Wetlands of the lower Mehi River and Ballin Boora Creek

Ecological values and flow constraints

Report to NSW Department of Planning, Industry and Environment

25/02/2022

DOCUMENT CONTROL

Project name:	Wetlands of the lower Mehi River and Ballin Boora Creek		
Report name	Ecological values and flow constraints		
Date	25/02/2022	Version 3	Status Final
Prepared by	Dr Julian Wall		
Company	2rog Consulting		
Reviewed by	Dr Paul Frazier		
Approved by	Dr Julian Wall		
Cover image	Lignum wetland (site J93) (courtesy J. Reid)		

ACKNOWLEDGEMENTS
2rog Consulting acknowledges DPIE staff for provision of advice and documentation. We thank Rebecca Ballard, Dan Mawer and Simon Hunter for their contributions to this project.

DISCLAIMER
This report was prepared according to the scope, brief and project information provided by DPIE It also relies upon documentation collected specifically for this project. All findings, conclusions or recommendations in the report are based on the information provided and collected for this project. The report is for the use of the DPIE only and 2rog Consulting accept no liability or responsibility for its use by other parties

EXECUTIVE SUMMARY

Delivery of environmental water to key floodplain and wetland assets in the Murray-Darling Basin is a focus of Commonwealth and State water planning and policy. To improve water delivery outcomes, knowledge about wetlands and other water-dependent assets and an understanding of hydrological constraints to water delivery are essential. This project aimed to improve the evidence-base around wetland assets and physical constraints to water delivery within the lower Mehi River and Ballin Boora Creek in north-west NSW (part of the Gwydir catchment).

A total of 1,399 wetland polygons were mapped across the region, including 1,095 that were connected to the Mehi River channel or Ballin Boora Creek channel via flood-runners or other channel types. A total 200 rapid flora points were completed within a stratified sub-set of these wetlands and channels to identify the main wetland flora and plant community types across the region. In total 97 dominant plant species were recorded including 91 native and 6 exotic species. The most encountered species were *Acacia stenophylla* (river cooba), *Duma florenta* (lignum) and *Eucalyptus coolibah* (coolabah). Common ground-cover species included *Alternanthera denticulata* (lesser joyweed), *Eleocharis plana* (ribbed spike-rush), *Juncus aridicola* (tussock rush), *Marsilea drummondii* (nardoo), *Paspalidium jubiflorum* (warrego grass) and *Sclerolaena muricata* (black roly-poly).

Based on their structure and floristics, mapped wetlands were assigned to one of 20 plant community types, the most extensive including river red gum tall open forest (PCT 36), coolabah-river cooba-lignum woodland (PCT 39), ephemerally flooded channels (PCT 53a), and permanently flooded watercourse channels and beds (PCT 238a). Some of the less frequently encountered types included eurah shrubland (PCT 115), golden goosefoot shrubland wetland (PCT 161) and lignum wetland shrubland (PCT 247).

Using a LiDAR-derived digital elevation model (DEM) and other spatial data supplied for this project, key hydrological data were also captured for each wetland, including commence-to-flow flood height, inlet and outlet elevation, and maximum depth and volume. A prioritisation assessment was undertaken to assign a rating (0 to 100) to each mapped wetland connected to the Mehi River or Ballin Boora Creek. Nine factors contributed to the assignment of ratings and the setting of wetland priority:

- Wetland status (natural, modified or constructed)
- Commence-to-flow height (linked to flow volume required to flood the wetland)
- Wetland area (ha)
- Wetland perimeter (m)
- Wetland maximum volume (ML)
- Wetland maximum depth (cm)
- Percent fringing woodland
- Plant community type
- Observed condition

Wetland ratings varied from 9 (lowest priority) to 74 (highest priority). A total of 153 wetlands were assigned a rating of ≥ 50 and these were classed as high priority wetlands.

Spatial inundation assessment of the lower Mehi catchment was undertaken by generating five regional inundation footprints from Sentinel satellite data, before, during and after the early April 2021 flood event, which peaked at about 18 GL/day at Combadello Weir on the Mehi River. Mapped wetlands were intersected with these inundation footprints to determine the proportion that were inundated six weeks prior to the flood, at the height of the flood, and six weeks after the flood. Prior to flooding only 29 wetlands (3%) showed any evidence of inundation. In contrast, at the height of the flood in early April a total 1,004 mapped wetlands (94%) showed evidence of inundation, of which 925 mapped wetlands (86%) were >75% inundated by area. Six weeks after the flood a total of 421 wetlands (39%) still retained some standing water.

For the subset of 952 relatively unmodified wetlands in the study region (i.e. wetlands that are neither constructed nor cropped), those that retained some level of inundation during drier conditions pre- and post-flood had a higher average rating than those that were dry. During the driest time in February 2021, almost 70% of wetlands with evidence of persistent standing water were high priority, while only 15% of wetlands showing no evidence of inundation were high priority. As floodwaters receded from early April to June 2021, a greater proportion of high priority wetlands remained inundated, suggesting that standing water is more persistent within wetlands identified as high priority for this project. This is intuitively logical as wetland value is influenced by availability of standing water.

An analysis of the indicative volume of water required to inundate groups of lower-lying wetlands along the Mehi River was undertaken, guided by flow requirements set under the Gwydir Long Term Watering Plan as summarised in Section 01.3 of this report. The analysis showed that some high-priority wetlands can be inundated even during small freshes (< 1,000 ML/day), although an increasing number can be inundated from larger freshes and bankfull flows. At bankfull flow for example (~ 15,000 ML/day, roughly equivalent to a flow depth of 2.35 m), about 85 ML of water would fill 202 mapped wetlands including 47 high priority wetlands (rating ≥ 50), mainly oxbow and other near-channel wetlands close to the Mehi channel. The number of wetlands inundated and volume of water delivered to wetlands increases markedly once overbank floods occur (> 15,000 ML/day). For example, flows of 25,000 ML/day would be expected to inundate almost 500 wetlands including 100 priority wetlands (about 2.4 times as many as a bankfull flow), and would deliver almost 600 ML of water into wetlands (about 7 times as much as what would be delivered via a bankfull flow). Larger floods would be required to inundate more elevated flood-runner wetlands and floodplain wetlands.

The analyses presented here strongly support the importance of pigging-backing environmental water delivery on natural or other managed flows. For example, piggy-backing an environmental flow of 2,000 ML/day onto a flow event of 3,000 ML/day in the Mehi River would double the number of priority wetlands that receive water. Piggy-backing will also be important for delivering environmental flows to Ballin Boora Creek as Mehi flows of 600-1,200 ML/day are required to achieve baseflow to Ballin Boora Creek via gauge 418048. It is likely that moderate flows of 1,200 - 3,000 ML/day directed from the Mehi River will serve to inundate up to 24 lower-lying wetlands along Ballin Boora Creek, including 19 high priority wetlands. Flows of up to 10,000 ML/day in Ballin Boora Creek are likely to inundate all wetlands associated with this channel, with over 100 ML of floodwaters captured by approximately 80 individual wetlands.

In addition to wetland survey, mapping and prioritisation, a field survey of constraints to flow such as physical obstructions (e.g. road crossings) and diversions (e.g. offtake channels) was undertaken. A total of 76 sites were assessed including 28 road sites, 21 embankment sites, 13 channels, and 14 other features including weirs, drains and choked fence-lines. The construction material and dimensions of about 20 constraints were recorded in the field via differential GPS. All constraints were assessed during relatively high flow conditions, and it was not possible to quantify the volume of flow potentially held up or diverted during low flow conditions. Further study on the flow effects of constraints is required, possibly using flow events (natural and released) over the past four years in combination with DEM and other data.

Three recommendations are made following this project.

Recommendation 1

Where data are not currently available, it is recommended that targeted LiDAR capture be undertaken in other lowland regions of the Gwydir Catchment that are known to support a near-channel wetlands, to facilitate improved mapping in future. Capture would be undertaken during seasonally dry periods when water levels are relatively low.

Recommendation 2

A project to map all wetlands and flood-runners along the length of the Mehi River upstream of Gundare regulator, as well as Moomin and Mallowa Creeks, would provide a more complete picture of the distribution of wetland assets associated with the Mehi River system. It would provide extra context around appropriate allocation of environmental flows to Mehi River, Moomin Creek and Mallowa Creek.

Recommendation 3

A scoping project could be initiated that identifies a cropped wetland (or series of connected wetlands) to be restored in consultation with the landholder. The wetland would be relatively low-lying and would directly connect to the main channel via a viable flood-runner, to ensure delivery of environmental water Rehabilitation would require cessation of cropping and planting of fringing canopy species. The study would also involve long-term monitoring of wetland recovery.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

Abbreviation	Description
BC Act	*Biodiversity Conservation Act 2016* (NSW)
CTF	Commence-to-flow
CMP	Constraints Measures Project
DEM	Digital Elevation Model
DPIE	NSW Department of Planning, Industry and Environment
EEC	Endangered Ecological Community
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth)
LiDAR	Light Detection and Ranging
MDB	Murray-Darling Basin
ML	Megalitres
ML/day	Megalitres per day
MNDWI	Modified Normalised Difference Water Index
MNES	Matters of National Environmental Significance
NBTK	Northern Basin Toolkit
PCT	Plant Community Type
PMST	Protected Matters Search Tool
TEC	Threatened Ecological Community
TSR	Travelling Stock Reserve

01 INTRODUCTION

01.1 Project overview

The NSW Department of Planning, Industry and Environment (DPIE) is undertaking the Gwydir Constraints Measures Project (Gwydir CMP) as part of the Northern Basin Toolkit (NBTK) to address operational and physical barriers that prevent effective delivery of environmental water to important river, wetland, and floodplain assets in the Gwydir Valley in north-west NSW[1].

The Gwydir CMP covers four study areas: Gingham Watercourse; Lower Gwydir Wetlands; Mehi River; and Ballin Boora Creek (in which DPIE is proposing to fund implementation of a constraints relaxation program). Within these areas the Gwydir CMP seeks to identify preferred delivery pathways for environmental flows and to reduce the impact of physical and operational constraints to facilitate these flows, thus improving outcomes under the Basin Plan and Basin-wide Watering Strategy[2]. Identifying preferred delivery pathways is informed not only by the ease of delivery, but also by the value of water-dependent ecological assets along the river and adjoining floodplain.

This project identified key wetland assets and physical constraints to flow along the entire reach of Ballin Boora Creek, and along a western reach of the Mehi River. The main objectives of this project were to undertake:

1. survey and mapping of important environmental areas along the Lower Mehi River and associated floodplains; and
2. field inspection of physical constraints that impact environmental water delivery in the Lower Mehi River and Ballin Boora Creek.

01.2 Region of study

The region of study included:

1. a 166 km reach of the Mehi River from its diffluence with Mallowa Creek at the Gundare regulator, to its confluence with Barwon River; and
2. the entire reach (32 km) of Ballin Boora Creek

The regional of study occurs within the Warrambool-Moonie and Castlereagh-Barwon IBRA sub-regions[3]. It covers a total area of about 27,500 ha, including 10,400 ha of channel and floodplain along Mehi River and 760 ha of channel and floodplain along Ballin Boora Creek that each provide pathways for environmental water delivery (Figure 01-1).

Water delivery pathways comprise two categories:

1. A – B pathways occur within core areas, where environmental water managers need flexibility to use higher river flows to deliver environmental water events to high priority ecological and cultural assets during any year. A – B areas are largely contained within the main channels and generally align with proactive environmental watering principles.

---

[1] https://www.environment.nsw.gov.au/research-and-publications/publications-search/northern-basin-toolkit-gwydir

[2] Murray-Darling Basin Authority (MDBA) (2019) Basin-wide environmental watering strategy. Second Edition. 22 November 2019. Published by the Murray-Darling Basin Authority. MDBA publication no: 42/19. ISBN (online): 978-1-925762-47-1.

[3] The Interim Biogeographic Regionalisation for Australia (IBRA) was developed in the 1990s and is endorsed by all levels of government as a key tool for identifying land for conservation under Australia's Strategy for the National Reserve System 2009-2030 (https://www.environment.gov.au/land/nrs/science/ibra)

2. A – C pathways coincide with areas where environmental water may be used in conjunction with natural events (e.g. piggy-backing) to inundate assets located away from the main channels, but that are connected via flood-runners and floodplain channels. A – C areas are largely associated with inner floodplain environments and generally align with reactive environmental watering principles.

