% of the total extent of the Basin floodplain receives Commonwealth environmental water. Floodplain inundation is rarely an objective for Commonwealth environmental water because volumes are limited and constraints imposed by infrastructure, built assets and policy often restricts watering actions to volumes that are contained within river channels and wetlands. Extensive floodplain inundation is not expected unless Commonwealth environmental water is delivered to augment natural floods. River red gum forest riparian zone/floodplain was inundated to the greatest extent with 3.1% to 4.8% of the total area of this type in the Basin inundated by Commonwealth environmental water in 2014–15, 2015–16, 2017–18 and 2018–19 (Table 10, Figure 15).

Less than 15 000 ha of floodplain was inundated by Commonwealth environmental water in 2006-17 as this was wet year with extensive natural flooding (Figure 15). River red gum forest riparian zone or floodplain received the most Commonwealth environmental water (45%-72% of the area watered) representing 13% of this ecosystem type in the basin and 21% on the managed floodplain. The apparent bias towards watering redgum floodplain likely reflects the distribution of this ecosystem type in priority assets (e.g. Barmah-Millewa Forest, the Lowbidgee floodplain and along the Murray-River channel) and the alignment of red gum forest along other river channels receiving Commonwealth environmental water in the southern Basin.

Table 10. Comparison of the contribution of Commonwealth environmental water to ecosystem diversity of floodplains in the basin from 2014–19. . Ecosystem types that have received Commonwealth environmental water in every year of the LTIM project are shaded blue. Ecosystem types that have not received Commonwealth environmental water during the period of LTIM are shaded red.

Australian National Aquatic Ecosystem (ANAE) wetland type	Total area in Basin (ha)	Area on Managed Floodplain (ha)	Area receiving Commonwealth environmental water (ha)				
			Y1 '14-'15	Y2 '15-'16	Y3 '16-'17	Y4 '17-'18	Y5 '18-'19
F1.10: Coolibah woodland and forest riparian zone or floodplain	1 215 726	294 586	3388	633	1007	1335	2300
F3.2: Sedge/forb/grassland riparian zone or floodplain	833 102	296 420	0	0	32	0	0
F1.8: Black box woodland riparian zone or floodplain	779 639	116 222	2273	5322	844	1830	432
F1.2: River red gum forest riparian zone or floodplain	639 022	294 854	24 589	26 210	6 525	25 708	19 092
F2.4: Shrubland riparian zone or floodplain	408 019	113 257	1115	5973	2554	473	485
F1.4: River red gum woodland riparian zone or floodplain	325 221	134 242	3509	1358	1237	4887	1247
F1.12: Woodland riparian zone or floodplain	318 645	84 203	14	10	136	93	57
F4: Unspecified riparian zone or floodplain	201 086	4613	2	10	9	36	3
F2.2: Lignum shrubland riparian zone or floodplain	143 880	29 764	5430	2154	1164	1474	1538
F1.6: Black box forest riparian zone or floodplain	131 442	30 711	489	1299	118	265	256
F1.11: River cooba woodland riparian zone or floodplain	11 541	3320	1135	236	779	840	1137
F1.13: Paperbark riparian zone or floodplain	17	0	0	0	0	0	0
TOTAL	**5 007 340**	**1 402 192**	**41 944**	**43 205**	**14 405**	**36 941**	**26 547**

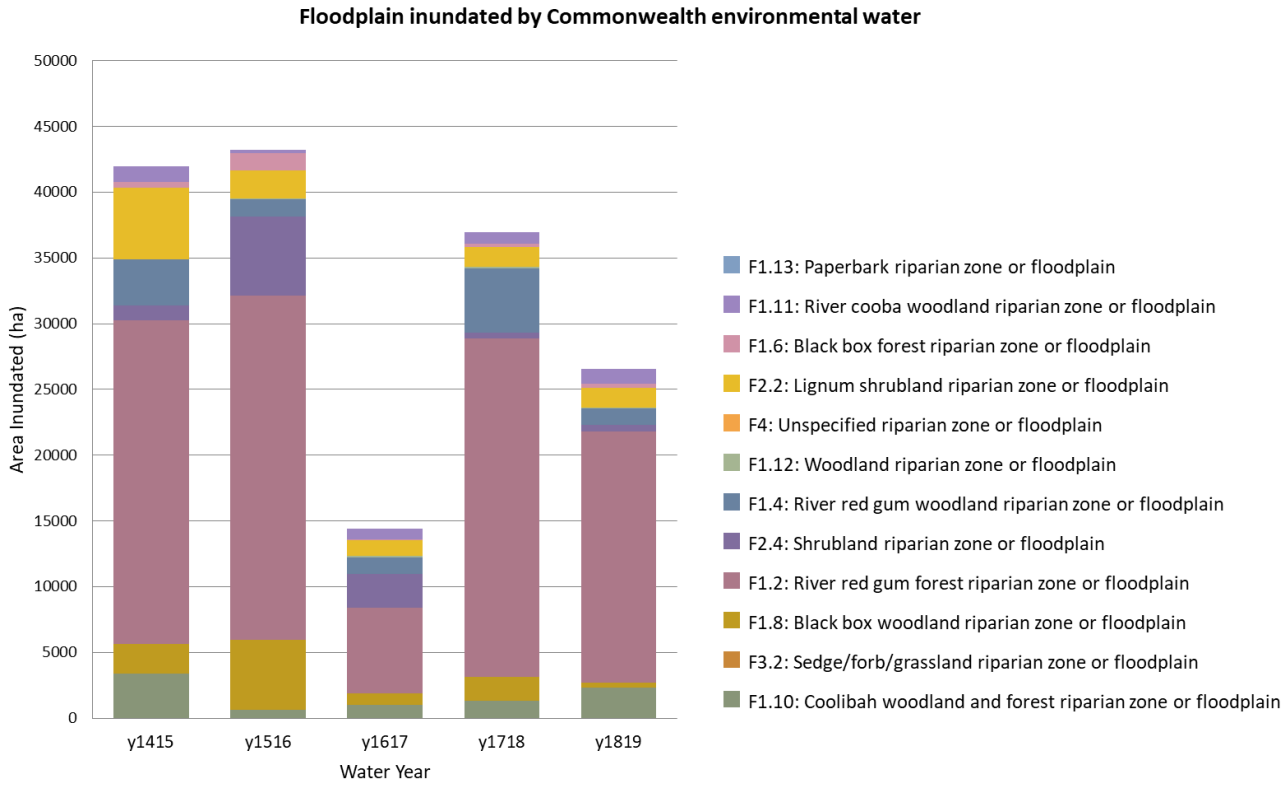


Figure 15. The extent of floodplain ecosystem types supported by Commonwealth environmental water in each year of the LTIM project.

Over the five years of LTIM, 101 735 ha of floodplain was inundated by Commonwealth environmental water with 60% of this area being classed as river red gum forest riparian zone or floodplain (Table 11). Only 831 ha was repeatedly inundated in every year, mostly fringing wetlands and channels in the Macquarie Marshes. The majority of floodplains (61%) receiving Commonwealth environmental water only did so once during the project. The 101 735 ha receiving Commonwealth environmental water over the duration of the project represents 2% of the floodplains in the Basin. The contribution of Commonwealth environmental water to Ecosystem Diversity of floodplains may be small at the Basin-scale, however the inundated areas are adjacent to wetlands and channels and are likely to be locally important to biodiversity by providing feeding and nesting habitat.

Table 11. Total area of floodplain ecosystems influenced by Commonwealth environmental water at differing frequencies during the five years of the LTIM project (2014–19).

Australian National Aquatic Ecosystem (ANAE) wetland type	1in5	2in5	3in5	4in5	5in5	Total (All years)
F1.2: River red gum forest riparian zone or floodplain	35 279	12 754	8907	3230	366	**60 536**
F1.8: Black box woodland riparian zone or floodplain	6897	1630	139	31	2	**8699**
F2.4: Shrubland riparian zone or floodplain	5951	1970	164	45	25	**8155**
F2.2: Lignum shrubland riparian zone or floodplain	5397	1519	594	249	121	**7880**
F1.4: River red gum woodland riparian zone or floodplain	3085	2641	678	247	195	**6846**
F1.10: Coolibah woodland and forest riparian zone or floodplain	3218	1541	489	205	15	**5468**
F1.6: Black box forest riparian zone or floodplain	1636	216	102	13	1	**1968**
F1.11: River cooba woodland riparian zone or floodplain	708	559	281	230	106	**1884**
F1.12: Woodland riparian zone or floodplain	223	42	2	0	0	**267**
F3.2: Sedge/forb/grassland riparian zone or floodplain	32	0	0	0	0	**32**
F1.13: Paperbark riparian zone or floodplain	0	0	0	0	0	**0**
TOTAL	**62 426**	**22 872**	**11 356**	**4250**	**831**	**101 735**

5.2.4 River Ecosystems

The managed floodplain contains approximately 10% of the river length in the Basin. Lowland rivers and streams dominate the managed floodplain area representing 88% of the near 50 000 km of rivers that are potentially in scope for water management (Figure 16, Table 12). Commonwealth environmental water is typically managed from storages; however there is some regulation of flows upstream of storages and in unregulated valleys through management of entitlements and extraction rules. The 11% (5464 km) of transitional and high energy stream lengths on the managed floodplain (Figure 16) is a mixture of these upland areas and high-energy outflow channels from storages before they flow out into the flat lowlands of the central and western Basin.

Commonwealth environmental water primarily supported permanent and temporary lowland rivers during the 5 years of LTIM. Approximately 90% of the flows in any one year were in lowland sections including 48% to 74% of the permanent river reaches and 10% to 17% of the temporary reaches on the managed floodplain (Table 12). The pattern of watering has been very consistent from 2014-2019 supporting 12 744 to 19 083 km of waterways with flows containing Commonwealth environmental water annually (Table 12). The increase in river length supported by Commonwealth environmental water in 2017–18 (Figure 17) reflects the success of the northern rivers connectivity event. This large environmental flow in early 2018 was delivered to support more than 2000 km of drought impacted lowland river along the Barwon-Darling from Glenlyon and Copeton dams near the Queensland / NSW border down to the Menindee Lakes.

Across all five years of LTIM 25 856 km of river were supported by Commonwealth environmental water. The same 5980 km was inundated in every year along permanent lowland sections of the Barwon, Macquarie, Lachlan, Murrumbidgee, Edward, Wakool, Murray, Ovens, Broken, Goulburn and Loddon Rivers. Permanent reaches in the Culgoa, Darling and Campaspe Rivers received Commonwealth environmental water in four of the five years. Temporary rivers received water less frequently, with the Warrego and Wimmera Rivers supported by Commonwealth environmental water twice in five years and the Nebine River and parts of Broken Creek in Victoria receiving Commonwealth environmental water only

once. The upland streams that received Commonwealth environmental water during the project were mostly outflows from storages into the upper reaches of the Murrumbidgee, Lachlan, Macquarie, Gwydir, and Severn Rivers however there were some unregulated entitlements used infrequently to deliver Commonwealth environmental water once in the Peel River above Chaffy dam, the Namoi River above Split Rock Dam, and three times in the Severn River above Glenlyon Dam.

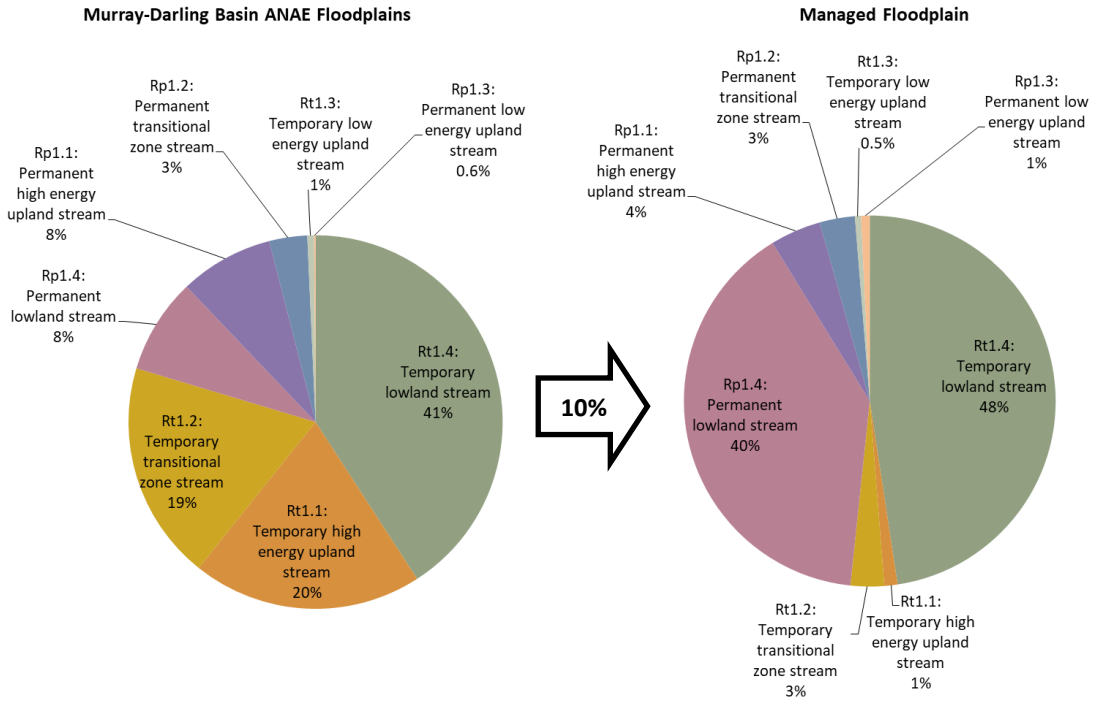


Figure 16. Comparison of the proportional representation of ANAE river ecosystem types in the Basin to the subset (10%) that occurs on the managed floodplain that is potentially in scope for Commonwealth environmental water management. There are an additional 2 river types not shown that make up less than 1% of the total and are an artefact of missing data (refer Table 12).

Table 12. Comparison of the contribution of Commonwealth environmental water to ecosystem diversity of rivers in the basin from 2014–19. Ecosystem types that have received Commonwealth environmental water in every year of the LTIM project are shaded blue.

Australian National Aquatic Ecosystem (ANAE) wetland type	Total length in Basin (km)	Length on Managed Floodplain (km)	Length receiving Commonwealth environmental water (km)				
			Y1 '14-'15	Y2 '15-'16	Y3 '16-'17	Y4 '17-'18	Y5 '18-'19
Rt1.4: Temporary lowland stream	198 551	22 516	2922	3030	2141	3793	3091
Rt1.1: Temporary high energy upland stream	96 565	544	89	49	3	96	31
Rt1.2: Temporary transitional zone stream	91 873	1379	22	22	59	45	80
Rp1.4: Permanent lowland stream	40 133	18 714	9068	8620	9501	13 256	9665
Rp1.1: Permanent high energy upland stream	39 421	2092	534	313	311	640	446
Rp1.2: Permanent transitional zone stream	15 962	1449	426	397	383	665	483
Rt1.3: Temporary low energy upland stream	2783	251	34	22	22	56	48
Rp1.3: Permanent low energy upland stream	633	355	191	177	168	250	263
Ru1: Unspecified river (landform unknown)	293	63	0	7	0	7	7
Rw1: Permanent river (landform unknown)	271	106	0	5	9	15	14
Total	**487 002**	**47 919**	**13 286**	**12 814**	**12 755**	**19 083**	**14 374**

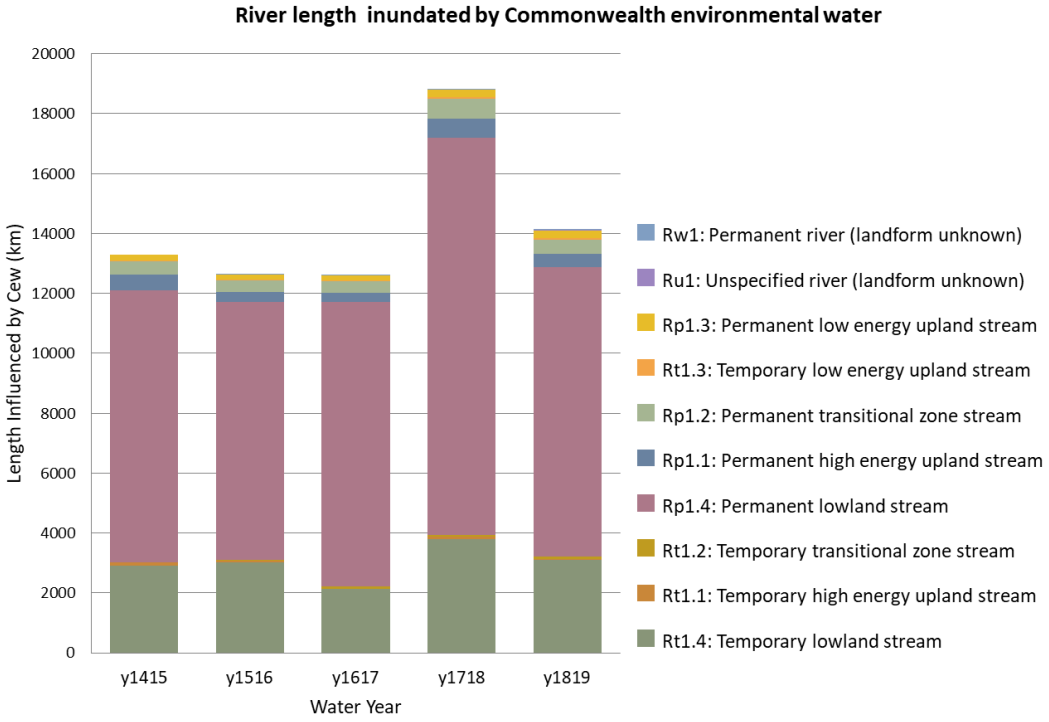


Figure 17. The length of rivers ecosystem types supported by Commonwealth environmental water in each year of the LTIM project.

Table 13. Total length of river and stream channels with flows containing Commonwealth environmental water at differing frequencies during the five years of the LTIM project (2014–19).

Australian National Aquatic Ecosystem (ANAE) wetland type	1in5	2in5	3in5	4in5	5in5	Total (All years)
Rp1.4: Permanent lowland stream	2732	2667	1898	1738	5980	**15 015**
Rt1.4: Temporary lowland stream	2130	3210	1660	1036	591	**8627**
Rp1.1: Permanent high energy upland stream	223	151	75	54	283	**786**
Rp1.2: Permanent transitional zone stream	208	122	68	40	319	**757**
Rt1.1: Temporary high energy upland stream	62	46	47	49	11	**215**
Rp1.3: Permanent low energy upland stream	27	20	12	10	123	**192**
Rt1.2: Temporary transitional zone stream	17	94	37	12	2	**162**
Rt1.3: Temporary low energy upland stream	16	23	9	19	19	**86**
Rw1: Permanent river (landform unknown)	2	0	0	0	7	**9**
Ru1: Unspecified river (landform unknown)	0	7	0	0	0	**7**
TOTAL	**5417**	**6340**	**3806**	**2958**	**7335**	**25 856**

6 Contribution to achievement of Basin Plan objectives and adaptive management

6.1 Adaptive management

There are a number of avenues by which the Ecosystem Diversity evaluation can foster improvements in Commonwealth environmental water management and evaluation that have been identified in previous Ecosystem Diversity evaluation reports (Brooks 2016, 2017a, 2018, 2019). These recommendations are reproduced below. Completing the update of the ANAE classification is now expected during the second half of 2020, and progress in developing expected outcomes for Ecosystem Diversity is planned for the CEWO Monitoring, Evaluation and Research (Flow-MER) project (2019-2022).

1) Improving confidence in the evaluation of the contribution of Commonwealth environmental water to Ecosystem Diversity. Completing the revision of the ANAE classification to include the new NSW state vegetation mapping for Western NSW and the Central Tablelands (Figure 18) will further improve the evaluation of the contribution of Commonwealth environmental water to Ecosystem Diversity in tributaries of the Darling River including the Junction of the Warrego and Darling rivers LTIM Selected Area.
2) Reducing the risks of implementing inappropriate watering regimes. Too much water, too frequently or consistently missing particular ecosystems types are all scenarios that are potentially deleterious to biodiversity in the Basin. Improving understanding of watering requirements at the aquatic ecosystem level should complement and enhance existing approaches that focus on the requirements of key species or communities. This evaluation highlighted the annually watered temporary wetlands in the Macquarie Marshes and further investigation is warranted beginning with the accuracy of the ecosystem classification during the planned 2020 update. Promotion of permanent wetlands to redress years of drought may also be a legitimate management objective for the Macquarie Marshes.
3) An authoritative, unambiguous resource for the timing, duration and extent of water management in the Basin is required. Through LTIM, we have assembled a library documenting the Basin wide watering by Commonwealth environmental water over the five years but the record of water from natural inundation and other sources of environmental water is still incomplete and sometimes conflicting. Evaluating Commonwealth environmental water in isolation ignores the fact that water planning includes consideration of the capacity for other water holders to meet environmental requirements with or without Commonwealth environmental water. For example, Barmah Forest and Hattah Lakes are two priority assets in the Basin that were watered using Victorian environmental water and MDBA (The Living Murray) water in years when Commonwealth environmental water was not used (Figure 19). The Flow-MER project that continues form LTIM has taken a step in the right direction to consider environmental water more broadly. Improved inter-agency communication and provision of a timely authoritative resource for all environmental water actions in the Basin to support Basin-scale evaluation is needed.
4) The CEWO currently does not have 1-year or 5-year expected outcomes for ecosystem diversity but it is hoped that this evaluation and other lessons learned from the LTIM project will seed thinking towards draft ecosystem objectives. Understanding how key ecosystem types influence patterns of Basin biodiversity, resilience, ecosystem function and ecosystem services paves the way towards delivering Commonwealth environmental water for ecosystem objectives that move beyond counting ecosystem watering targets. For example, shaping flow regimes to preserve patterns of spatio-temporal variability along a river, or delivering water at

critical times to maintain life forms or processes *because* they characterise ecosystem types that are to be preserved or improved. Managing to prevent or promote ecosystem turnover to new types may require long-term management frameworks with institutional memory and conviction to stay the course over decadal time scales and that allow temporary systems to remain dry for sufficient duration to support critical dry-phase ecosystem processes.

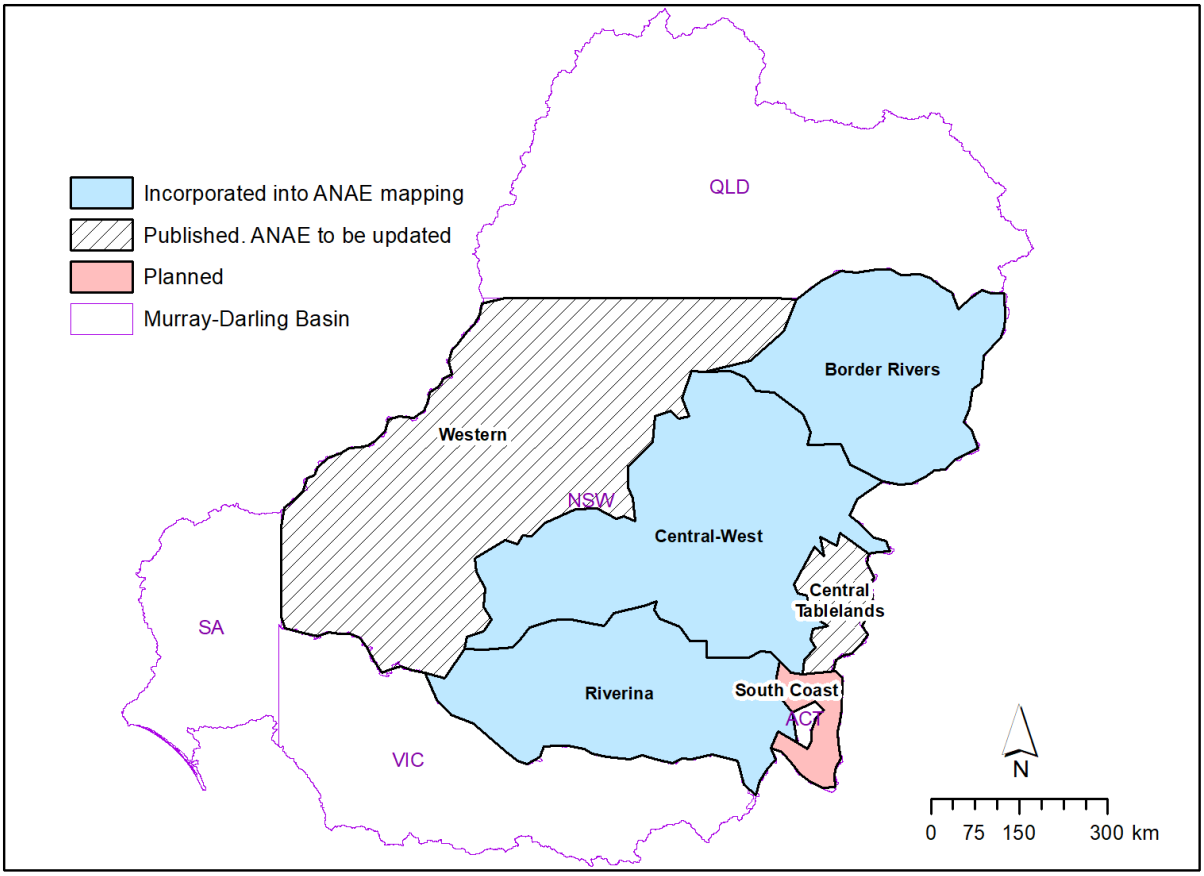


Figure 18: Extent and status of the new NSW state vegetation mapping. Published regions (blue) were used to update the ANAE classification in 2017. The Western region and Central Tablelands have now been published and are expected to improve the ANAE classification in 2020 to support evaluation of Ecosystem Diversity during the Flow-MER project.

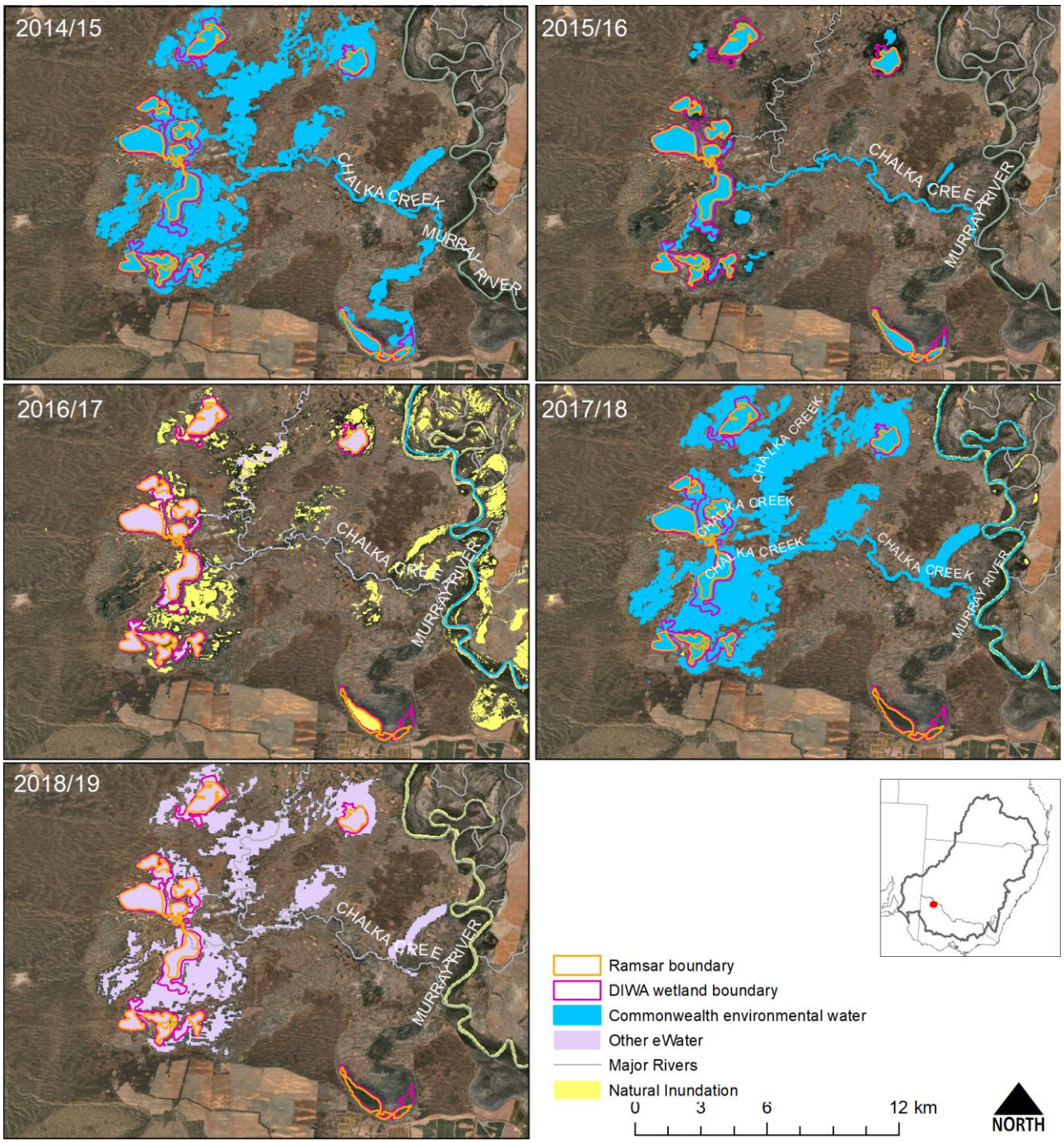


Figure 19. Annual inundation of Hattah Lakes. Interpreting the role of Commonwealth environmental water in supporting Ecosystem Diversity requires knowledge of water from other sources. In this case natural rainfall inundated the floodplains around the lakes in 2016–17 and environmental water from the Victorian Environmental Water inundated the floodplains in 2018–19.