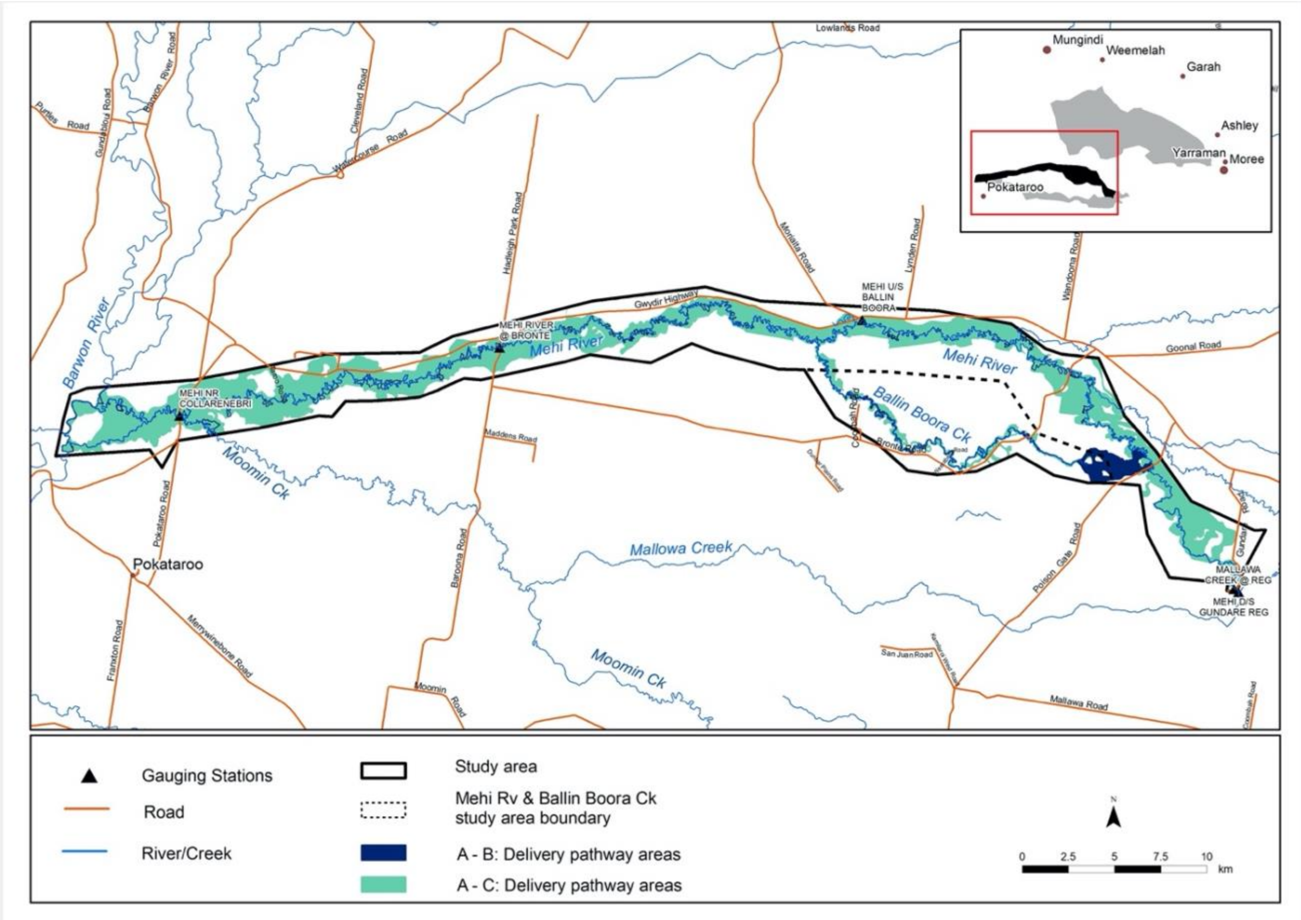


Figure 01-1. Region of study (courtesy DPIE)

01.3 Hydrological setting

The Mehi River is the largest of three main out-flowing systems of the Gwydir River, which also include Moomin Creek and Carole Creek. The Mehi River splits from the Gwydir River at the Tareelaroi regulator, about 5 km west of Pallamallawa, and terminates at its junction with the Barwon River after meandering about 335 km through the floodplain.

The headwaters of the Gwydir River are impounded by Copeton Dam which provides water for industry and environment. Copeton Dam has a capacity of 1,364 GL and controls abouts 55% of inflows to the Gwydir system[4]. Figure 01-2 shows a schematic diagram of the Gwydir River system below Copeton Dam, including the Mehi and Ballin Boora systems[5]. Note, this diagram suggests that Ballin Boora gauge 418068 is located upstream of the flood-dependent connector for Ballin Boora Creek, but in reality it is located downstream of this connector and upstream of the Mehi River confluence with Ballin Boora Creek.

The flow regime of the Gwydir River has been substantially altered by the construction of Copeton Dam and the various weirs and regulators that divert water to irrigators along distributor channels including the Mehi River, Moomin Creek and Carole Creek. Regulation of the river system has caused significant reduction in moderate to high flows in the lower Gwydir, an increase in the average period between large flows, and a reduction in the average volume of large flows[6].

The regulated Gwydir River reaches a maximum capacity at Pallamallawa upstream of Moree, where the mean daily flow is 2,053 ML/d. Above this discharge, overflow commences to the many anabranches and effluent channels that characterise the lower part of the catchment. As the channel capacity at Pallamallawa is greater than the combined capacity of the four major distributaries (Gwydir River, Mehi River, Moomin Creek and Carole Creek), small rises at Pallamallawa can cause overbank flow downstream.[7,8]

River regulation has had a significant effect on natural flows in the Mehi River. It has reduced large freshes and overbank flows and has reduced small freshes in autumn to spring, however irrigation deliveries and other managed flow events have also reduced periods of zero flow and increased base flows and small freshes over late spring to autumn compared to before regulation[9].

During flood events, the distribution of floodwaters between the Gwydir River, Mehi River and overbank flow to the floodplain is dependent on flood size. For example, in a 1-in-2 year flood, flow will be allocated to the Gwydir, Mehi and floodplain at a ratio of 85:15:0, while floodwaters in a 1-in-100 year flood will be allocated at a ratio of 30:27:43[10]. Large floods fan out in a delta-type drainage pattern to the southwest via the Mehi River, to the west via the Gingham channel, and to the northwest via Carole Creek[11].

---

[4] Keyte, P.A. (1994). *Lower Gwydir Wetland Plan of Management 1994–1997*. Report by NSW Department of Water Resource for the Lower Gwydir Wetland Steering Committee, Sydney.

[5] DPIE (2020). *Gwydir Long Term Water Plan. Part A: Gwydir Catchment.* NSW Department of Planning, Industry and Environment. EES 2020/0083. July 2020.

[6] CSIRO (2007). *Water Availability in the Gwydir.* A report to the Australian Government from the CSIRO Murray Darling Sustainable Yields Project, CSIRO, Australia.

[7] Pietsch, T.J. (2006). *Fluvial geomorphology and late quaternary geochronology of the Gwydir fan-plain.* PhD thesis, School of Earth and Environmental Science, University of Wollongong.

[8] DPI (2012). *Water Sharing Plan for the Gwydir Unregulated and Alluvial Water Sources 2012 – Background Document*. NSW Department of Primary Industries – Water.

[9] DPIE (2020). *Gwydir Long Term Water Plan. Part A: Gwydir Catchment.* NSW Department of Planning, Industry and Environment. EES 2020/0083. July 2020.

[10] McNamara, C. (1981). *Gwydir Valley Flood Plain Atlas*. Report prepared for the Water Resources Commission of NSW, printed by D West, Government Printer, Sydney.

[11] DPI (2015) *Background Document to the Floodplain Management Plan for the Gwydir Valley Floodplain*. NSW Department of Primary Industries – Water.

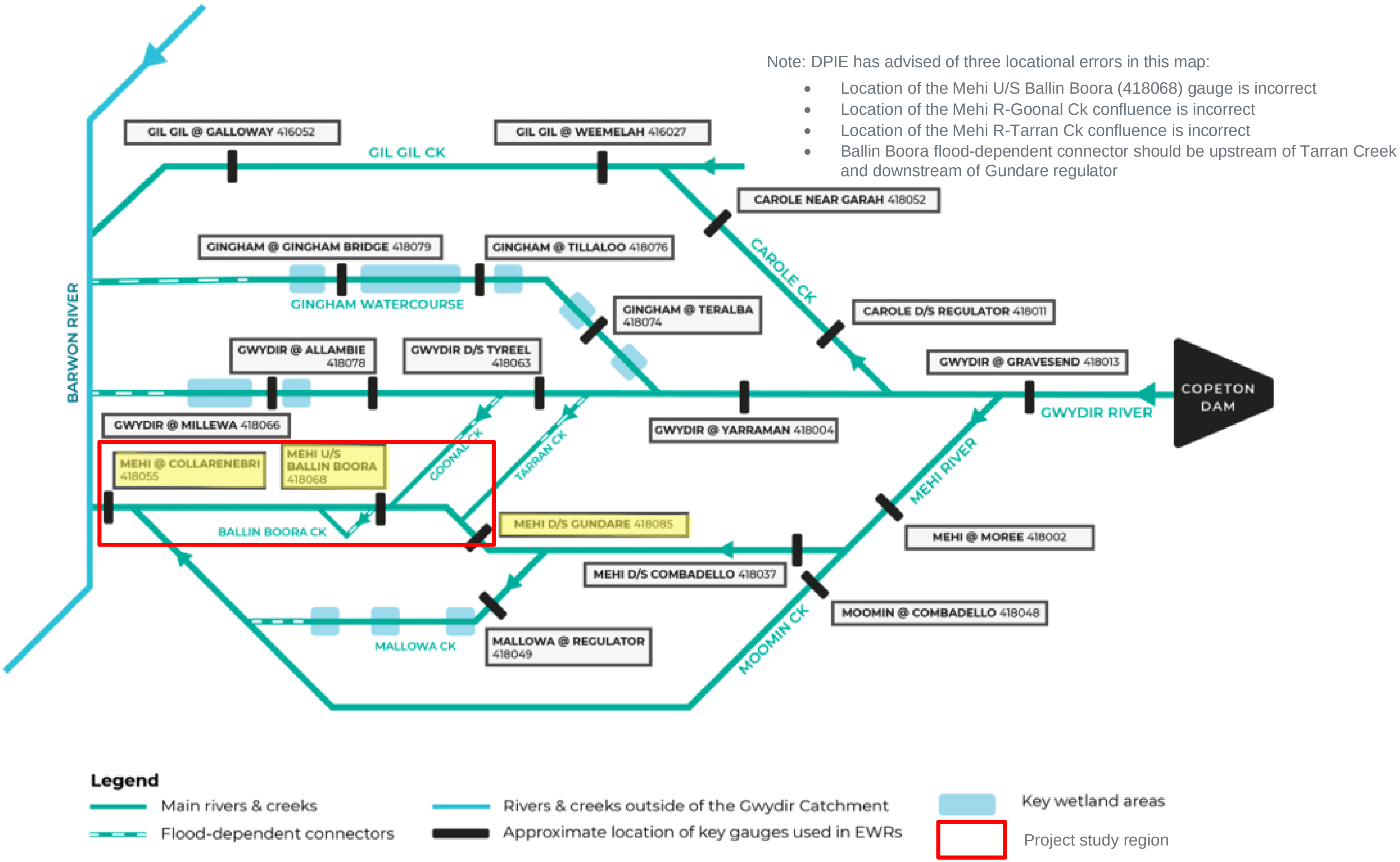


Figure 01-2. Schematic representation of the Gwydir system below Copeton Dam, including key river gauges (DPIE 2020) (red outline = region of study)

The bankfull capacity of Mehi River changes along its reach, ranging from about 49,680 ML/day at Moree to less than 430 ML/day upstream of the Mallowa Creek offtake, after which it increases downstream to about 8,640 ML/day at its confluence with the Barwon River[12]. Environmental water is delivered into the lower reaches of the Mehi River via gauges 418002 (Moree) and 418085 (Gundare), with different flow categories achieved at the following flow thresholds[13]:

- Baseflow: 50 - 100 ML/day
- Small fresh: 100 - 850 ML/day
- Large fresh: 850 - 12,000 ML/day
- Bankfull: 12,000 - 15,000 ML/day
- Large overbank: 20,000 - 30,000 ML/day

River regulation and engineering works mean that Ballin Boora Creek is now mostly disconnected from all Mehi flow categories except for higher overbank flows, or if held environmental water is actively delivered into them using infrastructure[14]. Environmental watering events of 600-1,200 ML can deliver baseflows to Ballin Boora Creek via gauge 418048, while overbank events need flows at least 3,000 ML/day via gauge 418048, and 20,000 ML/day via gauge 418002 on the Mehi River at Moree[15].