6.2 Contribution to Basin Plan objectives

The Ecosystem Diversity component of the Basin evaluation contributes to the Basin Plan objective for Biodiversity under Section 8.05 of the Basin Plan. The evaluation also contributes indirectly to additional Basin Plan objectives by informing the evaluation of the Vegetation and Generic Diversity Basin Matters within the LTIM Project (Capon & Campbell 2020; Hale *et al.* 2020).

The Commonwealth does not yet have 1-year or 5-year expected outcomes for ecosystem diversity (Table 14) and water is not currently delivered with explicit understanding of the contribution of Commonwealth environmental watering to ecosystem diversity at the Basin-scale. This evaluation provides a foundation from which expected outcomes for ecosystem diversity may be developed in the future as the spatial and temporal patterns of watering to different ecosystem types under current management regimes are better understood.

8.05 Protection and restoration of water-dependent ecosystems is supported in principle for 288 513 ha of lakes, wetlands and floodplain and 25 856 km of waterways representing 57 ecosystem types (83 % of the ecosystem types currently mapped in the basin).

Table 14. Commonwealth Environmental Outcomes framework for ecosystem diversity.

Basin Plan objectives	Basin outcomes	5–year expected outcomes	1–year expected outcomes	Measured and predicted 1-year outcomes 2018–19	Measured and predicted 1–5 year outcomes 2014–19
Biodiversity (Basin Plan S. 8.05)	Ecosystem diversity	None identified	None identified	Over 246 000 hectares of mapped wetland and floodplain inundated 74% of the different aquatic ecosystem types represented in areas supported by Commonwealth environmental water	288 513 ha of lakes, wetlands and floodplain and 25 856 km of waterways supported by Commonwealth environmental water representing 57 ecosystem types; 83 % of the water dependent ecosystem types

7 References

Aquatic Ecosystems Task Group (2012) *Aquatic Ecosystems Toolkit. Module 2 Interim Australian National Aquatic Ecosystems (ANAE) Classification Framework*. Department of Sustainability, Environment, Water Population and Communities, Canberra, Australia.

BOM (2019) Australian Hydrological Geospatial Fabric (Geofabric) beta v3.0.5.

Brooks SS (2016) *2014–15 Basin-scale evaluation of Commonwealth environmental water – Ecosystem Diversity* (No. MDFRC Publication 144/2017, May). Final Report prepared for the Commonwealth Environmental Water Office. Murray–Darling Freshwater Research Centre.

Brooks SS (2017a) *2015–16 Basin-scale evaluation of Commonwealth environmental water – Ecosystem Diversity* (No. MDFRC Publication 144/2017, May). Final Report prepared for the Commonwealth Environmental Water Office. Murray–Darling Freshwater Research Centre.

Brooks SS (2017b) *Classification of aquatic ecosystems in the Murray-Darling Basin: 2017 update*. Report to the Murray-Darling Basin Authority and Commonwealth Environmental Water Office, Canberra, Australia.

Brooks SS (2018) *2016–17 Basin-scale evaluation of Commonwealth environmental water – Ecosystem Diversity* (No. Publication 190/2018, September). Final Report prepared for the Commonwealth Environmental Water Office. La Trobe University Centre for Freshwater Ecosystems, Wodonga, Victoria.

Brooks SS (2019) *2017–18 Basin-scale evaluation of Commonwealth environmental water – Ecosystem Diversity* (No. Publication 234/2019, September). Final Report prepared for the Commonwealth Environmental Water Office. La Trobe University Centre for Freshwater Ecosystems, Wodonga, Victoria.

Brooks SS, Cottingham P, Butcher R, Hale J (2014) *Interim classification of aquatic ecosystems in the Murray-Darling Basin: Stage 2 report*. Peter Cottingham & Associates report to the Commonwealth Environmental Water Office and Murray-Darling Basin Authority. Canberra, Australia.

Cadotte MW, Carscadden K, Mirotchnick N (2011) Beyond species: functional diversity and the maintenance of ecological processes and services: Functional diversity in ecology and conservation. *J. Appl. Ecol.* **48(5)**, 1079–1087.

Capon SJ, Campbell C (2020) *2018–19 Basin-scale evaluation of Commonwealth environmental water - Vegetation Diversity* (Final Report prepared for the Commonwealth Environmental Water Office). CFE Publication 249. La Trobe University Centre for Freshwater Ecosystems, Wodonga, Victoria.

CBD (1993) The Convention on Biological Diversity.

CEWH (2013) Commonwealth Environmental Water – The Environmental Water Outcomes Framework v1.1.

Commonwealth of Australia (2012) Water Act 2007 Basin Plan.

Dunn B, Lymburner L, Newey V, Hicks A, Carey H (2019) Developing a Tool for Wetland Characterization Using Fractional Cover, Tasseled Cap Wetness And Water Observations From Space. In: *IGARSS 2019-2019 IEEE International Geoscience and Remote Sensing Symposium*. IEEE, pp. 6095–6097.

Geist J (2011) Integrative freshwater ecology and biodiversity conservation. *Ecol. Indic.* **11(6)**, 1507–1516.

Hale J, Bond, Nick, Brooks, Shane (2020) *2018–19 Basin-scale evaluation of Commonwealth environmental water – Biodiversity.* (Final Report prepared for the Commonwealth Environmental Water Office). CFE Publication 252. La Trobe University Centre for Freshwater Ecosystems, Wodonga, Victoria.

Junk J, Bayley P, Sparks R (1989) The flood pulse concept in river floodplain systems. *Can. Spec. Publ. Fish. Aquat. Sci.* **106**, 110–127.

MDBA (2014) Basin-wide environmental watering strategy. *Murray-Darling Basin Auth. Canberra*.

MDBA (2019) *Basin-wide environmental watering strategy* (No. 42/19). Murray–Darling Basin Authority, Canberra, ACT.

MDFRC (2013) *Long-term Intervention Monitoring - Generic Cause and Effect Diagrams* (No. 01.5/2013). The Murray-Darling Freshwater Research Centre, Albury.

Miles M, Eckert G (2013) Murray-Darling Basin ANAE dataset – Manual edits to SA component.

Poff NL (1997) Landscape filters and species traits: towards mechanistic understanding and prediction in stream ecology. *J. North Am. Benthol. Soc.* **16(2)**, 391–409.

Pollock LJ, Thuiller W, Jetz W (2017) Large conservation gains possible for global biodiversity facets. *Nature* **546(7656)**, 141–144.

Stewardson MJ, Guarino F (2020) *2018–19 Basin-scale evaluation of Commonwealth environmental water — Hydrology* (Final Report prepared for the Commonwealth Environmental Water Office). CFE Publication 246. La Trobe University Centre for Freshwater Ecosystems, Wodonga, Victoria.

Thorp JH, Thoms MC, Delong MD (2006) The riverine ecosystem synthesis: biocomplexity in river networks across space and time. *River Res. Appl.* **22(2)**, 123–147.

Appendix 1: GIS Workflow

All spatial layers use the 1994 Geocentric Datum of Australia (GDA94). Areas in this report are in hectares and have been calculated in the Australia Albers Equal Area Conic projection to report accurate area measurements across the Basin.

The area of ecosystems inundated by Commonwealth environmental water is the fraction of the wetland area that intersects the Commonwealth environmental water inundation extent.

GIS Workflow:

1. Intersect:
    a. The Basin ANAE classification mapping;
    b. Commonwealth environmental water Inundation; and
    c. LTIM Valleys
2. Calculate polygon area in hectares using equal area GDA94 Australian Albers projection.
3. Sum the area of each ANAE wetland type per valley.

The area of ecosystems influenced by Commonwealth environmental water is defined as the sum of the areas of mapped features that are partially or fully overlapped by Commonwealth environmental water inundation extent.

GIS Workflow:

1. Select by location all ANAE wetland polygons that intersect the Commonwealth environmental water Inundation.
2. Intersect the selected wetlands with the catchment boundaries.
3. Calculate polygon area in hectares using equal area GDA94 Australian Albers projection.
4. Sum the area of each ANAE wetland type per valley.

Length of waterways influenced by Commonwealth environmental water

GIS Workflow:

4. Intersect:
    a. The Basin ANAE Geofabric v3 Waterways
    b. Commonwealth environmental water Inundation
    c. LTIM Valleys
5. Calculate the channel length inundated for each riverine ecosystem type in kilometres using equal area GDA94 Australian Albers projection.
6. Calculate summary statistics to sum the length of each river ecosystem type per valley.

Appendix 2. Ongoing evolution of the Basin ANAE classification

Confidence in the accuracy of mapping and the Basin ANAE classification was examined in a previous LTIM ecosystem diversity evaluation (Brooks 2016a) and in the development of the ANAE classification (Brooks *et al.* 2014). In South Australia, ANAE types were manually ascribed to wetlands and riverine reaches along the full length of the Murray River to improve confidence and alignment of the classification to ecosystem types used by South Australian wetland managers. Some additional limitations of the ANAE classification in South Australia that influence the findings in this report are noted in Miles and Eckert (2013) and include: farm dams classified as natural wetland ecosystems, temporary wetlands to the south-east of the south lagoon of the Coorong being classified as permanent, and wetland boundaries adjacent to the Lake Alexandrina that encompass multiple ecosystem types. These errors are mainly associated with wetland types around Lake Alexandrina and the Coorong (M Miles, pers. comm., 2017) but similar examples can be found in all states in areas where fundamental hydrological data and vegetation mapping are limited. The recent update to the ANAE addressed some of these issues but a comprehensive evaluation against the issues raised by Miles and Eckert (2013) has not been conducted.

There was generally good agreement between the ecosystem types identified by the Basin ANAE classification when ground-truthed at Selected Area sampling sites (Brooks 2016). Most discrepancies were related to inaccuracies in the mapping of wetland boundaries rather than fundamental disagreement with the ANAE classification itself. The poorest representation of ecosystem types by the ANAE classification was in the Lachlan river system, Gwydir river system and Junction of the Warrego and Darling rivers Selected Areas (Brooks 2016). The Lachlan and Gwydir valleys were included in the 2017 major update to the ANAE classification which greatly improved the mapping for this and subsequent evaluations of the contribution of Commonwealth environmental water to Ecosystem Diversity in these Valleys (Brooks 2017b). Ecosystem mapping in the Central Murray Forests, the Macquarie Marshes, and Murrumbidgee were also improved in the revision.

A major component of the 2017 ANAE update relied on NSW State vegetation mapping that was incomplete at the time. Mapping for Western NSW and the Central Tablelands (Figure 18) has now been published by the NSW Office of Environment and Heritage (now Department of Planning, Industry and Environment). Integration of these updated maps into the ANAE classification of the Basin will greatly improve wetland and floodplain ecosystem mapping in the Junction of the Warrego and Darling rivers Selected Area and in southwestern NSW along the Darling and Murray River floodplains. These areas all regularly receive Commonwealth environmental water and updating the ANAE classification in these areas to improve the accuracy and consistency of aquatic ecosystem mapping is a high priority. The cumulative evaluation of Ecosystem Diversity can then be retrospectively brought up to date using the revised ANAE maps and inundation mapping collated by LTIM to date.

Appendix 3: ANAE wetland types influenced by Commonwealth environmental water by valley

Lake and wetland types influenced by Commonwealth environmental water are represented by the entire wetland when any portion of the wetland was recorded as having been inundated. The contribution of Commonwealth environmental water to supporting wetland ecosystem diversity within each valley is presented below in Table C1 excluding the Coorong, Lower Lakes and Murray Mouth which are presented in Table 5.

Table A3_1. Area of each lake and wetland ecosystem type and the contribution of Commonwealth environmental water to supporting wetland ecosystem diversity within each valley in 2018–19 (shaded blue).

Valley name	Australian National Aquatic Ecosystem (ANAE) lake and wetland types	Total Area (ha)	Cew Area (ha)	Percent
Avoca	Lst1.1: Temporary saline lake	19 829	0	0.0
Avoca	Pt3.1.2: Clay pan	18 587	0	0.0
Avoca	Pt1.2.2: Temporary black box swamp	4372	0	0.0
Avoca	Lt1.1: Temporary lake	4232	0	0.0
Avoca	Lst1.2: Temporary saline lake with aquatic bed	1820	0	0.0
Avoca	Pst1.1: Temporary saline swamp	1541	0	0.0
Avoca	Pst2.2: Temporary salt marsh	1174	0	0.0
Avoca	Pt1.6.2: Temporary woodland swamp	805	0	0.0
Avoca	Pt2.3.2: Freshwater meadow	723	0	0.0
Avoca	Pt1.7.2: Temporary lignum swamp	720	0	0.0
Avoca	Pst3.2: Salt pan or salt flat	309	0	0.0
Avoca	Psp2.1: Permanent salt marsh	209	0	0.0
Avoca	Pt4.2: Temporary wetland	208	0	0.0
Avoca	Pt1.1.2: Temporary river red gum swamp	145	0	0.0
Avoca	Lsp1.1: Permanent saline lake	137	0	0.0
Avoca	Lp1.1: Permanent lake	61	0	0.0
Avoca	Pt1.8.2: Temporary shrub swamp	51	0	0.0
Avoca	Pp4.2: Permanent wetland	50	0	0.0
Avoca	Pst4: Temporary saline wetland	50	0	0.0
Avoca	Pt4.1: Floodplain or riparian wetland	1	0	0.0
Barwon Darling	Lt1.1: Temporary lake	56 914	0	0.0
Barwon Darling	Lp1.1: Permanent lake	31 479	0	0.0
Barwon Darling	Pt1.6.2: Temporary woodland swamp	16 271	0	0.0
Barwon Darling	Pt1.8.2: Temporary shrub swamp	10 922	0	0.0
Barwon Darling	Pt1.2.2: Temporary black box swamp	2961	0	0.0
Barwon Darling	Pp4.2: Permanent wetland	2566	0	0.0
Barwon Darling	Pt2.3.2: Freshwater meadow	1225	0	0.0
Barwon Darling	Pt2.2.2: Temporary sedge/grass/forb marsh	1217	0	0.0
Barwon Darling	Pt1.1.2: Temporary river red gum swamp	378	0	0.0
Barwon Darling	Pt3.1.2: Clay pan	151	0	0.0
Barwon Darling	Pt1.3.2: Temporary coolibah swamp	64	0	0.0
Barwon Darling	Pps5: Permanent spring	0	0	0.0
Border Rivers	Pt2.2.2: Temporary sedge/grass/forb marsh	8659	0	0.0
Border Rivers	Pt4.2: Temporary wetland	3001	0	0.0
Border Rivers	Pt1.6.2: Temporary woodland swamp	2484	0	0.0
Border Rivers	Pp2.2.2: Permanent sedge/grass/forb marsh	1405	0	0.0
Border Rivers	Pp4.2: Permanent wetland	1097	0	0.0
Border Rivers	Lp1.1: Permanent lake	936	0	0.0
Border Rivers	Pt1.1.2: Temporary river red gum swamp	718	0	0.0
Border Rivers	Lt1.1: Temporary lake	655	0	0.0
Border Rivers	Pp3: Peat bog or fen marsh	633	0	0.0
Border Rivers	Pt2.3.2: Freshwater meadow	592	0	0.0
Border Rivers	Pt1.3.2: Temporary coolibah swamp	493	0	0.0
Border Rivers	Lp1.2: Permanent lake with aquatic bed	227	0	0.0
Border Rivers	Pt3.1.2: Clay pan	214	0	0.0

Border Rivers	Pt2.1.2: Temporary tall emergent marsh	96	0	0.0
Border Rivers	Pp2.3.2: Permanent grass marsh	26	0	0.0
Border Rivers	Lt1.2: Temporary lake with aquatic bed	12	0	0.0
Border Rivers	Pt1.2.2: Temporary black box swamp	9	0	0.0
Border Rivers	Pt1.8.2: Temporary shrub swamp	3	0	0.0
Border Rivers	Pst1.1: Temporary saline swamp	2	0	0.0
Border Rivers	Pps5: Permanent spring	0	0	0.0
Broken	Lp1.1: Permanent lake	3305	0	0.0
Broken	Pt3.1.2: Clay pan	2998	0	0.0
Broken	Pt1.1.2: Temporary river red gum swamp	1911	0	0.0
Broken	Pt1.6.2: Temporary woodland swamp	427	0	0.0
Broken	Pt2.3.2: Freshwater meadow	268	0	0.0
Broken	Pt1.7.2: Temporary lignum swamp	192	0	0.0
Broken	Lt1.1: Temporary lake	104	0	0.0
Broken	Pt2.1.2: Temporary tall emergent marsh	98	0	0.0
Broken	Pt1.2.2: Temporary black box swamp	84	0	0.0
Broken	Pt2.2.2: Temporary sedge/grass/forb marsh	77	0	0.0
Broken	Pt4.1: Floodplain or riparian wetland	66	0	0.0
Broken	Pp4.2: Permanent wetland	43	0	0.0
Broken	Pps5: Permanent spring	0	0	0.0
Campaspe	Pt3.1.2: Clay pan	1887	0	0.0
Campaspe	Pt1.1.2: Temporary river red gum swamp	280	0	0.0
Campaspe	Pt1.6.2: Temporary woodland swamp	232	0	0.0
Campaspe	Lt1.1: Temporary lake	49	0	0.0
Campaspe	Pt2.1.2: Temporary tall emergent marsh	24	0	0.0
Campaspe	Lp1.1: Permanent lake	12	0	0.0
Campaspe	Pt2.3.2: Freshwater meadow	10	0	0.0
Campaspe	Pp4.2: Permanent wetland	4	0	0.0
Campaspe	Pps5: Permanent spring	1	0	0.0
Castlereagh	Pt2.2.2: Temporary sedge/grass/forb marsh	10 737	0	0.0
Castlereagh	Lt1.1: Temporary lake	456	0	0.0
Castlereagh	Pt1.8.2: Temporary shrub swamp	51	0	0.0
Castlereagh	Pt1.6.2: Temporary woodland swamp	35	0	0.0
Castlereagh	Pt3.1.2: Clay pan	30	0	0.0
Castlereagh	Pt1.2.2: Temporary black box swamp	26	0	0.0
Castlereagh	Pp4.2: Permanent wetland	18	0	0.0
Castlereagh	Pt2.1.2: Temporary tall emergent marsh	16	0	0.0
Castlereagh	Pp2.2.2: Permanent sedge/grass/forb marsh	8	0	0.0
Castlereagh	Lp1.1: Permanent lake	6	0	0.0
Castlereagh	Pt1.1.2: Temporary river red gum swamp	1	0	0.0
Castlereagh	Pt2.3.2: Freshwater meadow	1	0	0.0
Castlereagh	Pps5: Permanent spring	1	0	0.0
Central Murray	Pt1.1.2: Temporary river red gum swamp	38 447	23 879	62.1
Central Murray	Lp1.1: Permanent lake	4518	1778	39.4
Central Murray	Pp4.2: Permanent wetland	9222	971	10.5
Central Murray	Pt2.2.2: Temporary sedge/grass/forb marsh	2856	820	28.7
Central Murray	Pt2.1.2: Temporary tall emergent marsh	1475	711	48.2
Central Murray	Pp2.1.2: Permanent tall emergent marsh	1169	707	60.5
Central Murray	Pt4.2: Temporary wetland	654	586	89.6
Central Murray	Pt1.6.2: Temporary woodland swamp	1543	437	28.3
Central Murray	Lt1.1: Temporary lake	13 062	301	2.3
Central Murray	Pt2.3.2: Freshwater meadow	5185	198	3.8
Central Murray	Pt1.2.2: Temporary black box swamp	4137	97	2.3
Central Murray	Pt1.8.2: Temporary shrub swamp	638	56	8.8
Central Murray	Pt3.1.2: Clay pan	17 536	46	0.3
Central Murray	Pt4.1: Floodplain or riparian wetland	462	9	1.9
Central Murray	Pp2.4.2: Permanent forb marsh	133	7	5.3
Central Murray	Pp2.3.2: Permanent grass marsh	80	2	2.5
Central Murray	Pp2.2.2: Permanent sedge/grass/forb marsh	45	2	4.4
Central Murray	Pst2.2: Temporary salt marsh	2122	0	0.0
Central Murray	Pst4: Temporary saline wetland	2114	0	0.0
Central Murray	Pt1.7.2: Temporary lignum swamp	1602	0	0.0
Central Murray	Lst1.1: Temporary saline lake	1303	0	0.0

Central Murray	Pst3.2: Salt pan or salt flat	732	0	0.0
Central Murray	Psp4: Permanent saline wetland	642	0	0.0
Central Murray	Lsp1.1: Permanent saline lake	461	0	0.0
Central Murray	Pst1.1: Temporary saline swamp	22	0	0.0
Condamine Balonne	Pt2.1.2: Temporary tall emergent marsh	38 236	0	0.0
Condamine Balonne	Pt1.8.2: Temporary shrub swamp	29 303	0	0.0
Condamine Balonne	Pt1.6.2: Temporary woodland swamp	13 223	0	0.0
Condamine Balonne	Pt1.7.2: Temporary lignum swamp	11 804	0	0.0
Condamine Balonne	Lt1.1: Temporary lake	11 526	0	0.0
Condamine Balonne	Lp1.1: Permanent lake	6454	0	0.0
Condamine Balonne	Pt4.2: Temporary wetland	6399	0	0.0
Condamine Balonne	Pt1.2.2: Temporary black box swamp	4684	0	0.0
Condamine Balonne	Pt2.2.2: Temporary sedge/grass/forb marsh	4248	0	0.0
Condamine Balonne	Pt2.3.2: Freshwater meadow	4102	0	0.0
Condamine Balonne	Pp4.2: Permanent wetland	3754	0	0.0
Condamine Balonne	Pp2.1.2: Permanent tall emergent marsh	2522	0	0.0
Condamine Balonne	Pt1.3.2: Temporary coolibah swamp	2423	0	0.0
Condamine Balonne	Pt3.1.2: Clay pan	1872	0	0.0
Condamine Balonne	Lp1.2: Permanent lake with aquatic bed	1648	0	0.0
Condamine Balonne	Lst1.1: Temporary saline lake	1624	0	0.0
Condamine Balonne	Pt1.1.2: Temporary river red gum swamp	1116	0	0.0
Condamine Balonne	Lt1.2: Temporary lake with aquatic bed	684	0	0.0
Condamine Balonne	Pt1.5.2: Temporary paperbark swamp	95	0	0.0
Condamine Balonne	Pp2.3.2: Permanent grass marsh	23	0	0.0
Condamine Balonne	Pps5: Permanent spring	6	0	0.0
Condamine Balonne	Lsp1.1: Permanent saline lake	3	0	0.0
Condamine Balonne	Pst4: Temporary saline wetland	1	0	0.0
Edward Wakool	Pp4.2: Permanent wetland	814	3	0.4
Edward Wakool	Pt3.1.2: Clay pan	3581	0	0.0
Edward Wakool	Pt1.2.2: Temporary black box swamp	1663	0	0.0
Edward Wakool	Pt1.1.2: Temporary river red gum swamp	1318	0	0.0
Edward Wakool	Lt1.1: Temporary lake	886	0	0.0
Edward Wakool	Pt2.3.2: Freshwater meadow	628	0	0.0
Edward Wakool	Pt1.6.2: Temporary woodland swamp	421	0	0.0
Edward Wakool	Pt1.8.2: Temporary shrub swamp	280	0	0.0
Edward Wakool	Pt2.2.2: Temporary sedge/grass/forb marsh	213	0	0.0
Edward Wakool	Pt1.7.2: Temporary lignum swamp	175	0	0.0
Edward Wakool	Lp1.1: Permanent lake	131	0	0.0
Edward Wakool	Pt2.1.2: Temporary tall emergent marsh	59	0	0.0
Edward Wakool	Pp2.3.2: Permanent grass marsh	19	0	0.0
Edward Wakool	Pp2.1.2: Permanent tall emergent marsh	7	0	0.0
Edward Wakool	Psp4: Permanent saline wetland	6	0	0.0
Edward Wakool	Pst1.1: Temporary saline swamp	5	0	0.0
Edward Wakool	Pp2.2.2: Permanent sedge/grass/forb marsh	1	0	0.0
Goulburn	Pt3.1.2: Clay pan	10 949	0	0.0
Goulburn	Pt1.1.2: Temporary river red gum swamp	5177	0	0.0
Goulburn	Lt1.1: Temporary lake	1598	0	0.0
Goulburn	Lp1.1: Permanent lake	1086	0	0.0
Goulburn	Pp4.2: Permanent wetland	1060	0	0.0
Goulburn	Pt1.6.2: Temporary woodland swamp	869	0	0.0
Goulburn	Pt2.1.2: Temporary tall emergent marsh	828	0	0.0
Goulburn	Pt2.3.2: Freshwater meadow	815	0	0.0
Goulburn	Pt1.7.2: Temporary lignum swamp	631	0	0.0
Goulburn	Pp2.4.2: Permanent forb marsh	571	0	0.0
Goulburn	Lst1.2: Temporary saline lake with aquatic bed	238	0	0.0
Goulburn	Pt2.2.2: Temporary sedge/grass/forb marsh	189	0	0.0
Goulburn	Pt4.1: Floodplain or riparian wetland	184	0	0.0
Goulburn	Pt1.2.2: Temporary black box swamp	118	0	0.0
Goulburn	Lsp1.1: Permanent saline lake	46	0	0.0
Goulburn	Lst1.1: Temporary saline lake	25	0	0.0
Goulburn	Pt4.2: Temporary wetland	19	0	0.0
Goulburn	Pp2.1.2: Permanent tall emergent marsh	4	0	0.0
Goulburn	Pst4: Temporary saline wetland	2	0	0.0