Part B of the Gwydir Long Term Water Plan (LTWP) for the lower Mehi River and Ballin Boora Creek[16] provide for different flow events to deliver the following environmental water requirements (EWRs):

Lower Mehi River

- Cease-to-flow (0 ML/day) measured at Collarenebri gauge 418055 should not persist longer than 100 days, and events > 100 days should not occur in more than 15% of years
- Baseflows of 40-100 ML/day measured at Collarenebri gauge 418055 should have a minimum duration of 130 days (or 40 days in very dry years) any time of the year
- Baseflows of 40-100 ML/day measured at Collarenebri gauge 418055 over the warmer months (September to March) should have a minimum duration of 110 days (or 30 days in very dry years), and should occur in 75% of years, with no more than 2 years between events
- A small fresh of at least 100 ML/day measured at Gundare gauge 418085, with minimum duration 10 days, should occur every year between October and April
- A small fresh of 100-850 ML/day measured at Gundare gauge 4180185, with minimum duration 14 days, should occur 75% of years between September and April, with no more than 2 years between events
- A small fresh of > 90 ML/day measured at Collarenebri gauge 418055, timed between October and April with minimum duration 10 days, should occur within 12 months of a large fresh (>800 ML/day at the same gauge), with no more than 4 years between events

[12] Pietsch, T.J. (2006). *Fluvial geomorphology and late quaternary geochronology of the Gwydir fan-plain.* PhD thesis, School of Earth and Environmental Science, University of Wollongong.

[13] DPIE (2020). *Gwydir Long Term Water Plan. Part A: Gwydir Catchment.* NSW Department of Planning, Industry and Environment. EES 2020/0083. July 2020.

[14] DPIE (2020). *Gwydir Long Term Water Plan Part B: Gwydir Planning Units.* NSW Department of Planning, Industry and Environment. EES 2020/0084. July 2020.

[15] DPIE (2020). *Gwydir Long Term Water Plan. Part A: Gwydir Catchment.* NSW Department of Planning, Industry and Environment. EES 2020/0083. July 2020.

[16] DPIE (2020). *Gwydir Long Term Water Plan Part B: Gwydir Planning Units.* NSW Department of Planning, Industry and Environment. EES 2020/0084. July 2020.

- A large fresh of >850 ML/day measured at Gundare gauge 418085, with minimum duration 5 days, should occur 75% of years between July and September, with no more than 2 years between events
- A large fresh of >850 ML/day measured at Gundare gauge 418085, with minimum duration 5 days, should occur 40% of years between October and April, with no more than 4 years between events
- A large fresh of > 800 ML/day measured at Collarenebri gauge 418055, timed between July and September with minimum duration 5 days, to be triggered by specific flow conditions in the Barwon-Darling, with no more than 4 years between events
- A large fresh of >150,000 ML (event) measured at Moree gauge 418003, with duration of 1-2 months (enabling 3-8 months of asset inundation), should occur 25% of years between September and May, with no more than 5 years between events
- A large overbank flow of 20,000 to 30,000 ML/day measured at Moree gauge 418003, at any time of the year for 1-2 days minimum (enabling 1-6 months of asset inundation) to occur 10% of years, with no more than 10 years between events)

Ballin Boora Creek

- A baseflow event of 600-1,200 ML should be delivered from the Mehi channel at 20-50 ML/day via diversion infrastructure at any time of the year, have a minimum duration of 12-60 days, with no more than 3 years between events
- A small overbank flow of > 2,000 ML/day (minimum 3,000 ML event) measured at Ballin Boora gauge 418068, timed between September and March with a duration of at least 1 day, should occur in 75% of years, with no more than 2 years between events
- A small overbank flow of > 2,000 ML/day (minimum 7,000 ML event) measured at Ballin Boora gauge 418068, timed between October and April with a duration of at least 2 days, should occur in 55% of years, with no more than 3 years between events
- A small overbank flow of > 2,000 ML/day (minimum 21,000 ML event) measured at Ballin Boora gauge 418068, timed between August and February with a duration of at least 5 days, should occur in 40% of years, with no more than 4 years between events
- A large overbank flow of 20,000 – 30,000 ML/day measured at Moree gauge 418002, should occur at any time of year with a duration of at least 1-2 days, in 10% of years with no more than 10-15 years between events.

01.4 Ecological setting

01.4.1 Overview

Knowledge about the distribution and value of water-dependent assets in the lower Mehi River and Ballin Boora Creek systems can help inform decisions about strategic delivery of environmental flows. This section provides an ecological setting for the lower Mehi region by identifying some key ecological values known in the region.

01.4.2 Native vegetation systems

The native vegetation of the lower Mehi region can be broadly separated into flood dependent and non-flood dependent ecosystems. Flood dependent vegetation systems require periodic inundation to regenerate and thrive, whereas non-flood dependent systems rely on local rainfall, and generally sit above the influence of flood waters.

Flood dependent vegetation systems include the riparian forests of river red gum (*Eucalyptus camaldulensis*) that fringe the Mehi River along most of its length, and the extensive floodplain woodlands dominated by coolibah (*E. coolabah*) and black box (*E. largiflorens*). Along the ephemeral channels and within low lying depressions, several wetland communities occur, including large semi-permanent billabong wetlands, and smaller ephemeral wetlands dominated by *Eleocharis spp. Marsilea spp.* and *Nymphoides spp.* The shrub lignum (*Duma florulenta*) is commonly associated with minor channels and low-lying areas throughout the region.

On upper parts of the floodplain that are infrequently flooded, treeless expanses of Mitchell grass (*Astrebla spp*.) and other grassland systems may occur, inter-dispersed with various chenopod associations (*Atriplex spp*., *Chenopodium spp*.). Bordering these systems are infrequently flooded ‘scalds and associated communities which support copperburrs (*Sclerolaena spp*.), saltbush (*Atriplex spp.*), cottonbush (*Maireana aphylla*) and daisies (Asteraceae family). Tree species including Gidgee (*A. cambagei*), leopardwood (*Flindersia maculata*) and poplar box (*Eucalyptus populnea*) are rarely flooded and provide a transition zone between the floodplain and the low hills that never flood.

With development of the cotton industry and other large-scale cropping enterprises since the mid-1900s, the original extent of floodplain vegetation and associated wetlands in the lower Mehi region has contracted significantly. Much of the remaining vegetation occurs along and adjacent to the main channels.

01.4.3 Wetlands and floodplains

Wetlands are areas of land that are wet by surface water or groundwater, or both, for long enough periods that the plants and animals in them are adapted to, and depend on, moist conditions for at least part of their lifecycle[17]. Wetlands are unique and dynamic features within terrestrial landscapes and provide multiple benefits that include:

- Cultural focus for many regional communities
- Integral to nutrient cycling, floodwater retention and release and trapping of sediments
- Vital component of regional and national biodiversity, providing habitat to a wide range of native plants and animals
- Nurseries for commercial and recreation fisheries
- Opportunities for science and education
- Places of tourism

[17] DECCW (2010). *NSW Wetland Policy.* NSW Department of Environment, Climate Change and Water. DECCW 2010/39. March 2010.

The lower Mehi River and Ballin Boora Creek feed a complex network of connected riverine wetlands (and associated flood channels) across the Gwydir floodplain, including numerous oxbow and flood-runner wetlands. Some are reasonably intact, some have been highly modified via cultivation and cropping, and a few have been constructed or expanded via installation of banks and/or farm storages. Many close to the main river are fringed by river red gum forest while others further from the channel are surrounded by chenopod shrublands, grasslands, and other low vegetation. Most wetlands are likely to be ephemeral, experiencing ongoing wet-dry cycles. The proportion of time that individual wetlands are inundated in the lower Mehi is likely to vary appreciably, dependent on their commence-to-flow elevation (thus the size of flow that initiates inundation) and their depth (possible measure of persistence).

01.4.4 Special values

Overview

A protected matters search using the Protected Matter Search Tool (PMST)[18] was conducted on 14 July 2021 to identify protected matters under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) that occur or are likely to occur in the western reaches of the Mehi River and the entirety of Ballin Boora Creek[19]. Web searches were also undertaken to identify NSW-listed communities and species under the *Biodiversity Conservation Act 2016* (BC Act). These searches identified 28 Commonwealth-listed matters of national environmental significance (MNES), and an additional 15 NSW-listed matters, including:

- Seven (7) threatened ecological communities (Table 01-1)
- Six (6) threatened flora species (Table 01-2)
- Thirty-five (35) threatened fauna species (Table 01-2).

Ecological communities

Within the western reaches of the Mehi River and Ballin Boora Creek, much of the remnant native vegetation includes coolabah, black box, river red gum, weeping myall (*Acacia pendula*) and poplar box woodlands. These woodlands provide ongoing habitat, refuge and connectivity for native flora and fauna, contribute to regulation of water flow, provide protection and nutrition for floodplain soils, and may regulate micro-climate. Given a history of clearing throughout the agricultural landscape, several vegetation types have been listed as threatened ecological communities (Table 01-1) occur chiefly on highly fertile and arable soil and are threatened by agricultural expansion as well as overgrazing and weed invasion.

Threatened plants and animals

Six (6) threatened plant species and 35 threatened animal species have been recorded or are predicted to occur within the region of study (Table 01-2). The Mehi River comprises watercourses, wetlands and associated vegetation communities that provide habitat and breeding grounds for many waterbirds, both migratory and threatened, and several rare and / or iconic fauna[20,21].

---

[18] https://www.awe.gov.au/environment/epbc/protected-matters-search-tool

[19] Search area defined by a 15 km buffer around a line connecting lat -29.5316 long 149.3190 and lat -29.5075 long 148.6892

[20] DPIE (2020). *Gwydir Long Term Water Plan – Part B: Gwydir Planning Units*. NSW Department of Planning, Industry and Environment.

[21] DPIE (2021). *Report: Environmental outcomes of implementing the Floodplain Harvesting Policy in the Gwydir Valley*. NSW Department of Planning, Industry and Environment.

Table 01-1. Threatened Ecological Communities in the lower Mehi region

TEC	Listing	Listing status	Equivalent PCTs
Coolibah-Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Cth, NSW	E	37,39,40,40a
Natural Grasslands on basalt and fine-textured alluvial plains of northern NSW and southern QLD	Cth, NSW	CE	52,102
Poplar Box Grassy Woodland on Alluvial Plains	Cth	E	56,87,207
Weeping Myall Woodlands	Cth, NSW	E	43
Marsh Club-rush Sedgeland in the Darling Riverine Plains Bioregion	NSW	CE	205
Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions	NSW	E	71,428,628
Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions	Cth, NSW	E	29,35,629

Table 01-2. Threatened plant and animal species in the lower Mehi region

Name		Presence	Listing status [A]	
Scientific	Common		Cth	State
Plants				
Cyperus conicus		Likely**	-	E
Lepidium monoplocoides	Winged Pepper-cress	Potential*	E	E
Platyzoma microphyllum	Braid Fern	Likely**	-	E
Sida rohlenae	Shrub Sida	Likely**	-	E
Swainsona murrayana	Slender Darling-pea	Likely*	V	V
Tylophora linearis	Slender Tylophora	Potential*	E	V
Birds				
Actitis hypoleucos	Common Sandpiper	Potential*	Mi, Ma	-
Anseranas semipalmata	Magpie Goose	Known***	Ma	V
Apus pacificus	Fork-tailed Swift	Likely*	Mi, Ma	-
Ardeotis australis	Australian Bustard	Known**	-	E
Botaurus poiciloptilus	Australasian Bittern	Potential*	E	E
Burhinus grallarius	Bush Stone-curlew	Known**	-	E
Calidris acuminata	Sharp-tailed Sandpiper	Known***	Mi, Ma	-
Calidris ferruginea	Curlew Sandpiper	Potential*	CE, Mi, Ma	E
Calidris melanotos	Pectoral Sandpiper	Potential*	Mi, Ma	-
Ephippiorhynchus asiaticus	Black-necked Stork	Known**	-	E
Falco hypoleucos	Grey Falcon	Known**	V	E
Gallinago hardwickii	Latham's Snipe	Known*	Mi, Ma	-
Grantiella picta	Painted Honeyeater	Likely*	V	V
Grus rubicunda	Brolga	Known**	-	V
Haliaeetus leucogaster	White-bellied Sea-eagle	Known	Ma	V
Hirundapus caudacutus	White-throated Needletail	Potential*	V, Mi, Ma	-
Hydroprogne caspia	Caspian Tern	Known**	Mi, Ma	-
Motacilla flava	Yellow Wagtail	Potential*	Mi, Ma	-

Name		Presence	Listing status [A]	
Scientific	Common		Cth	State
Myiagra cyanoleuca	Satin Flycatcher	Potential*	Mi, Ma	-
Polytelis swainsonii	Superb Parrot	Known*	V	V
Oxyura australis	Blue-billed Duck	Known**	-	V
Rostratula australis	Australian Painted Snipe	Known*	E	E
Stictonetta naevosa	Freckled Duck	Known**	-	V
Tringa nebularia	Common Greenshank	Known**	Mi, Ma	-
Tringa stagnatilis	Marsh Sandpiper	Known***	Mi, Ma	-
Mammals				
Chalinolobus dwyeri	Large-eared Pied Bat	Potential*	V	V
Nyctophilus corbeni	South-eastern Long-eared Bat	Potential*	V	V
Phascolarctos cinereus	Koala	Likely*	V	V
Fish				
Ambassis agassizii	Olive Perchlet (western population)	Likely*	-	E
Bidyanus bidyanus	Silver Perch	Known**	CE	V
Maccullochella peelii	Murray Cod	Known*	V	-
Mogurnda adspersa	Southern Purple-spotted Gudgeon	Likely**	-	E
Tandanus tandanus	Eel-tailed Catfish (MDB population)	Known**	-	E
Reptiles				
Anomalopus mackayi	Five-clawed Worm-skink	Potential*	V	E
Frogs				
Crinia sloanei	Sloane's froglet	Likely**	E	V

A. CE = critically endangered; E = endangered; Ma = marine; Mi = migratory; V = vulnerable

* Protected matters search (Attachment A)

** DPIE (2021). *Report: Environmental outcomes of implementing the Floodplain Harvesting Policy in the Gwydir Valley*. NSW Department of Planning, Industry and Environment

*** DPIE (2020). *Gwydir Long Term Water Plan – Part B: Gwydir Planning Units*. NSW Department of Planning, Industry and Environment

Notes on three iconic species

The social, ethical, aesthetic, and cultural values of plants and animals have been recognised in religion, art, and literature throughout history[22], and in any landscape certain plant and animal species are considered to be 'iconic'. For plants and animals that are respected, revered, and often protected in the landscape, an apt definition of 'iconic' is presented as[23] :

> *"Iconic species are animals or plants which are important to cultural identity as shown by their involvement in traditional activities such as local, ethnic or religious practices and/or which are locally or more broadly recognised for their existence and aesthetic values"*

An important benefit of iconic species is their power to promote changes in conservation and planning, and to drive flow-on conservation and educational benefits for many other species that share their habitat requirements. In the lower Mehi region, three iconic species include Murray cod (*Maccullochella peelii peelii*), white-bellied sea-eagle (*Haliaeetus leucogaster)* and koala (*Phascolarctos cinereus).*

Murray cod

Murray cod is the largest Australian freshwater fish, a long-lived, top-order aquatic predator, and a river-channel specialist with a high affinity for in-stream woody habitat[24]. Identified as a 'keystone species', the species has high conservation, biodiversity, cultural and recreational values[25]. Indigenous dreaming stories link the Murray cod to the creation of the Murray River itself and all the fish species it contains. Known as Guduu in the Kamilaroi language, the Murray cod was and is a major food source and cultural icon for the nations of the Murray-Darling Basin[26].

The Murray cod was historically distributed throughout the Murray-Darling Basin (MDB), which extends from southern Queensland, through NSW, the ACT and Victoria to South Australia, except for the upper reaches of some tributaries. The species still occurs in most parts of this natural distribution up to approximately 1,000 m above sea level[27], however, the species' listing as vulnerable under the EPBC Act reflects a significant decline in numbers, particularly over the last 80 years. Reasons for its decline include habitat loss and degradation, barriers to fish passage, flow regulation, cold water releases, fishing (legal and illegal), competition with exotic fish species, and climate change. These threats are exacerbated by the species' relatively narrow spawning period of September through to December while typically requiring water temperatures greater than 18°C and relatively high-flow events[28].

---

[22] McNeely, J.A., Miller, K.R., Reid, W.V., Mittermeier, R.A. and Werner, T.B. (1990). *Conserving the World's Biological Diversity*. IUCN, World Resources Institute, Conservation International, WWF-US and the World Bank: Washington, DC.

[23] Albert, C., Luque, G.M. and Courchamp, F. (2018). The twenty most charismatic species. *PLoS ONE.* 13(7): e0199149.

[24] Koehn, J. D., Raymond, S.M., Stuart, I., Todd, C.R., Balcombe, S.R., Zampatti, B.P., Bamford, H., Ingram, B.A., Bice, C.M., Burndred, K., Butler, G., Baumgartner, L., Clunie, P., Ellis, I., Forbes, J.P., Hutchison, M., Koster, W.M., Lintermans, M., Lyon, J.P., Mallen-Cooper, M., McLellan, M., Pearce, L., Ryall, J., Sharpe, C., Stoessel, D.J., Thiem, J.D., Tonkin, Z., Townsend, A. and Ye, Q. (2020) A compendium of ecological knowledge for restoration of freshwater fishes in Australia's Murray-Darling Basin. *Marine and Freshwater Research.* 71: 1391-1463.

[25] National Murray Cod Recovery Team (2010). *National Recovery Plan for the Murray Cod* Maccullochella peelii. Department of Sustainability and Environment, Victorian Government.

[26] Rowland, S. (2004). *Overview of the history, fishery, biology and aquaculture of Murray Cod* (Maccullochella peelii peelii). NSW Department of Primary Industries.

[27] TSSC (2003). *Commonwealth Listing Advice on* Maccullochella peelii *(Murray Cod, Cod, Goodoo).* Threatened Species Scientific Committee, Commonwealth of Australia.

[28] DPIE (2020). *Gwydir Long Term Water Plan – Part A: Gwydir Catchment.* NSW Department of Planning, Industry and Environment

White-bellied Sea-eagle

Despite its name, the white-bellied sea-eagle is not dependent on the ocean for any part of its life cycle. Although most of the white-bellied sea-eagle population utilises the coastline during breeding season, many will opt for inland areas provided there is quality foraging and nesting habitat available[29]. There are three key breeding habitat elements that must be met, regardless of coastal or inland setting:

- Intact woodland or forest
- Proximity to a permanent waterbody, and
- Limited human disturbance around the nesting site

The Mehi River, Ballin Boora Creek and associated natural and artificial watercourses and wetlands provide habitat for fish, turtles, reptiles, waterbirds, and small mammals, all of which may be targeted by the white-bellied sea-eagle as prey. Although its diet is highly variable, the health and continuing function of the aquatic system within which the sea-eagle hunts is the ultimate determinant of the species' ability to survive in the long-term[30].

Availability of nesting sites for birds of prey (often preferring the tallest mature trees in undisturbed stands as is the case for the white-bellied sea-eagle) and other avifauna is critical for population viability[31].

Koala

The koala is perhaps the most iconic fauna species native to Australia. It is currently listed as vulnerable under the EPBC Act and a proposal to revise its status to endangered is currently being considered by the Minister for the Environment based on its ongoing decline, recently exacerbated by the bushfires that burnt millions of hectares of habitat throughout the eastern states of Australia in the 2019/20 summer.

Inland koala habitat as described in the EPBC Act referral guidelines for koala[32] includes woodlands and forests with reliable access to soil moisture which are dominated by box gum or red gum (or other preferred eucalypt food trees). In semi-arid regions koala distribution and abundance is strongly influenced by the availability of water in soils from which food trees draw water[33], where koalas inhabit *Eucalyptus*-dominated forests and woodlands, particularly in the vicinity of riparian environments, as well as *Acacia*-dominated forests, woodlands and shrublands[34,35]. The river red gum and coolibah woodlands that dominate the banks and lower floodplain of the Mehi River and Ballin Boora Creek represent preferred habitat for this threatened species in the region.

---

[29] OEH (2016) White-bellied Sea-Eagle – profile. NSW Office of Environment and Heritage. https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20322

[30] Marchant, S. and Higgins, P. J. (1993). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 – Raptors to Lapwings*. Melbourne, Victoria. Oxford University Press.

[31] OEH (2016) White-bellied Sea-Eagle – profile. NSW Office of Environment and Heritage. https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20322

[32] DoE (2014). *EPBC Act referral guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory).* Commonwealth Department of the Environment.

[33] *ibid.*

[34] Melzer, A., Carrick, F., Menkhorst, P., Lunney, D. and John, B.S. (2000). Overview, critical assessment, and conservation implications of koala distribution and abundance. *Conservation Biology*. 14:619-628.

[35] Sullivan, B.J., Baxter, G.S. and Lisle, A.T. (2003). Low-density koala (*Phascolarctos cinereus*) populations in the mulgalands of south-west Queensland. III. Broad-scale patterns of habitat use. *Wildlife Research*. 30:583-591.

02 APPROACH

02.1 Vegetation mapping

02.1.1 Preamble

This project involved the digital capture of wetland and riverine features and associated PCTs across the study region, guided by on-screen aerial photographic interpretation, incorporation of existing map data, and field reconnaissance. The project also mapped out existing croplands as well as constructed features including channels, farm dams and major irrigation storages, and artificial wetlands associated with them.

Non-wetland vegetation types such as chenopod shrublands, native grasslands, and weeping myall woodlands that occur on the outer floodplain and are exclusively rain-fed or flooded infrequently via overland flow (rather than via flood-runners and other channels) were pooled into a “not mapped” category. However if a distinctive non-wetland type was encountered in the field or was readily detected via mapping, it was captured as a non-wetland polygon during the mapping phase.

02.1.2 Compilation of candidate PCTs

The standard classification for vegetation communities in NSW[36] includes a three-tiered hierarchy comprising 16 vegetation formations and 99 vegetation classes[37], as well as 1,500 - 2,000 fine resolution Plant Community Types (PCTs). For areas of NSW west of the Great Dividing Range, the PCT list has been largely guided by the NSW Vegetation Classification and Assessment (VCA) developed by the Royal Botanic Gardens and Domain Trust[38]. The current PCT list for western NSW is underpinned by Part 1 of the VCA[39] with a few types added for the BBS Bioregion from Part 3 of the VCA[40].

A list of candidate wetland PCTs that are known to occur in the lower Mehi system based on their known association with the Warrambool-Moonie and Castlereagh-Barwon IBRA sub-regions was compiled via existing PCT mapping and field reconnaissance. The final list is shown in Table 02-1. Each PCT is listed with its associated vegetation formation and class[41] and its broad hydro-ecological functional group[42]. A total of 24 wetland PCTs are known to occur in the study region.

---

[36] Sivertsen, D. (2009). *Native Vegetation Interim Type Standard.* Department of Environment, Climate Change and Water NSW, Sydney.

[37] Keith, D. (2004). *Ocean Shores to Desert Dunes: the Native Vegetation of New South Wales and the ACT.* NSW National Parks and Wildlife Service, Sydney.

[38] Benson, J.S. (2006). New South Wales Vegetation Classification and Assessment: Introduction - the classification, database, assessment of protected areas and threat status of plant communities. *Cunninghamia.* 9: 329-381.

[39] Benson, J.S., Allen, C.B., Togher, C. and Lemmon, J. (2006). New South Wales Vegetation Classification and Assessment: Part 1 Plant communities of the NSW Western Plains. *Cunninghamia.* 9: 383-450.