Goulburn	Pt1.8.2: Temporary shrub swamp	2	0	0.0
Goulburn	Pps5: Permanent spring	0	0	0.0
Gwydir	Pt2.2.2: Temporary sedge/grass/forb marsh	10 051	6626	65.9
Gwydir	Pt2.1.2: Temporary tall emergent marsh	373	373	100.0
Gwydir	Pt3.1.2: Clay pan	236	42	17.8
Gwydir	Lp1.1: Permanent lake	77	26	33.8
Gwydir	Lt1.1: Temporary lake	1142	26	2.3
Gwydir	Pt1.6.2: Temporary woodland swamp	183	1	0.5
Gwydir	Pp4.2: Permanent wetland	354	1	0.3
Gwydir	Pp2.2.2: Permanent sedge/grass/forb marsh	1579	0	0.0
Gwydir	Pt4.2: Temporary wetland	365	0	0.0
Gwydir	Pp3: Peat bog or fen marsh	185	0	0.0
Gwydir	Pt1.8.2: Temporary shrub swamp	92	0	0.0
Gwydir	Pt1.1.2: Temporary river red gum swamp	13	0	0.0
Gwydir	Pt1.3.2: Temporary coolibah swamp	9	0	0.0
Gwydir	Pt2.3.2: Freshwater meadow	6	0	0.0
Gwydir	Pt1.2.2: Temporary black box swamp	4	0	0.0
Gwydir	Pp1.1.2: Permanent paperbark swamp	1	0	0.0
Gwydir	Pps5: Permanent spring	0	0	0.0
Kiewa	Pp4.2: Permanent wetland	749	0	0.0
Kiewa	Pt3.1.2: Clay pan	323	0	0.0
Kiewa	Pt1.6.2: Temporary woodland swamp	39	0	0.0
Kiewa	Lp1.1: Permanent lake	37	0	0.0
Kiewa	Pt1.1.2: Temporary river red gum swamp	25	0	0.0
Kiewa	Pt2.2.2: Temporary sedge/grass/forb marsh	12	0	0.0
Kiewa	Pt2.1.2: Temporary tall emergent marsh	3	0	0.0
Kiewa	Pps5: Permanent spring	0	0	0.0
Lachlan	Pp2.1.2: Permanent tall emergent marsh	3450	3449	100.0
Lachlan	Pt2.1.2: Temporary tall emergent marsh	588	408	69.4
Lachlan	Pt2.3.2: Freshwater meadow	21 013	104	0.5
Lachlan	Lt1.1: Temporary lake	32 280	45	0.1
Lachlan	Pt2.2.2: Temporary sedge/grass/forb marsh	13 535	39	0.3
Lachlan	Pp4.2: Permanent wetland	2914	10	0.3
Lachlan	Pst2.2: Temporary salt marsh	30 311	0	0.0
Lachlan	Pt1.7.2: Temporary lignum swamp	22 220	0	0.0
Lachlan	Pt1.8.2: Temporary shrub swamp	21 194	0	0.0
Lachlan	Pt1.2.2: Temporary black box swamp	15 294	0	0.0
Lachlan	Pt3.1.2: Clay pan	14 938	0	0.0
Lachlan	Lp1.1: Permanent lake	7405	0	0.0
Lachlan	Pt1.6.2: Temporary woodland swamp	3305	0	0.0
Lachlan	Pt1.1.2: Temporary river red gum swamp	2206	0	0.0
Lachlan	Pt4.2: Temporary wetland	348	0	0.0
Lachlan	Pp2.2.2: Permanent sedge/grass/forb marsh	63	0	0.0
Lachlan	Pp2.3.2: Permanent grass marsh	44	0	0.0
Lachlan	Pps5: Permanent spring	7	0	0.0
Loddon	Pt3.1.2: Clay pan	12 139	0	0.0
Loddon	Lp1.1: Permanent lake	5976	0	0.0
Loddon	Pt1.2.2: Temporary black box swamp	5762	0	0.0
Loddon	Pt1.7.2: Temporary lignum swamp	3995	0	0.0
Loddon	Pt2.3.2: Freshwater meadow	3483	0	0.0
Loddon	Lst1.1: Temporary saline lake	1478	0	0.0
Loddon	Pt1.6.2: Temporary woodland swamp	1404	0	0.0
Loddon	Pst1.1: Temporary saline swamp	1379	0	0.0
Loddon	Pt1.1.2: Temporary river red gum swamp	1256	0	0.0
Loddon	Lsp1.1: Permanent saline lake	1252	0	0.0
Loddon	Lt1.1: Temporary lake	417	0	0.0
Loddon	Pp4.2: Permanent wetland	314	0	0.0
Loddon	Lsp1.2: Permanent saline lake with aquatic bed	181	0	0.0
Loddon	Pt1.8.2: Temporary shrub swamp	109	0	0.0
Loddon	Pst3.2: Salt pan or salt flat	109	0	0.0
Loddon	Pst4: Temporary saline wetland	55	0	0.0
Loddon	Lt1.2: Temporary lake with aquatic bed	55	0	0.0
Loddon	Pt2.1.2: Temporary tall emergent marsh	54	0	0.0

Loddon	Psp2.1: Permanent salt marsh	37	0	0.0
Loddon	Pst2.2: Temporary salt marsh	28	0	0.0
Loddon	Pps5: Permanent spring	4	0	0.0
Lower Darling	Lt1.1: Temporary lake	187 338	0	0.0
Lower Darling	Pt1.8.2: Temporary shrub swamp	103 569	0	0.0
Lower Darling	Lp1.1: Permanent lake	9685	0	0.0
Lower Darling	Pt2.3.2: Freshwater meadow	8082	0	0.0
Lower Darling	Pt1.6.2: Temporary woodland swamp	4422	0	0.0
Lower Darling	Pt1.2.2: Temporary black box swamp	1921	0	0.0
Lower Darling	Pt3.1.2: Clay pan	1470	0	0.0
Lower Darling	Pp4.2: Permanent wetland	1221	0	0.0
Lower Darling	Pt1.1.2: Temporary river red gum swamp	879	0	0.0
Lower Darling	Lst1.1: Temporary saline lake	509	0	0.0
Lower Darling	Pt4.2: Temporary wetland	53	0	0.0
Lower Darling	Pp2.3.2: Permanent grass marsh	26	0	0.0
Lower Darling	Pst2.2: Temporary salt marsh	4	0	0.0
Lower Murray	Pt4.1: Floodplain or riparian wetland	10 366	2073	20.0
Lower Murray	Lp1.1: Permanent lake	21 883	923	4.2
Lower Murray	Lt1.1: Temporary lake	30 741	825	2.7
Lower Murray	Pt1: Temporary swamp	3767	675	17.9
Lower Murray	Psp4: Permanent saline wetland	1430	639	44.7
Lower Murray	Pt2.3.2: Freshwater meadow	8976	627	7.0
Lower Murray	Pp4.2: Permanent wetland	4377	625	14.3
Lower Murray	Pst1.1: Temporary saline swamp	1974	316	16.0
Lower Murray	Pt3.1.2: Clay pan	9909	291	2.9
Lower Murray	Pt2.1.2: Temporary tall emergent marsh	6002	132	2.2
Lower Murray	Pt1.1.2: Temporary river red gum swamp	503	71	14.1
Lower Murray	Pt2.2.2: Temporary sedge/grass/forb marsh	4502	24	0.5
Lower Murray	Pp2.3.2: Permanent grass marsh	109	22	20.2
Lower Murray	Pt1.8.2: Temporary shrub swamp	3006	13	0.4
Lower Murray	Pt1.7.2: Temporary lignum swamp	2651	8	0.3
Lower Murray	Pt1.2.2: Temporary black box swamp	412	6	1.5
Lower Murray	Pp2.1.2: Permanent tall emergent marsh	11	0	0.0
Lower Murray	Pt4.2: Temporary wetland	4954	0	0.0
Lower Murray	Pu1: Unspecified wetland	1763	0	0.0
Lower Murray	Lst1.1: Temporary saline lake	1529	0	0.0
Lower Murray	Pt1.6.2: Temporary woodland swamp	862	0	0.0
Lower Murray	Pst3.2: Salt pan or salt flat	465	0	0.0
Lower Murray	Lsp1.1: Permanent saline lake	432	0	0.0
Lower Murray	Pst4: Temporary saline wetland	187	0	0.0
Lower Murray	Pt1.5.2: Temporary paperbark swamp	132	0	0.0
Lower Murray	Pst2.2: Temporary salt marsh	67	0	0.0
Lower Murray	Pp2.4.2: Permanent forb marsh	36	0	0.0
Lower Murray	Pps5: Permanent spring	2	0	0.0
Macquarie	Pp4.2: Permanent wetland	18 998	17 994	94.7
Macquarie	Pt2.2.2: Temporary sedge/grass/forb marsh	41 785	6406	15.3
Macquarie	Pt1.1.2: Temporary river red gum swamp	5783	5018	86.8
Macquarie	Pt2.1.2: Temporary tall emergent marsh	3014	2379	78.9
Macquarie	Pt1.8.2: Temporary shrub swamp	1704	194	11.4
Macquarie	Pt1.6.2: Temporary woodland swamp	2636	141	5.3
Macquarie	Pt1.2.2: Temporary black box swamp	1919	55	2.9
Macquarie	Lt1.1: Temporary lake	9214	30	0.3
Macquarie	Pp2.2.2: Permanent sedge/grass/forb marsh	46	15	32.6
Macquarie	Pt3.1.2: Clay pan	1895	4	0.2
Macquarie	Pt2.3.2: Freshwater meadow	2348	0	0.0
Macquarie	Pt1.3.2: Temporary coolibah swamp	1434	0	0.0
Macquarie	Lp1.1: Permanent lake	814	0	0.0
Macquarie	Pps5: Permanent spring	15	0	0.0
Macquarie	Pp3: Peat bog or fen marsh	9	0	0.0
Macquarie	Pt4.2: Temporary wetland	8	0	0.0
Mitta Mitta	Pp4.2: Permanent wetland	984	0	0.0
Mitta Mitta	Pt2.3.2: Freshwater meadow	626	0	0.0
Mitta Mitta	Pt3.1.2: Clay pan	594	0	0.0

Mitta Mitta	Pt1.6.2: Temporary woodland swamp	562	0	0.0
Mitta Mitta	Pt1.8.2: Temporary shrub swamp	449	0	0.0
Mitta Mitta	Lp1.1: Permanent lake	86	0	0.0
Mitta Mitta	Pt4.2: Temporary wetland	57	0	0.0
Mitta Mitta	Pt1.1.2: Temporary river red gum swamp	3	0	0.0
Murrumbidgee	Pt1.1.2: Temporary river red gum swamp	7371	4465	60.6
Murrumbidgee	Pp4.2: Permanent wetland	8910	2280	25.6
Murrumbidgee	Pt2.2.2: Temporary sedge/grass/forb marsh	30 863	1561	5.1
Murrumbidgee	Pt1.8.2: Temporary shrub swamp	22 695	1244	5.5
Murrumbidgee	Pt3.1.2: Clay pan	17 188	760	4.4
Murrumbidgee	Lp1.1: Permanent lake	1484	662	44.6
Murrumbidgee	Pt1.2.2: Temporary black box swamp	4795	136	2.8
Murrumbidgee	Lt1.1: Temporary lake	30 616	64	0.2
Murrumbidgee	Pt2.1.2: Temporary tall emergent marsh	855	26	3.0
Murrumbidgee	Pst2.2: Temporary salt marsh	1739	8	0.5
Murrumbidgee	Pt2.3.2: Freshwater meadow	35 225	3	<0.1
Murrumbidgee	Pp2.3.2: Permanent grass marsh	36	0	0.0
Murrumbidgee	Pp2.2.2: Permanent sedge/grass/forb marsh	31	0	0.0
Murrumbidgee	Pp3: Peat bog or fen marsh	1784	0	0.0
Murrumbidgee	Pt1.6.2: Temporary woodland swamp	1611	0	0.0
Murrumbidgee	Pt4.2: Temporary wetland	1475	0	0.0
Murrumbidgee	Pt1.7.2: Temporary lignum swamp	1464	0	0.0
Murrumbidgee	Pp2.1.2: Permanent tall emergent marsh	186	0	0.0
Murrumbidgee	Pps5: Permanent spring	19	0	0.0
Namoi	Pp4.2: Permanent wetland	11 298	0	0.0
Namoi	Pt3.1.2: Clay pan	5331	0	0.0
Namoi	Pt2.2.2: Temporary sedge/grass/forb marsh	5183	0	0.0
Namoi	Lp1.1: Permanent lake	5123	0	0.0
Namoi	Pt1.6.2: Temporary woodland swamp	3427	0	0.0
Namoi	Pt4.2: Temporary wetland	2900	0	0.0
Namoi	Lt1.1: Temporary lake	2604	0	0.0
Namoi	Pt1.2.2: Temporary black box swamp	1771	0	0.0
Namoi	Pt1.1.2: Temporary river red gum swamp	1618	0	0.0
Namoi	Pt2.3.2: Freshwater meadow	622	0	0.0
Namoi	Pt1.3.2: Temporary coolibah swamp	609	0	0.0
Namoi	Pt1.8.2: Temporary shrub swamp	567	0	0.0
Namoi	Pp2.2.2: Permanent sedge/grass/forb marsh	392	0	0.0
Namoi	Pp3: Peat bog or fen marsh	17	0	0.0
Namoi	Pt1.7.2: Temporary lignum swamp	16	0	0.0
Namoi	Pps5: Permanent spring	1	0	0.0
Ovens	Pt3.1.2: Clay pan	2015	0	0.0
Ovens	Pt2.3.2: Freshwater meadow	915	0	0.0
Ovens	Pt1.6.2: Temporary woodland swamp	818	0	0.0
Ovens	Pt1.1.2: Temporary river red gum swamp	441	0	0.0
Ovens	Pp4.2: Permanent wetland	213	0	0.0
Ovens	Pt4.2: Temporary wetland	106	0	0.0
Ovens	Lp1.1: Permanent lake	80	0	0.0
Ovens	Pt2.1.2: Temporary tall emergent marsh	47	0	0.0
Ovens	Pt2.2.2: Temporary sedge/grass/forb marsh	45	0	0.0
Ovens	Pp2.1.2: Permanent tall emergent marsh	30	0	0.0
Ovens	Pt4.1: Floodplain or riparian wetland	23	0	0.0
Ovens	Lt1.1: Temporary lake	4	0	0.0
Ovens	Pps5: Permanent spring	0	0	0.0
Paroo	Pt1.6.2: Temporary woodland swamp	152 703	0	0.0
Paroo	Lt1.1: Temporary lake	44 652	0	0.0
Paroo	Pt1.8.2: Temporary shrub swamp	29 765	0	0.0
Paroo	Lp1.1: Permanent lake	18 283	0	0.0
Paroo	Pt2.1.2: Temporary tall emergent marsh	12 485	0	0.0
Paroo	Pt1.2.2: Temporary black box swamp	8427	0	0.0
Paroo	Pt2.3.2: Freshwater meadow	7398	0	0.0
Paroo	Lsp1.1: Permanent saline lake	5868	0	0.0
Paroo	Pp4.2: Permanent wetland	4470	0	0.0
Paroo	Pt2.2.2: Temporary sedge/grass/forb marsh	4165	0	0.0