[40] Benson, J.S., Richards, P.G., Waller, S. and Allen, C.B. (2010). New South Wales Vegetation Classification and Assessment: Part 3 Plant communities of the Brigalow Belt South, Nandewar and west New England Bioregions and update of NSW Western Plains and South-western Slopes plant communities. *Cunninghamia.* 11: 457-579

[41] Keith, D. (2004). *Ocean Shores to Desert Dunes: the Native Vegetation of New South Wales and the ACT.* NSW National Parks and Wildlife Service, Sydney.

[42] Brock, M. A. and Casanova, M. T. (1997). 15. Plant life at the edge of wetlands: ecological responses to wetting and drying. *Frontiers in Ecology: Building the Links.* 181.

Table 02-1. Wetland PCTs of the Lower Mehi region

PCT ID	PCT Name	Vegetation Formation	Vegetation Class	Hydro-Ecological Functional Group
24	Canegrass swamp tall grassland wetland of drainage depressions, lakes, and pans of the inland plains	Freshwater Wetlands	Inland Floodplain Shrublands	Non-Woody Wetland
25	Lignum shrubland wetland on floodplains and depressions of the Mulga Lands Bioregion, Channel Country Bioregion in the arid and semi-arid (hot) climate zones	Freshwater Wetlands	Inland Floodplain Shrublands	Flood-Dependent Shrubland Wetland
36	River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	Forested Wetlands	Inland Riverine Forests	Flood-Dependent Forest
37	Black Box woodland wetland on NSW central and northern floodplains including the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	Semi-arid Woodlands (grassy sub-formation)	North-west Floodplain Woodlands	Flood-Dependent Woodland
39	Coolibah - River Cooba - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	Semi-arid woodlands (grassy sub-formation)	North-west Floodplain Woodlands	Flood-Dependent Woodland
40	Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains	Semi-arid woodlands (grassy sub-formation)	North-west Floodplain Woodlands	Flood-Dependent Woodland
40a	Coolibah – Belah open woodland wetland with chenopod / grassy groundcover	Semi-arid woodlands (grassy sub-formation)	North-west Floodplain Woodlands	Flood-Dependent Woodland
50	Couch Grass grassland wetland on river banks and floodplains	Freshwater Wetlands	Inland Floodplain Swamps	Non-Woody Wetland
53	Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains	Freshwater Wetlands	Inland Floodplain Swamps	Non-Woody Wetland
53a	Ephemerally flooded wetlands with open water/bare ground or pale poverty bush and ephemeral forbs	Freshwater Wetlands	Inland Floodplain Swamps	Non-Woody Wetland
62	Samphire saline shrubland/forbland wetland of lake beds and lake margins in the arid and semi-arid (hot) zones	Saline Wetlands	Inland Saline Lakes	Non-Woody Wetland

PCT ID	PCT Name	Vegetation Formation	Vegetation Class	Hydro-Ecological Functional Group
63	Spiny Lignum - Slender Glasswort open forbland saline wetland on lake edges in the semi-arid and arid climate zones	Saline Wetlands	Inland Saline Lakes	Non-Woody Wetland
115	Eurah shrubland of inland floodplains	Freshwater wetlands	Inland Floodplain Shrublands	Flood-Dependent Shrubland Wetland
160	Nitre Goosefoot shrubland wetland on clays of the inland floodplains	Freshwater Wetlands	Inland Floodplain Shrublands	Flood-Dependent Shrubland Wetland
161	Golden Goosefoot shrubland wetland in swamps of the arid and semi-arid (hot summer) zones	Freshwater Wetlands	Inland Floodplain Shrublands	Flood-Dependent Shrubland Wetland
181	Common Reed - Bushy Groundsel aquatic tall reedland grassland wetland of inland river systems	Freshwater Wetlands	Inland Floodplain Swamps	Non-Woody Wetland
182	Cumbungi rushland wetland of shallow semi-permanent water bodies and inland watercourses	Freshwater Wetlands	Inland Floodplain Swamps	Non-Woody Wetland
195	Bladder Saltbush chenopod shrubland on alluvial plains mainly in the Darling Riverine Plain Bioregion	Arid Shrublands (chenopod sub-formation)	Riverine Chenopod Shrublands	Flood-Dependent Shrubland Wetland
198	Sparse saltbush forbland wetland of the irregularly inundated lakes of the arid and semi-arid (persistently hot) climate zones	Saline Wetlands	Inland Saline Lakes	Non-Woody Wetland
204	Water Couch marsh grassland on frequently flooded inland watercourses	Freshwater Wetlands	Inland Floodplain Swamps	Non-Woody Wetland
205	Marsh Club-rush wetland very tall sedgeland of inland watercourses, mainly Darling Riverine Plains Bioregion	Freshwater Wetlands	Inland Floodplain Swamps	Non-Woody Wetland
211	Slender Saltbush - samphire - copperburr low open shrubland wetland on irregularly inundated floodplains mainly in the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	Arid Shrublands (chenopod sub-formation)	Riverine Chenopod Shrublands	Flood-Dependent Shrubland Wetland
238	Permanent and semi-permanent freshwater lakes wetland of the inland slopes and plains	Freshwater Wetlands	Inland Floodplain Swamps	Non-Woody Wetland

PCT ID	PCT Name	Vegetation Formation	Vegetation Class	Hydro-Ecological Functional Group
238a	Ephemeral herbaceous vegetation of the channels and beds of western NSW	Freshwater Wetlands	Inland Floodplain Swamps	Non-Woody Wetland
238b	Water bodies associated with intermittently flooded oxbows and closed depressions	Freshwater Wetlands	Inland Floodplain Swamps	Non-Woody Wetland
241	River Cooba swamp wetland on the floodplains of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	Freshwater Wetlands	Inland Floodplain Shrublands	Flood-Dependent Shrubland Wetland
242	Rats Tail Couch sod grassland wetland of inland floodplains	Grasslands	Semi-arid Floodplain Grasslands	Non-Woody Wetland
247	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	Freshwater Wetlands	Inland Floodplain Shrublands	Flood-Dependent Shrubland Wetland
375	Budda Pea - Channel Millet ephemeral reedland wetland on floodplains in north-western NSW	Freshwater Wetlands	Inland Floodplain Swamps	Non-Woody Wetland
454	River Red Gum grassy chenopod open tall woodland (wetland) on floodplain clay soil of the Darling Riverine Plains Bioregion and western Brigalow Belt South Bioregion	Semi-arid Woodlands (grassy formation)	Inland Floodplain Woodlands	Flood-Dependent Forest
1000	Anthropologic herbland/cropland	na	na	na
1005	Man-made water storage	na	na	na
1010	Built	na	na	na

02.1.3 Existing vegetation mapping

Four spatial datasets have each captured the distribution of vegetation types in the study region, and these were provided for this project (Table 02-2). Each dataset provided an additional line of visual evidence in allocating PCTs to floodplain vegetation patterns captured for this project.

Table 02-2. Existing vegetation mapping products in the lower Mehi region

Dataset	No polygons	No .unique features mapped	
		Native vegetation	Other
Ecological assets of the Gwydir wetlands and floodplains [A,B,C]	113	7	4
State Vegetation Type Map: Border Rivers Gwydir / Namoi Region V.2.0 [D]	1,800	13	1
Vegetation communities of the Gwydir Wetlands 2008 and 2015 [E]	192	10	5
North West Vegetation Mapping, Moree and Part Walgett Shire [F]	475	14	4

A. Bowen, S. and Simpson, S. (2009). *2008 Vegetation map of the Gwydir Wetlands and floodplain.* NSW Wetland Recovery Program. NSW Department of Environment, Climate Change and Water: Sydney

B. Bowen, S. and Simpson, S. (2010) Changes in extent and condition of the Vegetation Communities of the Gwydir Wetlands and Floodplain 1996-2008. Final Report for the NSW Wetland Recovery Program. NSW Department of Environment, Climate Change and Water: Sydney.

C. Bowen, S., Simpson, S. L., Thomas, R. T. and Spencer, J. A. (2012) Healthy Floodplains Project - Defining ecological assets of the Gwydir Wetlands. Report for the Healthy Floodplains Project. NSW Office of Environment and Heritage: Sydney.

D. Information about NSW SVTM available at: https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/nsw-bionet/about-bionet-vegetation-classification/vegetation-maps/state-vegetation-type-map

E. Bowen, S., Simpson, S.L., Honeysett, J. and Humphries, J. (2019). *Technical report: Vegetation extent and condition mapping of the Gwydir Wetlands and floodplains 2008 -2015.* NSW Office of Environment and Heritage. June 2019.

F. Peasley, B. and Walsh, A. (undated). Mapping Vegetation Landscapes of the NSW North West Slopes and Plains. NHT Project NW0339.97. Department of Land & Water Conservation & North West Catchment Management Committee.

02.1.4 Aerial photographic interpretation and mapping of wetlands

Digital aerial photographs were provided by DPIE for the study region. These images were captured by Geoscience Australia in 2013 during concurrent capture and development of LiDAR data[43]. The images provide a high resolution (50 cm) colour photographic dataset which is well suited to on-screen vegetation mapping. A DEM entitled *Mehi_DEM1m* and associated inundation layer entitled *Mehi_DEMfill_2*, each developed from LiDAR data, were also provided by DPIE for the study region to assist with delineation of wetland and channels in the landscape.

Aerial photographic interpretation (API) was undertaken using 2-dimensional on-screen digitising within ArcMAP to manually capture distinctive hydrological and ecological features (Table 02-3) and their associated PCTs. Manual API was guided by contextual data including existing vegetation mapping (Table 02-2) as well as LiDAR derived hydrological data and delivery pathway mapping (Table 02-4).

Vegetative patterns were interpreted from aerial photos at a maximum scale of 1:5,000. As a guideline, a minimum polygon size of 0.02 ha was used for wetland types. However, wetlands 0.02 to 0.05 ha were not mapped if they were found to be relatively shallow (< 20 cm) when fully inundated and were not evident as distinctive patterns on the aerial photographs.

Five floodplain types were mapped: constructed; flood-runner; floodplain; near-channel; and oxbow wetlands. Each was assigned a unique wetland identifier other than wetlands with no obvious upstream connection to Mehi River or Ballin Boora Creek, or constructed wetlands not associated with a flood-runner that linked series of natural wetlands.

[43] Information available at: https://dev.ecat.ga.gov.au/geonetwork/srv/api/records/24c97df0-86bc-3129-e053-12a3070a8916

Table 02-3. Features captured during API

Feature	Definition
Channel bed	Channel beds of main channels only, including Ballin Boora Creek and Mehi River, as well as sections of Barwon River, Tarran Creek and Moomin Creek
Constructed channel	Channel constructed to carry irrigation water to croplands
Constructed wetland	Wetland that is not likely to have occurred prior to land modification, but now exists because of construction of dams, levees, roads, and other structures
Cropland	Area of land cleared of native vegetation and managed to produce crops such as cotton, wheat, and sorghum
Culvert	Structure under road or embankment in which water flows form one side to the other
Embankment	Earth bank associated with construction of a tank or turkey nest dam
Farm dam	Small shallow dam, generally constructed by building an earth wall across a watercourse
Flood-runner	Natural channel that carries floodwaters from an upstream breakout point back to the main channel, often via a series of flood-runner wetlands
Flood-runner wetland	Natural wetland (and former wetland within cropland) that occurs along a flood-runner
Floodplain channel	Shallow channel on the floodplain that carries floodwater across the floodplain during larger floods (floodplain channels generally occur higher in the landscape, feed floodplain wetlands, and are topographically less pronounced than flood-runners)
Floodplain wetlands	Floodplain that occurs higher in the landscape and is only likely to be inundated during relatively large floods
Floodplain woodland	Woodland that occurs in low lying areas that is subject to periodic inundation, notably Coolibah wetlands (PCT 39)
Near-channel wetland	Wetland other than an oxbow wetland and flood-runner wetlands that is adjacent to main channel (these wetlands generally fill from overbank flow, and do not feed downstream wetlands)
Oxbow	Natural u-shaped channel adjacent to the main channel that may feed one or more oxbow wetlands (part of the oxbow in which water accumulates), or downstream flood-runner wetlands (oxbows are also referred to as billabongs)
Oxbow wetland	Wetland within an oxbow (billabong)
Riverine forests	Tall eucalypt forest growing along the Mehi and Barwon Rivers, dominated by river red gum (*Eucalyptus camaldulensis*)
Riverine woodland	Woodland that occurs on parts of the upper floodplain that is seldomly inundated, including Coolibah (PCT 40)
Tank	Relatively deep, square-shaped farm storage constructed via deep excavation along a channel to hold irrigation water (spoil is generally deposited around its margins to form a distinctive embankment)
Turkey nest dam	Very large (multiple hectare) storage formed by constructing a sizable embankment around its perimeter, to hold significant volumes of irrigation water

02.2 Capture of hydrological features

02.2.1 Natural features

Accurate high-resolution maps of maximum wetland inundation extents are valuable inventorial resources[44]. This and other spatial topographic and hydrological data supplied by DPIE (Table 02-4) were used to support capture of four types of data points within ArcMap:

- Channel outflow point: point in the main channel from which floodwater originates to feed wetland (coincides with the channel bed)
- Breakout point or commence-to-flow point: point of highest elevation in the feeder channel above which floodwater will overflow and feed the recipient wetland(s)
- Wetland inlet point: point in which water flows into the wetland when the wetland is at maximum capacity (same elevation as the outlet point above)
- Wetland outlet point: point in which water flows from the wetland when the wetland is at maximum capacity (same elevation as the inlet point above)

An inlet point, breakout point and outflow point was captured for all mapped wetlands in which a distinctive delivery pathway from either the Mehi River or Ballin Boora Creek was evident. This included natural (intact) wetlands, cropped wetlands, and a handful of constructed wetlands associated with storages that connected a series of wetlands along a flood-runner. An outlet point was only captured for a subset of the above wetlands in which floodwater would continue to feed downstream wetlands or flow back into the main channel. Some wetlands shared the same breakout point, and some outflow points distributed water to multiple channels, breakouts, and wetlands. All outflow and breakout points were assigned a unique identifier that linked back to its associated wetland(s).

The direction of flow (north, north-east, east, south-east, south, south-west, west, or north-west) was recorded for each point. An elevation value was also assigned to each point from the 1m DEM supplied by DPIE[45]. The commence-to-flow (CTF) height of each wetland was calculated as the difference between its breakout point and outflow point (Figure 02-1 shows an example for an oxbow wetland). This height roughly equates to the flood level the main channel must achieve (measured against baseflow) prior to inundation of the wetland. Finally, the 'Mehi_DEMfill_2' raster surface supplied by DPIE[46] was intersected with each wetland polygon to calculate its depth (m) and stored volume (ML) at capacity.

[44] Hall, A., Thomas, R.F. and Wassens, S. (2019). Mapping the maximum inundation extent of lowland intermittent riverine wetland depressions using LiDAR. *Remote Sensing of the Environment.* 233: 111376.

[45] DEM sourced by DPIE from https://elevation.fsdf.org.au

[46] This surface was developed by DPIE from the 1m DEM

Table 02-4. Hydrological data supplied by DPIE to assist with capture of wetland footprints and hydrological points

Dataset Name	Description
Mehi_Delivery_Pathways_V1	Includes A – B pathways along main channels and A – C pathways where environmental water may be utilised in conjunction with natural events (e.g. piggy backing) to achieve project objectives
BallinBoora_Delivery_Pathways_V1	
Mehi_DEM1m	Fine-resolution DEM (1 m pixel and 1 cm elevation resolution)
Mehi_DEMfill_2	Inundation layer derived from 1m DEM (1 m pixel and 1 cm depth resolution)
Hillshade_LiDAR_1mDEM	Shaded relief derived from 1m DEM
Contours_50cm_Mehi_20210317	50cm contour lines in the study area derived from the LiDAR 1m DEM
Contours_20cm_Mehi_ ACPathwayClip_20210318	20cm contour lines in the A to C delivery pathway derived from the LiDAR 1m DEM
GwydirValley2013_rgb-050_mosaic _551_mehi.tif	Fine resolution aerial image of the study region, other than the far west
Macintyre2013_RGB-0_2_6296708_55 _0167_0140.ecw	Fine resolution aerial image of the far western part of the study region

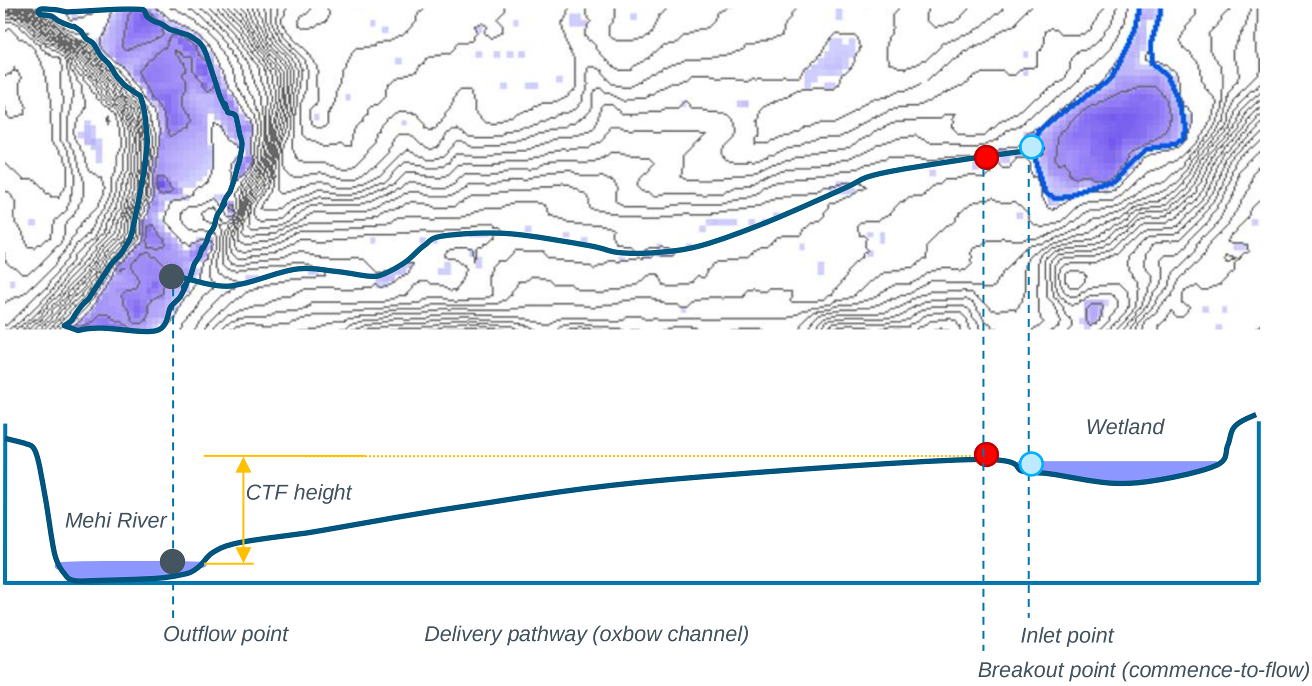


Figure 02-1. Aerial and section examples of outflow, breakout and inlet points captured for each wetland

02.2.2 Constraints to flow

Hydrological processes in the Mehi and Ballin Boora channels and nearby floodplains have been highly modified over the past 100 years via development of cropping industry, and associated irrigation infrastructure including major storages and pumping stations, intake channels, distribution channels, retention banks, pipes/culverts, and bores. DPIE pre-mapped a few physical constraints for this project and supplied a list of 10 that are likely to constrain delivery of environmental water to wetland assets in the lower Mehi and Ballin Boora catchments (Table 02-5).

Table 02-5. Number of major constraint features identified by DPIE

Constraint feature	Watercourse	
	Mehi	Ballin Boora
Bank	-	1
Channel	1	-
Road crossing	3	2
Weir	3	-

02.2.3 Flood inundation mapping

The Mehi River system experienced a major flood event in late March 2021, a timely event in the context of the project as it provided the opportunity:

1. for wetlands to recover following the 2017-2020 drought, prior to botanical survey
2. to undertake flood inundation mapping to verify CTF data captured from the DEM.

Two data sources were employed to map inundation in the lower Mehi River: flow hydrograph; and Sentinel 2 satellite imagery. A flood hydrograph was sourced from WaterNSW[47] and is shown in Figure 02-2. This included six dates (1-6) at which inundation mapping was undertaken using Sentinel 2 satellite images.

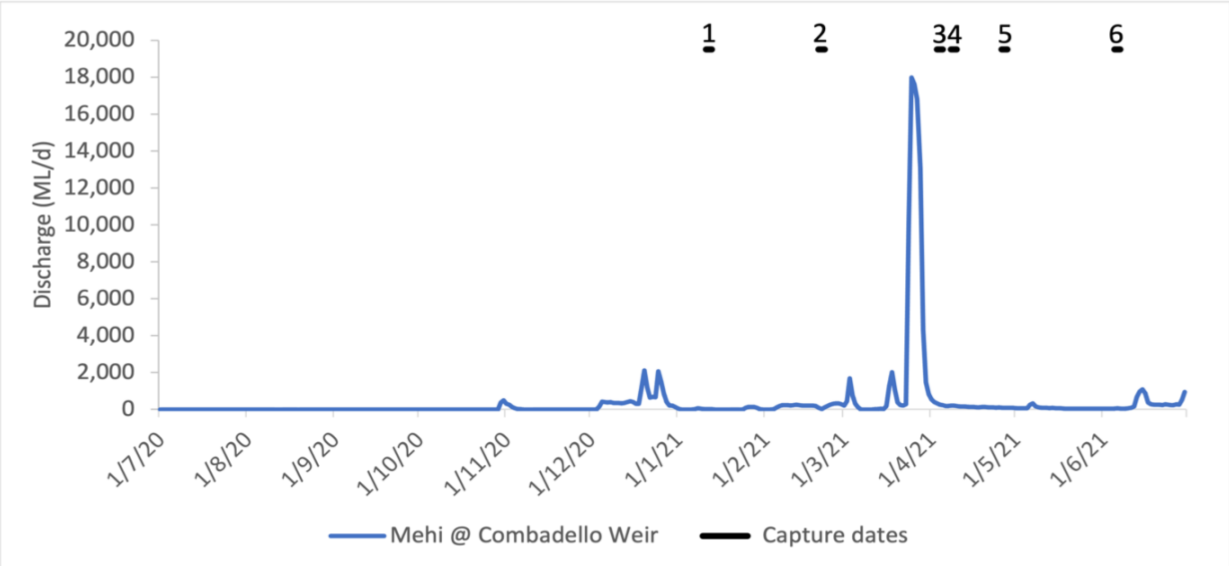


Figure 02-2. Hydrograph of Mehi River discharge (ML/day), July 2020 to June 2021

[47] Available at: https://realtimedata.waternsw.com.au/

Six high quality Sentinel 2 images were selected from January 2021 to June 2021 to explore inundation of the channels and wetlands of the Mehi River. These are listed in Table 02-6.

The Modified Normalised Difference Water Index (MNDWI) was applied to each satellite image to distinguish open water from dry land in the landscape. The MNDWI equation as defined by Xu (2006)[48] was used for this analysis (where SWIR = short-wave infrared):

$$MNDWI = \frac{(Green - SWIR)}{(Green + SWIR)}$$

MNDWI thresholds were determined using each MNDWI histogram and the displayed image. In each case a threshold of -0.12 was used to differentiate water from non-water pixels.

Table 02-6. Sentinel tiles used for inundation analysis

Sentinel image	Image date (2020)	MNDWI thresholds	
1	12 January	-0.12	0.91
2	21 January	-0.12	0.94
3	04 April	-0.12	0.99
4	07 April	-0.12	0.97
5	27 April	-0.12	0.96
6	06 June	-0.12	0.98

02.3 Field survey

02.3.1 Vegetation reconnaissance

Field reconnaissance was undertaken to verify vegetation patterns captured during API and to facilitate assignment of one or more PCTs to each mapped feature. A systematic vegetation survey was also completed during field reconnaissance, in which a minimum 200 rapid floristic plots were completed across the study region. Vegetation reconnaissance fieldtrips were undertaken by Bruce Wilson and Jared Reid in May 2021 and October 2021. Field survey was originally intended to be completed by August 2021 but was challenged by Covid-19 disruptions and local rainfall and flood events.