Paroo	Pt1.7.2: Temporary lignum swamp	3471	0	0.0
Paroo	Pt1.3.2: Temporary coolibah swamp	1932	0	0.0
Paroo	Pst2.2: Temporary salt marsh	1449	0	0.0
Paroo	Pp2.1.2: Permanent tall emergent marsh	586	0	0.0
Paroo	Lst1.1: Temporary saline lake	371	0	0.0
Paroo	Pt1.1.2: Temporary river red gum swamp	111	0	0.0
Paroo	Pst4: Temporary saline wetland	77	0	0.0
Paroo	Pt3.1.2: Clay pan	31	0	0.0
Paroo	Pt4.2: Temporary wetland	17	0	0.0
Paroo	Pps5: Permanent spring	9	0	0.0
Upper Murray	Pp3: Peat bog or fen marsh	1611	0	0.0
Upper Murray	Pt3.1.2: Clay pan	1457	0	0.0
Upper Murray	Pp2.3.2: Permanent grass marsh	1144	0	0.0
Upper Murray	Pt2.2.2: Temporary sedge/grass/forb marsh	725	0	0.0
Upper Murray	Pp4.2: Permanent wetland	408	0	0.0
Upper Murray	Pt1.1.2: Temporary river red gum swamp	290	0	0.0
Upper Murray	Pt1.6.2: Temporary woodland swamp	137	0	0.0
Upper Murray	Lp1.1: Permanent lake	94	0	0.0
Upper Murray	Pps5: Permanent spring	63	0	0.0
Upper Murray	Lt1.1: Temporary lake	50	0	0.0
Upper Murray	Pt4.2: Temporary wetland	50	0	0.0
Upper Murray	Pt2.3.2: Freshwater meadow	24	0	0.0
Upper Murray	Pp2.1.2: Permanent tall emergent marsh	16	0	0.0
Upper Murray	Pt2.1.2: Temporary tall emergent marsh	3	0	0.0
Upper Murray	Pp2.2.2: Permanent sedge/grass/forb marsh	1	0	0.0
Warrego	Pt2.3.2: Freshwater meadow	19 130	0	0.0
Warrego	Pt1.6.2: Temporary woodland swamp	4611	0	0.0
Warrego	Pt2.1.2: Temporary tall emergent marsh	4389	0	0.0
Warrego	Pt1.8.2: Temporary shrub swamp	3691	0	0.0
Warrego	Lp1.1: Permanent lake	3277	0	0.0
Warrego	Pp4.2: Permanent wetland	3227	0	0.0
Warrego	Lt1.1: Temporary lake	2330	0	0.0
Warrego	Pt1.3.2: Temporary coolibah swamp	1307	0	0.0
Warrego	Pt2.2.2: Temporary sedge/grass/forb marsh	875	0	0.0
Warrego	Pt3.1.2: Clay pan	653	0	0.0
Warrego	Pt4.2: Temporary wetland	265	0	0.0
Warrego	Pp2.1.2: Permanent tall emergent marsh	23	0	0.0
Warrego	Pt1.1.2: Temporary river red gum swamp	12	0	0.0
Warrego	Pps5: Permanent spring	2	0	0.0
Warrego	Pst1.1: Temporary saline swamp	2	0	0.0
Wimmera	Lt1.1: Temporary lake	25 070	0	0.0
Wimmera	Lt1.2: Temporary lake with aquatic bed	8300	0	0.0
Wimmera	Pt1.8.2: Temporary shrub swamp	5885	0	0.0
Wimmera	Pt3.1.2: Clay pan	4918	0	0.0
Wimmera	Pt1.1.2: Temporary river red gum swamp	4712	0	0.0
Wimmera	Pt2.3.2: Freshwater meadow	3729	0	0.0
Wimmera	Pst4: Temporary saline wetland	3311	0	0.0
Wimmera	Pt1.6.2: Temporary woodland swamp	3222	0	0.0
Wimmera	Pst1.1: Temporary saline swamp	2232	0	0.0
Wimmera	Pt1.2.2: Temporary black box swamp	1912	0	0.0
Wimmera	Pst3.2: Salt pan or salt flat	1633	0	0.0
Wimmera	Lp1.1: Permanent lake	1541	0	0.0
Wimmera	Lst1.1: Temporary saline lake	1132	0	0.0
Wimmera	Pt4.2: Temporary wetland	559	0	0.0
Wimmera	Pst2.2: Temporary salt marsh	404	0	0.0
Wimmera	Lp1.2: Permanent lake with aquatic bed	192	0	0.0
Wimmera	Pt1.5.2: Temporary paperbark swamp	185	0	0.0
Wimmera	Lst1.2: Temporary saline lake with aquatic bed	180	0	0.0
Wimmera	Pt1.7.2: Temporary lignum swamp	174	0	0.0
Wimmera	Pp4.2: Permanent wetland	145	0	0.0
Wimmera	Pt2.1.2: Temporary tall emergent marsh	127	0	0.0
Wimmera	Pt4.1: Floodplain or riparian wetland	111	0	0.0
Wimmera	Psp1.1: Saline paperbark swamp	31	0	0.0

Wimmera	Lsp1.1: Permanent saline lake	24	0	0.0
Wimmera	Psp4: Permanent saline wetland	16	0	0.0

Appendix 4. ANAE floodplain types inundated by Commonwealth environmental water by valley

For floodplains, the area inundated by out-of-channel delivery of Commonwealth environmental water is presented in Table D1.

Table A4_1. Area of each floodplain ecosystem type and the contribution of Commonwealth environmental water to supporting floodplain ecosystem diversity within each valley in 2018–19 (shaded blue).

Valley name	Australian National Aquatic Ecosystem (ANAE) lake and wetland types	Total Area (ha)	Cew Area (ha)	Percent
Avoca	F1.4: River red gum woodland riparian zone or floodplain	3128	0	0.0
Avoca	F1.8: Black box woodland riparian zone or floodplain	2988	0	0.0
Avoca	F1.6: Black box forest riparian zone or floodplain	977	0	0.0
Avoca	F1.12: Woodland riparian zone or floodplain	891	0	0.0
Avoca	F2.2: Lignum shrubland riparian zone or floodplain	80	0	0.0
Avoca	F2.4: Shrubland riparian zone or floodplain	4	0	0.0
Avoca	F1.2: River red gum forest riparian zone or floodplain	1	0	0.0
Barwon Darling	F3.2: Sedge/forb/grassland riparian zone or floodplain	238 710	0	0.0
Barwon Darling	F1.8: Black box woodland riparian zone or floodplain	76 020	0	0.0
Barwon Darling	F1.10: Coolibah woodland and forest riparian zone or floodplain	65 076	0	0.0
Barwon Darling	F2.4: Shrubland riparian zone or floodplain	38 493	0	0.0
Barwon Darling	F1.6: Black box forest riparian zone or floodplain	26 563	0	0.0
Barwon Darling	F4: Unspecified riparian zone or floodplain	19 854	0	0.0
Barwon Darling	F1.2: River red gum forest riparian zone or floodplain	4951	0	0.0
Barwon Darling	F1.12: Woodland riparian zone or floodplain	4545	0	0.0
Barwon Darling	F2.2: Lignum shrubland riparian zone or floodplain	1154	0	0.0
Barwon Darling	F1.4: River red gum woodland riparian zone or floodplain	357	0	0.0
Barwon Darling	F1.11: River cooba woodland riparian zone or floodplain	17	0	0.0
Border Rivers	F1.10: Coolibah woodland and forest riparian zone or floodplain	73 063	0	0.0
Border Rivers	F1.2: River red gum forest riparian zone or floodplain	26 218	0	0.0
Border Rivers	F1.12: Woodland riparian zone or floodplain	24 908	0	0.0
Border Rivers	F3.2: Sedge/forb/grassland riparian zone or floodplain	14 098	0	0.0
Border Rivers	F4: Unspecified riparian zone or floodplain	2749	0	0.0
Border Rivers	F2.2: Lignum shrubland riparian zone or floodplain	2383	0	0.0
Border Rivers	F1.11: River cooba woodland riparian zone or floodplain	2322	0	0.0
Border Rivers	F1.8: Black box woodland riparian zone or floodplain	1788	0	0.0
Border Rivers	F1.6: Black box forest riparian zone or floodplain	803	0	0.0
Border Rivers	F1.4: River red gum woodland riparian zone or floodplain	655	0	0.0
Border Rivers	F2.4: Shrubland riparian zone or floodplain	323	0	0.0
Broken	F1.4: River red gum woodland riparian zone or floodplain	4503	0	0.0
Broken	F1.12: Woodland riparian zone or floodplain	1355	0	0.0
Broken	F1.8: Black box woodland riparian zone or floodplain	61	0	0.0
Broken	F1.2: River red gum forest riparian zone or floodplain	20	0	0.0
Broken	F2.2: Lignum shrubland riparian zone or floodplain	6	0	0.0
Campaspe	F1.4: River red gum woodland riparian zone or floodplain	2961	0	0.0
Campaspe	F1.12: Woodland riparian zone or floodplain	1966	0	0.0
Campaspe	F1.2: River red gum forest riparian zone or floodplain	17	0	0.0
Campaspe	F2.2: Lignum shrubland riparian zone or floodplain	1	0	0.0
Castlereagh	F1.10: Coolibah woodland and forest riparian zone or floodplain	41 417	0	0.0
Castlereagh	F1.8: Black box woodland riparian zone or floodplain	31 874	0	0.0
Castlereagh	F1.2: River red gum forest riparian zone or floodplain	11 973	0	0.0
Castlereagh	F1.6: Black box forest riparian zone or floodplain	4553	0	0.0
Castlereagh	F1.12: Woodland riparian zone or floodplain	4156	0	0.0
Castlereagh	F2.4: Shrubland riparian zone or floodplain	1725	0	0.0
Castlereagh	F1.4: River red gum woodland riparian zone or floodplain	214	0	0.0

Valley name	Australian National Aquatic Ecosystem (ANAE) lake and wetland types	Total Area (ha)	Cew Area (ha)	Percent
Castlereagh	F2.2: Lignum shrubland riparian zone or floodplain	102	0	0.0
Castlereagh	F1.11: River cooba woodland riparian zone or floodplain	61	0	0.0
Central Murray	F1.2: River red gum forest riparian zone or floodplain	161 186	3881	2.4
Central Murray	F1.4: River red gum woodland riparian zone or floodplain	23 554	175	0.7
Central Murray	F1.12: Woodland riparian zone or floodplain	6760	56	0.8
Central Murray	F1.8: Black box woodland riparian zone or floodplain	48 213	20	<0.1
Central Murray	F2.4: Shrubland riparian zone or floodplain	1245	2	0.2
Central Murray	F1.6: Black box forest riparian zone or floodplain	4414	0	0.0
Central Murray	F2.2: Lignum shrubland riparian zone or floodplain	7212	0	0.0
Central Murray	F4: Unspecified riparian zone or floodplain	671	0	0.0
Condamine Balonne	F1.10: Coolibah woodland and forest riparian zone or floodplain	327 426	0	0.0
Condamine Balonne	F3.2: Sedge/forb/grassland riparian zone or floodplain	290 499	0	0.0
Condamine Balonne	F4: Unspecified riparian zone or floodplain	173 655	0	0.0
Condamine Balonne	F1.12: Woodland riparian zone or floodplain	68 315	0	0.0
Condamine Balonne	F1.8: Black box woodland riparian zone or floodplain	30 578	0	0.0
Condamine Balonne	F1.2: River red gum forest riparian zone or floodplain	18 032	0	0.0
Condamine Balonne	F1.4: River red gum woodland riparian zone or floodplain	13 901	0	0.0
Condamine Balonne	F2.4: Shrubland riparian zone or floodplain	9419	0	0.0
Condamine Balonne	F2.2: Lignum shrubland riparian zone or floodplain	3474	0	0.0
Edward Wakool	F1.2: River red gum forest riparian zone or floodplain	58 568	24	<0.1
Edward Wakool	F1.4: River red gum woodland riparian zone or floodplain	7710	8	0.1
Edward Wakool	F1.8: Black box woodland riparian zone or floodplain	77 935	0	0.0
Edward Wakool	F1.6: Black box forest riparian zone or floodplain	4196	0	0.0
Edward Wakool	F2.4: Shrubland riparian zone or floodplain	2484	0	0.0
Edward Wakool	F2.2: Lignum shrubland riparian zone or floodplain	1858	0	0.0
Goulburn	F1.12: Woodland riparian zone or floodplain	26 248	0	0.0
Goulburn	F1.4: River red gum woodland riparian zone or floodplain	18 088	0	0.0
Goulburn	F1.2: River red gum forest riparian zone or floodplain	5721	0	0.0
Goulburn	F1.8: Black box woodland riparian zone or floodplain	130	0	0.0
Goulburn	F2.4: Shrubland riparian zone or floodplain	35	0	0.0
Goulburn	F2.2: Lignum shrubland riparian zone or floodplain	27	0	0.0
Gwydir	F1.10: Coolibah woodland and forest riparian zone or floodplain	161 514	2126	1.3
Gwydir	F1.11: River cooba woodland riparian zone or floodplain	4501	1050	23.3
Gwydir	F2.2: Lignum shrubland riparian zone or floodplain	656	53	8.1
Gwydir	F1.2: River red gum forest riparian zone or floodplain	15 550	9	<0.1
Gwydir	F2.4: Shrubland riparian zone or floodplain	87	0	0.0
Gwydir	F1.12: Woodland riparian zone or floodplain	15 189	0	0.0
Gwydir	F1.6: Black box forest riparian zone or floodplain	12 186	0	0.0
Gwydir	F1.8: Black box woodland riparian zone or floodplain	5679	0	0.0
Gwydir	F1.4: River red gum woodland riparian zone or floodplain	859	0	0.0
Kiewa	F1.12: Woodland riparian zone or floodplain	2713	0	0.0
Kiewa	F1.4: River red gum woodland riparian zone or floodplain	1436	0	0.0
Lachlan	F1.2: River red gum forest riparian zone or floodplain	96 919	1067	1.1
Lachlan	F1.8: Black box woodland riparian zone or floodplain	100 711	55	<0.1
Lachlan	F2.2: Lignum shrubland riparian zone or floodplain	9694	47	0.5
Lachlan	F1.6: Black box forest riparian zone or floodplain	22 898	14	<0.1
Lachlan	F1.4: River red gum woodland riparian zone or floodplain	4123	1	<0.1
Lachlan	F2.4: Shrubland riparian zone or floodplain	222 840	0	0.0
Lachlan	F1.12: Woodland riparian zone or floodplain	2260	0	0.0
Lachlan	F1.11: River cooba woodland riparian zone or floodplain	3	0	0.0
Lachlan	F3.2: Sedge/forb/grassland riparian zone or floodplain	1	0	0.0
Loddon	F1.4: River red gum woodland riparian zone or floodplain	8031	0	0.0
Loddon	F1.8: Black box woodland riparian zone or floodplain	7835	0	0.0
Loddon	F2.2: Lignum shrubland riparian zone or floodplain	6600	0	0.0
Loddon	F1.12: Woodland riparian zone or floodplain	2524	0	0.0
Loddon	F2.4: Shrubland riparian zone or floodplain	104	0	0.0
Loddon	F1.2: River red gum forest riparian zone or floodplain	100	0	0.0