Site selection

Location of rapid floristic plots considered the following:

- strata that have been relatively poorly sampled to date, including under-represented soils (e.g. great soil groups) and under-represented vegetation types
- low-lying ephemeral wetlands associated with irregularly flooded oxbow channels and notable depressions along flood-runners
- geographic gaps (the survey aimed to cover all parts of the region of study)
- distinctive and/or unique vegetative patterns identified during mapping, including at least 5% of plots assigned for distinctive non-wetland PCTs
- private as well as public land sites

[48] Xu, H. (2006). Modification of Normalised Difference Water Index (NDWI) to Enhance Open Water Features in Remotely Sensed Imagery. *International Journal of Remote Sensing.* 27: 3025-3033.

Site selection was constrained mainly to the lower floodplain and channels connected to the Mehi and Ballin Boora channels. On private lands, site selection was also constrained to areas for which access had been granted by landholders.

Plot data

Floristic data were recorded within 400 m^2 plots[49] and aligned with Module 1 protocols established under the interim vegetation Standard[50]. Key data collected within each plot were:

- Recorder, date, geo-position, and plot dimensions
- Location/property and land-use
- Plot photo ID and bearing
- Geology, soil type and soil colour
- Landscape feature and element
- Disturbance type and severity
- Projected foliage cover (PFC) and maximum height (m) of each stratum (trees, shrubs, ground-cover)
- Dominant species in each stratum[51]
- PFC of dominant species in each stratum
- Main exotic species and total PFC of exotics
- Evidence of regeneration
- PCT assigned
- Other observations (notes)

In addition to Module 1 plot requirements, several other field attributes were recorded on site via general reconnaissance of mapped wetlands, including:

- Standard plot photo and incidental site photo/s (all geo-referenced)
- Incidental records of threatened plants and significant weed infestations (photo and geo-reference)
- General observations of physical wetland features (e.g. root-balls) and notes on possible constraints to inflow
- Contextual information on fauna including sightings of waterbirds and other aquatic species, and notes on behaviour, including nesting and breeding.

02.3.2 Constraints

Key constraints to flow identified by DPIE-EES (Table 02-5), and others identified during mapping, were measured in the field using the CORSnet NSW system via differential field GPS[52] to provide high-definition elevational and other data. The following field protocols were adopted:

---

[49] Most commonly 20m x 20m plots, but also 40m x 10m and occasionally 80m x 5m plots

[50] Sivertsen, D. (2009). *Native Vegetation Interim Type Standard*. Department of Environment, Climate Change and Water NSW, Sydney.

[51] Identified in the field, or collected and identified post-survey using an appropriate botanical key

[52] CORSnet-NSW is a network of Global Navigation Satellite System (GNSS) Continuously Operating Reference Stations (CORS) covering the state of NSW that providing centimetre-level real-time positioning.
More information at: https://www.spatial.nsw.gov.au/surveying/corsnet-nsw

- Field image/s of each feature taken from upstream and downstream (each image identified using a unique ID include feature type)
- High-accuracy X,Y,Z coordinates of the crest of each structure at both ends of the structure: and of any apertures or opening including pipes of culverts
- Detailed description of any waterway opening/s on constraint features, including number and type, geometry, aperture dimensions and length, material of construction, and details of guardrails or similar structures.

02.3.3 Other observations

The location of notable ecological features such as significant fauna sightings, bird roosts and nests, and threatened flora species was recorded during vegetation and constraints surveys. Landholders were also consulted about on-farm ecological values where appropriate.

02.4 Wetland prioritisation analysis

All mapped wetlands that were connected to Mehi River or Ballin Boora Creek via oxbows, flood-runners or floodplain channels were assembled as a separate spatial layer in ArcMap. A priority rating from 1 (lowest) to 10 or 20 (highest) was assigned to each wetland for each of eight key metrics. A summary of prioritisation rules, and rationale for their application, is provided in Table 02-7.

It was originally intended that constraints be included in the prioritisation analysis, however a high level of uncertainty about the hydrological effects of existing constraints could not justify their inclusion. That is, the extent to which existing constraints might prevent water from being delivered (if at all) could not confidently be determined, especially as none of the constraints was subjected low flow conditions at any time during the project.

Table 02-7. Prioritisation rules applied to mapped wetlands

Criterion	Rationale	Priority ratings	
Wetland status	Natural wetlands have greater value than constructed wetlands, and both have greater value that cropped wetlands that are highly modified	1. modified 7. constructed 10. natural	
CTF height (m)	The lower the commence-to-flow height, the lower the size of natural flows required to fill the wetland, the more time the wetland is likely to be at least partially inundated, and the greater the potential to deliver environmental water during low-flow conditions (this variable is a proxy for the level of connectivity to the main channel)	1. > 4.00 m 2. 3.81 – 4.00 m 3. 3.61 – 3.80 m 4. 3.41 – 3.60 m 5. 3.21 – 3.40 m 6. 3.01 – 3.20 m 7. 2.81 – 3.00 m 8. 2.61 – 2.80 m 9. 2.41 – 2.60 m 10. 2.21 – 2.40 m	11. 2.01 – 2.20 m 12. 1.81 – 2.00 m 13. 1.61 – 1.80 m 14. 1.41 – 1.60 m 15. 1.21 – 1.40 m 16. 1.01 – 1.20 m 17. 0.76 – 1.00 m 18. 0.51 – 0.75 m 19. 0.26 – 0.50 m 20. ≤ 0.25 m
Area (ha)	The larger the wetted surface area, the greater the number of surface-using fauna and flora that can occupy the wetland	1. 0.0 – 0.05 ha 2. 0.051 – 0.10 ha 3. 0.11 – 0.20 ha 4. 0.21 – 0.50 ha 5. 0.51 – 1.0 ha	6. 1.01 – 2.0 ha 7. 2.01 – 5.0 ha 8. 5.01 – 10.0 ha 9. 10.01 – 20.0 ha 10. > 20.0 ha
Perimeter length (m)	The longer the wetland perimeter, the greater the wet/dry interface that provides critical foraging habitat for many wetland-dependent fauna	1. ≤ 50 m 2. 51 – 100 m 3. 101 – 150 m 4. 151 – 200 m 5. 201 – 300 m	6. 301 – 500 m 7. 501 – 1000 m 8. 1001 – 2000 m 9. 2001 – 5000 m 10. > 5000 m

Criterion	Rationale	Priority ratings
Maximum capacity (ML)	The greater the capacity of wetland, the greater the level of biotic activity and energy exchange, and the greater the supply of aquatic biomass into the local food-chain	1. ≤ 0.1 ML 2. 0.11 – 0.25 ML 3. 0.26 – 0.50 ML 4. 0.51 – 0.75 ML 5. 0.76 – 1.00 ML 6. 1.01 – 2 ML 7. 2.01 – 5 ML 8. 5.01 – 10 ML 9. 10.01 – 50 ML 10. > 50 ML
Maximum depth (m)	The deeper the wetland, the longer that water is likely to persist through dry periods (i.e. the greater the likelihood of the wetland providing ongoing refugia), and the more ecologically diverse/complex the water column	1. ≤ 0.10 m 2. 0.11 – 0.20 m 3. 0.21 – 0.30 m 4. 0.31 – 0.40 m 5. 0.41 – 0.50 m 6. 0.51 – 0.75 m 7. 0.76 – 1.0 m 8. 1.01 – 1.5 m 9. 1.51 – 2.0 m 10. > 2.0 m
Fringing forest and woodland	The greater the proportion of the wetland that contains fringing forest and woodland (mainly river red gum and coolabah), the more litterfall, shade and adjacent habitat opportunity	0. no fringing vegetation 1. 0.01 - 10% 2. 10.01 – 20% 3. 20.01 – 30% 4. 30.01 – 40% 5. 40.01 – 50% 6. 50.01 – 60% 7. 60.01 – 70% 8. 70.01 – 80% 9. 80.01 – 90% 10. 90.01 – 100%
PCT representation	The more unusual the wetland in terms of PCTs represented, the greater the local conservation value. Ratings are assigned based on the percent area of PCTs mapped within wetlands across the region. A value of '0' was assigned to highly modified wetlands (i.e. those subject to cropping) as well as constructed wetlands	1. > 50% 2. 40.01 – 50% 3. 30.01 – 40% 4. 25.01 – 30% 5. 20.01 – 25% 6. 15.01 – 20% 7. 12.51 – 15% 8. 10.01 – 12.5% 9. 7.51 – 10% 10. 5.01 – 7.5% 11. 4.01 – 5% 12. 3.01 – 4% 13. 2.01 – 3% 14. 1.01 – 2% 15. ≤ 1%
Field observations	Any wetland visually observed to be in particularly good condition in the field was assigned an additional score of 5. Accounted for plant diversity and cover and observed level of disturbance of adjacent land.	5. noted as being in very good condition

02.5 Development of a geodatabase

A geodatabase entitled "Lower_Mehi_Wetland_Data_2rog_v1" was developed for DPIE. This geodatabase comprised five spatial datasets as listed in Table 02-8 and used the GDA_1994_MGA_Zone_55 projection. A summary of the fields captured within each of the five layers is shown in Attachment B.

Table 02-8. Summary of spatial layers within the geodatabase

Spatial layer	Number of fields	Number of records	Number of images
Channel_Points_v1	7	3097	na
Constraints_Jan2022_v1	23	182	181
Obs_all_v1	11	394	235
Rapids_Jan2022_v1	10	240	219
Wetland_Veg_Final_v1	29	2511	na

03 RESULTS AND DISCUSSION

03.1 Mapping

A total of 25 unique feature types were captured via on-screen mapping, including channel beds, forested and non-forested wetlands, croplands, and constructed features. These include a total 2,511 polygons mapped across a combined area of 14,396 ha (Table 03-1). A sub-set of 2,034 polygons totalling 2,599 ha were each assigned one of 20 PCTs (Table 03-2). A map of features is shown in Figure 03-1 for the eastern part of the study region, and Figure 03-2 for the western part of the study region.

Table 03-1. Summary of features captured in the Lower Mehi / Ballin Boora wetland layer

Feature name	No. polygons	Total area (ha)	PCTs assigned (area-dominant PCT in **bold**)
Ballin Boora Creek bed	3	58.1	53, 247, **238a**
Ballin Boora delivery channel	1	0.9	na
Barwon River bed	1	20.8	**238a**
Constructed channel	27	152.3	**na**, 36, **39**, 241
Constructed wetland	148	412.1	na, 27, 39, 40, 40a, 53, **53a**, 160, 168, 238b, 247
Cropland	76	10,598.5	na
Culvert	1	0.02	na
Embankment	54	103.6	na
Farm Dam	37	7.8	**na**, **53**
Floodplain channel	20	3.0	na, **53a**, 98
Floodplain wetland	216	215.3	na, 36, 39, 40, 53, **53a**, 55, 98, 115, 161, 168, 238b, 242, 247
Floodplain woodland	6	62.4	27, **39**, 55
Flood-runner	220	50.8	na, 36, 39, 40a, 53, **53a**, 242, 247
Flood-runner wetland	611	231.1	na, 36, 39, 40, 53, **53a**, 55, 98, 53a, 115, 238b, 242, 247
Goonal Creek channel bed	1	0.8	**238a**
Mehi River channel bed	1	273.0	**238a**
Moomin Creek channel bed	1	9.3	**238a**
Near-channel wetland	127	19.5	na, 36, 39, 40, 53, **53a**, 182, 238b, 241, 247, 454
Oxbow	143	60.9	na, 36, 39, 53, **53a**, 247
Oxbow wetland	297	94.7	na, 36, 39, 40, 53a, **238b**, 241, 247,
Riverine forest	365	1,025.7	**36**, 39, 40, 53a, 454
Riverine woodland	99	263.9	36, **39**, 40, 40a, 53a, 247
Tank	36	9.9	na
Tarran Creek channel bed	1	6.6	**238a**
Turkey Nest Dam	19	715.0	na
ALL	**2,511**	**14,396.0**	na, 27, **36**, 39, 40, 40a, 53, 53a, 55, 98, 115, 160, 161, 168, 182, 238a, 238b, 241, 242, 247, 454