Valley name	Australian National Aquatic Ecosystem (ANAE) lake and wetland types	Total Area (ha)	Cew Area (ha)	Percent
Loddon	F1.6: Black box forest riparian zone or floodplain	33	0	0.0
Lower Darling	F1.8: Black box woodland riparian zone or floodplain	71 157	0	0.0
Lower Darling	F1.6: Black box forest riparian zone or floodplain	20 532	0	0.0
Lower Darling	F1.2: River red gum forest riparian zone or floodplain	13 158	0	0.0
Lower Darling	F2.4: Shrubland riparian zone or floodplain	11 441	0	0.0
Lower Darling	F1.12: Woodland riparian zone or floodplain	1270	0	0.0
Lower Darling	F4: Unspecified riparian zone or floodplain	279	0	0.0
Lower Darling	F3.2: Sedge/forb/grassland riparian zone or floodplain	106	0	0.0
Lower Darling	F2.2: Lignum shrubland riparian zone or floodplain	8	0	0.0
Lower Murray	F1.4: River red gum woodland riparian zone or floodplain	35 798	242	0.7
Lower Murray	F1.8: Black box woodland riparian zone or floodplain	35 566	208	0.6
Lower Murray	F1.2: River red gum forest riparian zone or floodplain	11 190	136	1.2
Lower Murray	F2.2: Lignum shrubland riparian zone or floodplain	20 410	114	0.6
Lower Murray	F2.4: Shrubland riparian zone or floodplain	27 221	60	0.2
Lower Murray	F4: Unspecified riparian zone or floodplain	567	3	0.5
Lower Murray	F1.11: River cooba woodland riparian zone or floodplain	348	3	0.9
Lower Murray	F1.12: Woodland riparian zone or floodplain	1545	1	<0.1
Lower Murray	F1.6: Black box forest riparian zone or floodplain	109	0	0.0
Macquarie	F1.2: River red gum forest riparian zone or floodplain	73 188	2034	2.8
Macquarie	F1.4: River red gum woodland riparian zone or floodplain	14 799	688	4.6
Macquarie	F1.10: Coolibah woodland and forest riparian zone or floodplain	154 377	175	0.1
Macquarie	F2.4: Shrubland riparian zone or floodplain	41 097	107	0.3
Macquarie	F1.11: River cooba woodland riparian zone or floodplain	2752	84	3.1
Macquarie	F1.6: Black box forest riparian zone or floodplain	20 284	67	0.3
Macquarie	F2.2: Lignum shrubland riparian zone or floodplain	6048	31	0.5
Macquarie	F1.8: Black box woodland riparian zone or floodplain	158 447	22	<0.1
Macquarie	F1.12: Woodland riparian zone or floodplain	6905	0	0.0
Macquarie	F4: Unspecified riparian zone or floodplain	1146	0	0.0
Macquarie	F3.2: Sedge/forb/grassland riparian zone or floodplain	142	0	0.0
Mitta Mitta	F1.12: Woodland riparian zone or floodplain	7466	0	0.0
Mitta Mitta	F1.4: River red gum woodland riparian zone or floodplain	320	0	0.0
Mitta Mitta	F2.4: Shrubland riparian zone or floodplain	37	0	0.0
Mitta Mitta	F1.2: River red gum forest riparian zone or floodplain	0	0	0.0
Murrumbidgee	F1.2: River red gum forest riparian zone or floodplain	127 050	11 940	9.4
Murrumbidgee	F2.2: Lignum shrubland riparian zone or floodplain	70 420	1292	1.8
Murrumbidgee	F2.4: Shrubland riparian zone or floodplain	29 070	316	1.1
Murrumbidgee	F1.6: Black box forest riparian zone or floodplain	9120	175	1.9
Murrumbidgee	F1.4: River red gum woodland riparian zone or floodplain	5154	133	2.6
Murrumbidgee	F1.8: Black box woodland riparian zone or floodplain	95 432	127	0.1
Murrumbidgee	F4: Unspecified riparian zone or floodplain	80	0	0.0
Murrumbidgee	F1.12: Woodland riparian zone or floodplain	49	0	0.0
Murrumbidgee	F1.11: River cooba woodland riparian zone or floodplain	24	0	0.0
Murrumbidgee	F1.10: Coolibah woodland and forest riparian zone or floodplain	23	0	0.0
Namoi	F1.10: Coolibah woodland and forest riparian zone or floodplain	87 799	0	0.0
Namoi	F1.12: Woodland riparian zone or floodplain	26 612	0	0.0
Namoi	F1.8: Black box woodland riparian zone or floodplain	13 142	0	0.0
Namoi	F1.2: River red gum forest riparian zone or floodplain	10 920	0	0.0
Namoi	F1.6: Black box forest riparian zone or floodplain	3401	0	0.0
Namoi	F2.2: Lignum shrubland riparian zone or floodplain	2614	0	0.0
Namoi	F1.11: River cooba woodland riparian zone or floodplain	1513	0	0.0
Namoi	F1.4: River red gum woodland riparian zone or floodplain	599	0	0.0
Namoi	F2.4: Shrubland riparian zone or floodplain	153	0	0.0
Namoi	F1.13: Paperbark riparian zone or floodplain	17	0	0.0
Ovens	F1.12: Woodland riparian zone or floodplain	11 406	0	0.0
Ovens	F1.4: River red gum woodland riparian zone or floodplain	6845	0	0.0
Ovens	F1.2: River red gum forest riparian zone or floodplain	1903	0	0.0
Paroo	F3.2: Sedge/forb/grassland riparian zone or floodplain	258 815	0	0.0

Valley name	Australian National Aquatic Ecosystem (ANAE) lake and wetland types	Total Area (ha)	Cew Area (ha)	Percent
Paroo	F1.4: River red gum woodland riparian zone or floodplain	98 116	0	0.0
Paroo	F1.12: Woodland riparian zone or floodplain	62 686	0	0.0
Paroo	F1.10: Coolibah woodland and forest riparian zone or floodplain	32 524	0	0.0
Paroo	F2.4: Shrubland riparian zone or floodplain	20 116	0	0.0
Paroo	F1.8: Black box woodland riparian zone or floodplain	17 227	0	0.0
Paroo	F4: Unspecified riparian zone or floodplain	1210	0	0.0
Upper Murray	F1.12: Woodland riparian zone or floodplain	3845	0	0.0
Upper Murray	F1.2: River red gum forest riparian zone or floodplain	2261	0	0.0
Upper Murray	F1.4: River red gum woodland riparian zone or floodplain	1475	0	0.0
Upper Murray	F2.4: Shrubland riparian zone or floodplain	265	0	0.0
Upper Murray	F2.2: Lignum shrubland riparian zone or floodplain	10	0	0.0
Warrego	F1.10: Coolibah woodland and forest riparian zone or floodplain	272 507	0	0.0
Warrego	F1.4: River red gum woodland riparian zone or floodplain	60 448	0	0.0
Warrego	F3.2: Sedge/forb/grassland riparian zone or floodplain	30 732	0	0.0
Warrego	F1.12: Woodland riparian zone or floodplain	18 687	0	0.0
Warrego	F2.2: Lignum shrubland riparian zone or floodplain	10 980	0	0.0
Warrego	F2.4: Shrubland riparian zone or floodplain	1048	0	0.0
Warrego	F4: Unspecified riparian zone or floodplain	835	0	0.0
Warrego	F1.8: Black box woodland riparian zone or floodplain	441	0	0.0
Warrego	F1.2: River red gum forest riparian zone or floodplain	96	0	0.0
Wimmera	F1.12: Woodland riparian zone or floodplain	16 032	0	0.0
Wimmera	F1.4: River red gum woodland riparian zone or floodplain	12 038	0	0.0
Wimmera	F1.8: Black box woodland riparian zone or floodplain	4416	0	0.0
Wimmera	F1.6: Black box forest riparian zone or floodplain	1373	0	0.0
Wimmera	F2.4: Shrubland riparian zone or floodplain	809	0	0.0
Wimmera	F2.2: Lignum shrubland riparian zone or floodplain	146	0	0.0
Wimmera	F1.13: Paperbark riparian zone or floodplain	1	0	0.0
Wimmera	F1.2: River red gum forest riparian zone or floodplain	0	0	0.0

Appendix 5: ANAE river channel types influenced by Commonwealth environmental water by valley

The lengths of river and stream channels of differing ANAE type influenced by the delivery of Commonwealth environmental water are presented in Table E1 as an in indicator of the contribution of Commonwealth environmental water towards riverine ecosystem diversity within each valley. River length measurement is highly dependent on the resolution of the mapping with higher resolution mapping capturing more twists and turns in the river that increase the measured river length along the flow path between two points. The Geofabric v3 beta Network Streams were used which are based on a 1 arc-second DEM with an approximate resolution of 30m.

Commonwealth environmental water is typically delivered from storages into lowland rivers. In hilly landscapes and where rivers cut through gorges the ANAE classification often identifies individual river sections as high energy streams. These transition into low energy lowland rivers as the valleys widen and flatten further downstream. The different ANAE ecosystem types in Table A5_1 are mostly distributed along the same major river within each valley rather than separate watercourses (refer Figure 6).

Table A5_1. Length of river and stream ecosystem types influenced by the delivery of Commonwealth environmental water in 2018–19 (shaded blue) as represented by the Basin ANAE waterways data set in each valley.

Valley name	Australian National Aquatic Ecosystem (ANAE) lake and wetland types	Total Length (km)	Cew Length (km)	Percent
Avoca	Rt1.4: Temporary lowland stream	1752	0	0.0
Avoca	Rt1.2: Temporary transitional zone stream	1086	0	0.0
Avoca	Rt1.1: Temporary high energy upland stream	511	0	0.0
Avoca	Rp1.4: Permanent lowland stream	66	0	0.0
Avoca	Rp1.2: Permanent transitional zone stream	23	0	0.0
Avoca	Rt1.3: Temporary low energy upland stream	21	0	0.0
Barwon Darling	Rp1.4: Permanent lowland stream	4575	821	17.9
Barwon Darling	Rt1.4: Temporary lowland stream	20 412	9	<0.1
Barwon Darling	Rp1.2: Permanent transitional zone stream	36	2	5.6
Barwon Darling	Rp1.3: Permanent low energy upland stream	1	1	100.0
Barwon Darling	Rp1.1: Permanent high energy upland stream	3	1	33.3
Barwon Darling	Rt1.2: Temporary transitional zone stream	4715	0	0.0
Barwon Darling	Rt1.1: Temporary high energy upland stream	874	0	0.0
Barwon Darling	Rt1.3: Temporary low energy upland stream	178	0	0.0
Barwon Darling	Ru1: Unspecified river (landform unknown)	32	0	0.0
Barwon Darling	Rw1: Permanent river (landform unknown)	1	0	0.0
Border Rivers	Rp1.4: Permanent lowland stream	2431	454	18.7
Border Rivers	Rt1.4: Temporary lowland stream	13 996	315	2.3
Border Rivers	Rp1.2: Permanent transitional zone stream	2349	30	1.3
Border Rivers	Rp1.1: Permanent high energy upland stream	2844	8	0.3
Border Rivers	Rt1.1: Temporary high energy upland stream	7129	8	0.1
Border Rivers	Rt1.2: Temporary transitional zone stream	8963	4	<0.1
Border Rivers	Rt1.3: Temporary low energy upland stream	92	0	0.0
Border Rivers	Ru1: Unspecified river (landform unknown)	39	0	0.0
Border Rivers	Rw1: Permanent river (landform unknown)	9	0	0.0
Broken	Rt1.4: Temporary lowland stream	1342	190	14.2
Broken	Rt1.1: Temporary high energy upland stream	906	0	0.0
Broken	Rt1.2: Temporary transitional zone stream	394	0	0.0
Broken	Rt1.3: Temporary low energy upland stream	67	0	0.0
Broken	Rp1.2: Permanent transitional zone stream	67	0	0.0
Broken	Rp1.1: Permanent high energy upland stream	61	0	0.0
Broken	Rp1.4: Permanent lowland stream	53	0	0.0
Broken	Ru1: Unspecified river (landform unknown)	10	0	0.0
Broken	Rw1: Permanent river (landform unknown)	5	0	0.0
Campaspe	Rp1.4: Permanent lowland stream	66	52	78.8

Valley name	Australian National Aquatic Ecosystem (ANAE) lake and wetland types	Total Length (km)	Cew Length (km)	Percent
Campaspe	Rp1.3: Permanent low energy upland stream	38	37	97.4
Campaspe	Rp1.2: Permanent transitional zone stream	61	14	23.0
Campaspe	Rp1.1: Permanent high energy upland stream	86	6	7.0
Campaspe	Rt1.4: Temporary lowland stream	610	4	0.7
Campaspe	Rt1.1: Temporary high energy upland stream	1042	1	<0.1
Campaspe	Rt1.2: Temporary transitional zone stream	1410	0	0.0
Campaspe	Rt1.3: Temporary low energy upland stream	37	0	0.0
Campaspe	Rw1: Permanent river (landform unknown)	15	0	0.0
Campaspe	Ru1: Unspecified river (landform unknown)	2	0	0.0
Castlereagh	Rt1.4: Temporary lowland stream	4076	0	0.0
Castlereagh	Rt1.2: Temporary transitional zone stream	3078	0	0.0
Castlereagh	Rt1.1: Temporary high energy upland stream	1731	0	0.0
Castlereagh	Rp1.4: Permanent lowland stream	596	0	0.0
Castlereagh	Rp1.2: Permanent transitional zone stream	482	0	0.0
Castlereagh	Rp1.1: Permanent high energy upland stream	169	0	0.0
Castlereagh	Rt1.3: Temporary low energy upland stream	164	0	0.0
Castlereagh	Rp1.3: Permanent low energy upland stream	45	0	0.0
Central Murray	Rp1.4: Permanent lowland stream	3271	1616	49.4
Central Murray	Rt1.4: Temporary lowland stream	3470	398	11.5
Central Murray	Rp1.3: Permanent low energy upland stream	108	71	65.7
Central Murray	Rp1.2: Permanent transitional zone stream	143	24	16.8
Central Murray	Rp1.1: Permanent high energy upland stream	306	17	5.6
Central Murray	Rt1.3: Temporary low energy upland stream	93	15	16.1
Central Murray	Rt1.2: Temporary transitional zone stream	869	9	1.0
Central Murray	Ru1: Unspecified river (landform unknown)	5	1	20.0
Central Murray	Rt1.1: Temporary high energy upland stream	1467	0	0.0
Condamine Balonne	Rt1.4: Temporary lowland stream	33 874	0	0.0
Condamine Balonne	Rt1.2: Temporary transitional zone stream	16 518	0	0.0
Condamine Balonne	Rt1.1: Temporary high energy upland stream	3421	0	0.0
Condamine Balonne	Rp1.4: Permanent lowland stream	1163	0	0.0
Condamine Balonne	Rt1.3: Temporary low energy upland stream	111	0	0.0
Condamine Balonne	Rp1.2: Permanent transitional zone stream	48	0	0.0
Condamine Balonne	Ru1: Unspecified river (landform unknown)	37	0	0.0
Condamine Balonne	Rp1.1: Permanent high energy upland stream	27	0	0.0
Condamine Balonne	Rp1.3: Permanent low energy upland stream	2	0	0.0
Condamine Balonne	Rw1: Permanent river (landform unknown)	0	0	0.0
Edward Wakool	Rp1.4: Permanent lowland stream	2304	911	39.5
Edward Wakool	Rt1.4: Temporary lowland stream	904	64	7.1
Goulburn	Rp1.4: Permanent lowland stream	528	302	57.2
Goulburn	Rp1.1: Permanent high energy upland stream	965	61	6.3
Goulburn	Rp1.2: Permanent transitional zone stream	313	30	9.6
Goulburn	Rt1.4: Temporary lowland stream	2065	9	0.4
Goulburn	Rt1.1: Temporary high energy upland stream	7563	6	<0.1
Goulburn	Rt1.2: Temporary transitional zone stream	2529	3	0.1
Goulburn	Rt1.3: Temporary low energy upland stream	230	1	0.4
Goulburn	Rp1.3: Permanent low energy upland stream	51	0	0.0
Goulburn	Ru1: Unspecified river (landform unknown)	24	0	0.0
Goulburn	Rw1: Permanent river (landform unknown)	22	0	0.0
Gwydir	Rp1.4: Permanent lowland stream	1753	669	38.2
Gwydir	Rt1.4: Temporary lowland stream	3288	208	6.3
Gwydir	Rp1.2: Permanent transitional zone stream	3049	127	4.2
Gwydir	Rp1.1: Permanent high energy upland stream	2508	55	2.2
Gwydir	Rp1.3: Permanent low energy upland stream	118	50	42.4
Gwydir	Rt1.3: Temporary low energy upland stream	131	24	18.3
Gwydir	Rt1.1: Temporary high energy upland stream	4098	0	0.0
Gwydir	Rt1.2: Temporary transitional zone stream	2616	0	0.0
Gwydir	Rw1: Permanent river (landform unknown)	23	0	0.0
Gwydir	Ru1: Unspecified river (landform unknown)	6	0	0.0
Kiewa	Rt1.1: Temporary high energy upland stream	1266	0	0.0
Kiewa	Rt1.2: Temporary transitional zone stream	135	0	0.0
Kiewa	Rp1.1: Permanent high energy upland stream	104	0	0.0

Valley name	Australian National Aquatic Ecosystem (ANAE) lake and wetland types	Total Length (km)	Cew Length (km)	Percent
Kiewa	Rp1.4: Permanent lowland stream	96	0	0.0
Kiewa	Rt1.4: Temporary lowland stream	68	0	0.0
Kiewa	Rp1.2: Permanent transitional zone stream	5	0	0.0
Kiewa	Rt1.3: Temporary low energy upland stream	1	0	0.0
Kiewa	Ru1: Unspecified river (landform unknown)	0	0	0.0
Kiewa	Rp1.3: Permanent low energy upland stream	0	0	0.0
Lachlan	Rp1.4: Permanent lowland stream	4877	1225	25.1
Lachlan	Rp1.1: Permanent high energy upland stream	6095	75	1.2
Lachlan	Rp1.2: Permanent transitional zone stream	2215	38	1.7
Lachlan	Rt1.4: Temporary lowland stream	15 336	20	0.1
Lachlan	Rp1.3: Permanent low energy upland stream	40	4	10.0
Lachlan	Rt1.1: Temporary high energy upland stream	10 526	0	0.0
Lachlan	Rt1.2: Temporary transitional zone stream	7848	0	0.0
Lachlan	Rt1.3: Temporary low energy upland stream	172	0	0.0
Lachlan	Rw1: Permanent river (landform unknown)	27	0	0.0
Lachlan	Ru1: Unspecified river (landform unknown)	20	0	0.0
Loddon	Rp1.4: Permanent lowland stream	405	325	80.2
Loddon	Rt1.4: Temporary lowland stream	3931	27	0.7
Loddon	Rp1.2: Permanent transitional zone stream	39	11	28.2
Loddon	Rt1.2: Temporary transitional zone stream	2684	9	0.3
Loddon	Rp1.1: Permanent high energy upland stream	71	2	2.8
Loddon	Rt1.1: Temporary high energy upland stream	1156	0	0.0
Loddon	Rt1.3: Temporary low energy upland stream	87	0	0.0
Loddon	Ru1: Unspecified river (landform unknown)	4	0	0.0
Lower Darling	Rt1.4: Temporary lowland stream	3158	0	0.0
Lower Darling	Rp1.4: Permanent lowland stream	1852	0	0.0
Lower Darling	Rt1.2: Temporary transitional zone stream	285	0	0.0
Lower Darling	Rt1.3: Temporary low energy upland stream	68	0	0.0
Lower Darling	Rp1.2: Permanent transitional zone stream	35	0	0.0
Lower Darling	Rt1.1: Temporary high energy upland stream	19	0	0.0
Lower Murray	Rp1.4: Permanent lowland stream	1402	685	48.9
Lower Murray	Rp1: Permanent stream	360	165	45.8
Lower Murray	Rt1.4: Temporary lowland stream	9129	131	1.4
Lower Murray	Rt1: Temporary stream	156	80	51.3
Lower Murray	Rp1.3: Permanent low energy upland stream	63	18	28.6
Lower Murray	Rp1.1: Permanent high energy upland stream	17	15	88.2
Lower Murray	Rw1: Permanent river (landform unknown)	10	7	70.0
Lower Murray	Ru1: Unspecified river (landform unknown)	48	6	12.5
Lower Murray	Rt1.2: Temporary transitional zone stream	5123	5	<0.1
Lower Murray	Rt1.1: Temporary high energy upland stream	4048	3	<0.1
Lower Murray	Rp1.2: Permanent transitional zone stream	36	2	5.6
Lower Murray	Rt1.3: Temporary low energy upland stream	370	1	0.3
Macquarie	Rp1.4: Permanent lowland stream	5458	734	13.4
Macquarie	Rt1.4: Temporary lowland stream	12 345	186	1.5
Macquarie	Rp1.2: Permanent transitional zone stream	2962	96	3.2
Macquarie	Rp1.1: Permanent high energy upland stream	7953	38	0.5
Macquarie	Rt1.1: Temporary high energy upland stream	13 036	0	0.0
Macquarie	Rt1.2: Temporary transitional zone stream	8679	0	0.0
Macquarie	Rt1.3: Temporary low energy upland stream	113	0	0.0
Macquarie	Rw1: Permanent river (landform unknown)	40	0	0.0
Macquarie	Rp1.3: Permanent low energy upland stream	8	0	0.0
Macquarie	Ru1: Unspecified river (landform unknown)	5	0	0.0
Mitta Mitta	Rt1.1: Temporary high energy upland stream	4235	0	0.0
Mitta Mitta	Rp1.1: Permanent high energy upland stream	519	0	0.0
Mitta Mitta	Rt1.2: Temporary transitional zone stream	144	0	0.0
Mitta Mitta	Rp1.4: Permanent lowland stream	97	0	0.0
Mitta Mitta	Rp1.2: Permanent transitional zone stream	57	0	0.0
Mitta Mitta	Rt1.4: Temporary lowland stream	38	0	0.0
Mitta Mitta	Rw1: Permanent river (landform unknown)	18	0	0.0
Mitta Mitta	Ru1: Unspecified river (landform unknown)	17	0	0.0
Mitta Mitta	Rt1.3: Temporary low energy upland stream	3	0	0.0

Valley name	Australian National Aquatic Ecosystem (ANAE) lake and wetland types	Total Length (km)	Cew Length (km)	Percent
Murrumbidgee	Rp1.4: Permanent lowland stream	4192	1003	23.9
Murrumbidgee	Rt1.4: Temporary lowland stream	8283	359	4.3
Murrumbidgee	Rp1.1: Permanent high energy upland stream	9992	126	1.3
Murrumbidgee	Rp1.2: Permanent transitional zone stream	1996	72	3.6
Murrumbidgee	Rp1.3: Permanent low energy upland stream	122	69	56.6
Murrumbidgee	Rt1.1: Temporary high energy upland stream	12 939	1	<0.1
Murrumbidgee	Rt1.2: Temporary transitional zone stream	5841	0	0.0
Murrumbidgee	Rt1.3: Temporary low energy upland stream	56	0	0.0
Murrumbidgee	Rw1: Permanent river (landform unknown)	41	0	0.0
Namoi	Rp1.4: Permanent lowland stream	2324	456	19.6
Namoi	Rp1.2: Permanent transitional zone stream	1552	20	1.3
Namoi	Rp1.1: Permanent high energy upland stream	3594	19	0.5
Namoi	Rp1.3: Permanent low energy upland stream	25	12	48.0
Namoi	Rt1.1: Temporary high energy upland stream	9412	0	0.0
Namoi	Rt1.4: Temporary lowland stream	7502	0	0.0
Namoi	Rt1.2: Temporary transitional zone stream	5744	0	0.0
Namoi	Rt1.3: Temporary low energy upland stream	251	0	0.0
Namoi	Rw1: Permanent river (landform unknown)	25	0	0.0
Namoi	Ru1: Unspecified river (landform unknown)	3	0	0.0
Ovens	Rp1.4: Permanent lowland stream	388	174	44.8
Ovens	Rt1.4: Temporary lowland stream	1017	90	8.8
Ovens	Rp1.1: Permanent high energy upland stream	344	24	7.0
Ovens	Rp1.2: Permanent transitional zone stream	82	18	22.0
Ovens	Rt1.1: Temporary high energy upland stream	3885	11	0.3
Ovens	Rp1.3: Permanent low energy upland stream	2	2	100.0
Ovens	Rt1.2: Temporary transitional zone stream	579	0	0.0
Ovens	Rt1.3: Temporary low energy upland stream	50	0	0.0
Ovens	Rw1: Permanent river (landform unknown)	1	0	0.0
Paroo	Rt1.4: Temporary lowland stream	26 096	0	0.0
Paroo	Rt1.2: Temporary transitional zone stream	4115	0	0.0
Paroo	Rp1.4: Permanent lowland stream	1167	0	0.0
Paroo	Rt1.1: Temporary high energy upland stream	297	0	0.0
Paroo	Rt1.3: Temporary low energy upland stream	142	0	0.0
Paroo	Rp1.2: Permanent transitional zone stream	40	0	0.0
Paroo	Ru1: Unspecified river (landform unknown)	25	0	0.0
Paroo	Rw1: Permanent river (landform unknown)	3	0	0.0
Upper Murray	Rt1.1: Temporary high energy upland stream	4829	0	0.0
Upper Murray	Rp1.1: Permanent high energy upland stream	3674	0	0.0
Upper Murray	Rp1.4: Permanent lowland stream	423	0	0.0
Upper Murray	Rt1.2: Temporary transitional zone stream	406	0	0.0
Upper Murray	Rp1.2: Permanent transitional zone stream	324	0	0.0
Upper Murray	Rt1.4: Temporary lowland stream	233	0	0.0
Upper Murray	Rw1: Permanent river (landform unknown)	25	0	0.0
Upper Murray	Rt1.3: Temporary low energy upland stream	9	0	0.0
Upper Murray	Rp1.3: Permanent low energy upland stream	4	0	0.0
Upper Murray	Ru1: Unspecified river (landform unknown)	2	0	0.0
Warrego	Rt1.4: Temporary lowland stream	20 641	905	4.4
Warrego	Rp1.4: Permanent lowland stream	599	241	40.2
Warrego	Rt1.2: Temporary transitional zone stream	5797	49	0.8
Warrego	Rt1.3: Temporary low energy upland stream	268	7	2.6
Warrego	Rw1: Permanent river (landform unknown)	7	7	100.0
Warrego	Rt1.1: Temporary high energy upland stream	493	0	0.0
Warrego	Rp1.3: Permanent low energy upland stream	6	0	0.0
Warrego	Ru1: Unspecified river (landform unknown)	1	0	0.0
Wimmera	Rt1.4: Temporary lowland stream	3531	177	5.0
Wimmera	Rt1.2: Temporary transitional zone stream	1965	2	0.1
Wimmera	Rt1.1: Temporary high energy upland stream	1353	2	0.1
Wimmera	Rt1.3: Temporary low energy upland stream	68	0	0.0
Wimmera	Rp1.4: Permanent lowland stream	45	0	0.0
Wimmera	Rp1.2: Permanent transitional zone stream	43	0	0.0
Wimmera	Ru1: Unspecified river (landform unknown)	13	0	0.0