Table 03-2. PCTs mapped and surveyed in the study region

PCT code	PCT label	No rapid plots	Mapped area (ha)	Number of polygons mapped
27	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	1	6.1	2
36	River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	30	1033.6	409
39	Coolabah - River Cooba - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	15	263.9	145
40	Coolabah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains	12	137.4	22
40a	Coolabah - Belah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains	7	123.6	40
43	Mitchell Grass grassland - chenopod low open shrubland on floodplains in the semi-arid (hot) and arid zones	2	0.0	0
53	Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains	37	43.1	46
53a	Ephemerally flooded floodplain channels and margins of oxbows and other closed depressions	31	348.8	944
55	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions.	5	54.0	10
98	Poplar Box - White Cypress Pine - Wilga - Ironwood shrubby woodland on red sandy-loam soils in the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	4	11.4	17
115	Eurah shrubland of inland floodplains	7	1.7	4
160	Nitre Goosefoot shrubland wetland on clays of the inland floodplains	1	0.2	1
161	Golden Goosefoot shrubland wetland in swamps of the arid and semi-arid (hot summer) zones	4	43.2	4
168	Derived Copperburr shrubland of the NSW northern inland alluvial floodplains	3	22.3	8
182	Cumbungi rushland wetland of shallow semi-permanent water bodies and inland watercourses	1	0.5	1
238a	Permanently flooded watercourse channels and beds	0	352.3	6
238b	Intermittently flooded oxbow wetlands and deeper floodplain depressions	0	96.1	304
241	River Cooba swamp wetland on the floodplains of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	3	2.1	4

PCT code	PCT label	No rapid plots	Mapped area (ha)	Number of polygons mapped
242	Rats Tail Couch sod grassland wetland of inland floodplains	1	0.5	3
247	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	35	56.4	61
454	River Red Gum grassy chenopod open tall woodland (wetland) on floodplain clay soil of the Darling Riverine Plains Bioregion and western Brigalow Belt South Bioregion	1	1.8	3
NA	*Crops, dams, etc.*	*0*	*11,797.0*	*477*
ALL		**200**	**14,396.0**	**2,511**

The Mehi River channel bed is mapped as a meandering linear strip that spans east to west across the study region (Figure 03-1; Figure 03-2), while Ballin Boora Creek channel spans a much smaller part of the region (Figure 03-1). Each major channel is mapped as PCT 238a and is surrounded by a complex network of secondary channels (flood-runners, floodplain channels, oxbows) that deliver water to a series of natural palustrine wetlands[53] (total 1251 mapped, including flood-runner, floodplain, oxbow, and other near-channel wetlands) during higher flow events. Each wetland has its own distinctive eco-hydrological profile associated with inundation (frequency, volume, depth, persistence). Construction of levee banks for farm storages, canals and roads and has also created a series of artificial wetlands across the region.

Most wetlands are mapped as PCT 53a or 238b. PCT 53a is largely associated with highly ephemeral flood-runner and floodplain wetlands and associated channels (including the higher parts of oxbows) and is dominated by ephemeral terrestrial species such as *Sclerolaena muricata* (black roly poly) and various forbs, with scattered sedges and rushes often dominating the dampest parts. These wetlands often have a high weed cover (e.g. *Brassica spp.* and *Medicago spp*.) during dry periods, but that would probably be removed by flooding. In contrast, PCT 238b is associated with intermittently flooded oxbows and other closed depressions in which water persists for longer periods. As they dry, however, flora associated with PCT 53a will tend to encroach.

Where intensive agricultural development has not occurred, the wetlands and channel are surround by a mosaic of native forest and woodland types. Riverine forest fringes most of the length of the Mehi River and associated oxbows and other near-channel wetlands and is dominated by river red gum (PCT 36). In contrast, Ballin Boora Creek and the upper reaches of the Mehi River are surrounded by coolabah dominated woodland (PCT 39).

Unmapped parts of study region are those that support vegetation types that are slightly higher elevated in the landscape and are not flood-dependent, including grasslands, shrublands and woodlands. A few patches of non-wetland vegetation were mapped if they possessed and distinctive visual footprint or were sampled in the field as part of the field reconnaissance program.

[53] Palustrine systems are primarily shallow, vegetated, non-channel environments, including billabongs, bogs, swamps, and soaks. Aquatic Ecosystems Task Group (2012). *Aquatic Ecosystems Toolkit. Module 2. Interim Australian National Aquatic Ecosystem Classification Framework.* Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra.

03.2 Floristic survey

A total 200 rapid plots were completed for this project, including 51 plots in May 2021 and 149 plots in October 2021. Plots were located across a total 26 properties as well as areas of travelling stock reserve (TSR). Field assessment was challenged by relatively high rainfall and river flows in the study region, as well as travel restrictions associated with Covid-19. Nonetheless, a robust coverage of sites was achieved, with a total 19 PCTs sampled (Table 03-2). Of the 200 rapid plots completed, 196 were undertaken within the study region while 4 plots were undertaken just outside. These four plots were included because they occurred accessible wetland patterns represented in the study region. The overall coverage of plots is shown in Figure 03-3. Photographic examples of PCTs within the study region are shown in Figure 03-4.

A total 97 dominant plant species were recorded within the 200 plots, including 91 native and 6 exotic species. Each dominant species is listed in Table 03-3, along with its eco-hydrological functional group[54] and frequency with which it was encountered as a dominant species. The three most encountered species were river cooba, lignum and coolabah. Common ground-cover species included lesser joyweed *(Alternanthera denticulata*), ribbed spike-rush *(Eleocharis plana*), tussock rush *(Juncus aridicola*), nardoo *(Marsilea drummondii*), warrego grass and black roly-poly. Over half of the species were recorded in three or fewer plots, with 28 species recorded in one plot only.

Table 03-3. Dominant taxa recorded during surveys

Species	Common name	Functional Group #	Exotic?	No. plots
Abutilon oxycarpum	Straggly Lantern-bush	Tdr		3
Acacia pendula	Weeping Myall	Tdr		1
Acacia salicina	Cooba	Tda		5
Acacia stenophylla	River Cooba	ATe		88
Alectryon oleifolius	Western Rosewood	Tdr		2
Alternanthera denticulata	Lesser Joyweed	Tda		28
Apophyllum anomalum	Warrior Bush	Tdr		1
Astrebla lappacea	Curly Mitchell Grass	Tdr		3
Atalaya hemiglauca	Whitewood	Tdr		38
Atriplex muelleri	Mueller's Saltbush	Tdr		4
Azolla pinnata	Mosquitofern	ARf		2
Brachyscome dentata	Lobe-seed Daisy	Tda		7
Brachyscome melanocarpa	Black-seed Daisy	Tda		1
Brassica tournefortii	Mediterranean Turnip	Tdr	yes	3
Bulbine semibarbata	Wild Onion	Tda		3
Capillipedium spicigerum	Scented-top Grass	Tda		1
Capparis lasiantha	Nepine	Tdr		2
Capparis mitchellii	Native Orange	Tdr		5
Casuarina cristata	Belah	Tdr		17
Centipeda cunninghamii	Common Sneezeweed	Tda		19
Chenopodium auricomum	Queensland Bluebush	ATe		5
Chenopodium nitrariaceum	Nitre Goosefoot	ATe		1
Cirsium vulgare	Spear Thistle	Tdr	yes	1

[54] Bowen, S. and Simpson, S. L (2010). *Changes in extent and condition of the vegetation communities of the Macquarie Marshes floodplain 1991-2008*. Final Report to the NSW Wetland Recovery Program. Rivers and Wetlands Unit, Department of Environment Climate Change and Water, NSW, Sydney.

Species	Common name	Functional Group #	Exotic?	No. plots
Convolvulus erubescens	Pink Bindweed	Tdr		1
Crinum flaccidum	Darling Lily	Tda		1
Cynodon dactylon	Common Couch	Tda		24
Cyperus bifax	Downs Nutgrass	Tda		4
Cyperus difformis	Dirty Dora	Tda		17
Cyperus exaltatus	Giant Sedge	ATe		17
Daucus glochidatus	Native Carrot	Tda		1
Dichanthium sericium	Queensland Bluegrass	Tdr		1
Digitaria brownii	Cotton Panic Grass	Tda		3
Digitaria divaricatissima	Umbrella Grass	Tdr		5
Diplachne fusca	Brown Beetle Grass	Tdr		9
Dissocarpus paradoxus	Cannonball Burr	Tdr		1
Duma florulenta	Lignum	ATe		86
Ehretia membranifolia	Peach Bush	Tdr		1
Einadia nutans	Climbing Saltbush	Tdr		12
Eleocharis acuta	Common Spikerush	ATe		10
Eleocharis pallens	Pale Spike Sedge	ATe		12
Eleocharis plana	Flat Spike Sedge	ATe		35
Enchylaena tomentosa	Ruby Saltbush	Tdr		2
Eragrostis setifolius	Neverfail Grass	Tdr		2
Eremophila bignoniiflora	Eurah	Tda		55
Eremophila maculata	Spotted Fuchsia	Tdr		1
Eremophila mitchellii	Budda	Tdr		7
Eriochloa crebra	Cup Grass	Tdr		1
Eucalyptus camaldulensis	River Red Gum	ATe		36
Eucalyptus coolabah	Coolibah	ATe		71
Eucalyptus populnea	Bimble Box	Tdr		6
Euphorbia tannnensis	Desert Spurge	Tdr		1
Geijera parviflora	Wilga	Tdr		10
Haloragis aspera	Rough Raspwort	Tda		10
Juncus aridicola	Tussock Rush	ATe		36
Juncus flavidus	Yellow Rush	ATe		2
Lachnagrostis filiformis	Brown Grass	Tdr		2
Leiocarpa brevicompta	Flat Billy-buttons	Tda		3
Leptochloa digitata	Umbrella Canegrass	ATe		9
Lobelia concolor	Poison Pratia	Tdr		1
Lomandra leucocephala	Woolly Mat-rush	Tda		3
Ludwigia peploides	Water Primrose	ARf		1
Maireana microcarpa	Swamp Bluebush	Tdr		1
Marsilea drummondii	Nardoo	Tda		37
Medicago polymorpha	Burr Medic	Tdr	yes	15
Myriophyllum vericosum	Red Water-milfoil	S		3
Ottelia ovalifolia	Swamp Lily	ARf		2
Owenia acidula	Gruie	Tda		1

Species	Common name	Functional Group #	Exotic?	No. plots
Oxalis perennans	Grassland Wood-sorrel	Tdr		2
Panicum decompositum	Native Millet	Tdr		7
Panicum queenslandicum	Yabila Grass	Tdr		14
Paspalidium caespitosum	Brigalow Grass	Tdr		2
Paspalidium jubiflorum	Warrego Grass	Tda		39
Persicaria lapathifolia	Pale Knotweed	ATe		3
Phyla canescens	Lippia	Tda	yes	2
Pittosporum longifolium	Butterbush	Tdr		1
Poaceae spp	A grass	Tdr		4
Psydrax oleifolia	Wild Lemon	Tdr		1
Pynconosorus globosus	Drumsticks	Tda		2
Rapistrum rugosum	Turnip Weed	Tdr	yes	6
Rhagodia spinescens	Thorny Saltbush	Tdr		6
Rumex brownii	Swamp Dock	Tdr		5
Sclerolaena bicornis	Goathead Burr	Tdr		1
Sclerolaena birchii	Galvanised Burr	Tdr		1
Sclerolaena muricata	Black Roly-poly	Tda		38
Sesbania cannabina	Sesbania Pea	ATe		4
Sida trichopoda	High Sida	Tdr		2
Sonchus oleraceus	Common Sowthistle	Tdr	yes	1
Sporobolus caroli	Fairy Grass	Tdr		3
Sporobolus mitchellii	Rat's Tail Couch	Tda		29
Stellaria angustifolia	Swamp Starwort	Tda		1
Tetragonia tetragonoides	New Zealand Spinach	Tdr		24
Typha domingensis	Narrow-leaved Cumbungi	ATe		1
Vachellia farnesiana	Mimosa Bush	Tdr		8
Ventilago viminalis	Supple Jack	Tdr		1
Vittadinia cuneata	Fuzzweed	Tda		3
Wahlenbergia fluminalis	River Bluebell	Tda		4

ARf = Amphibious – Fluctuation Responder – floating/stranded; ATe = Amphibious – Fluctuation – emergent; ATl = Amphibious – Fluctuation Tolerator – low growing; S = Submerged; Tda = terrestrial – damp places; Tdr = terrestrial – dry places

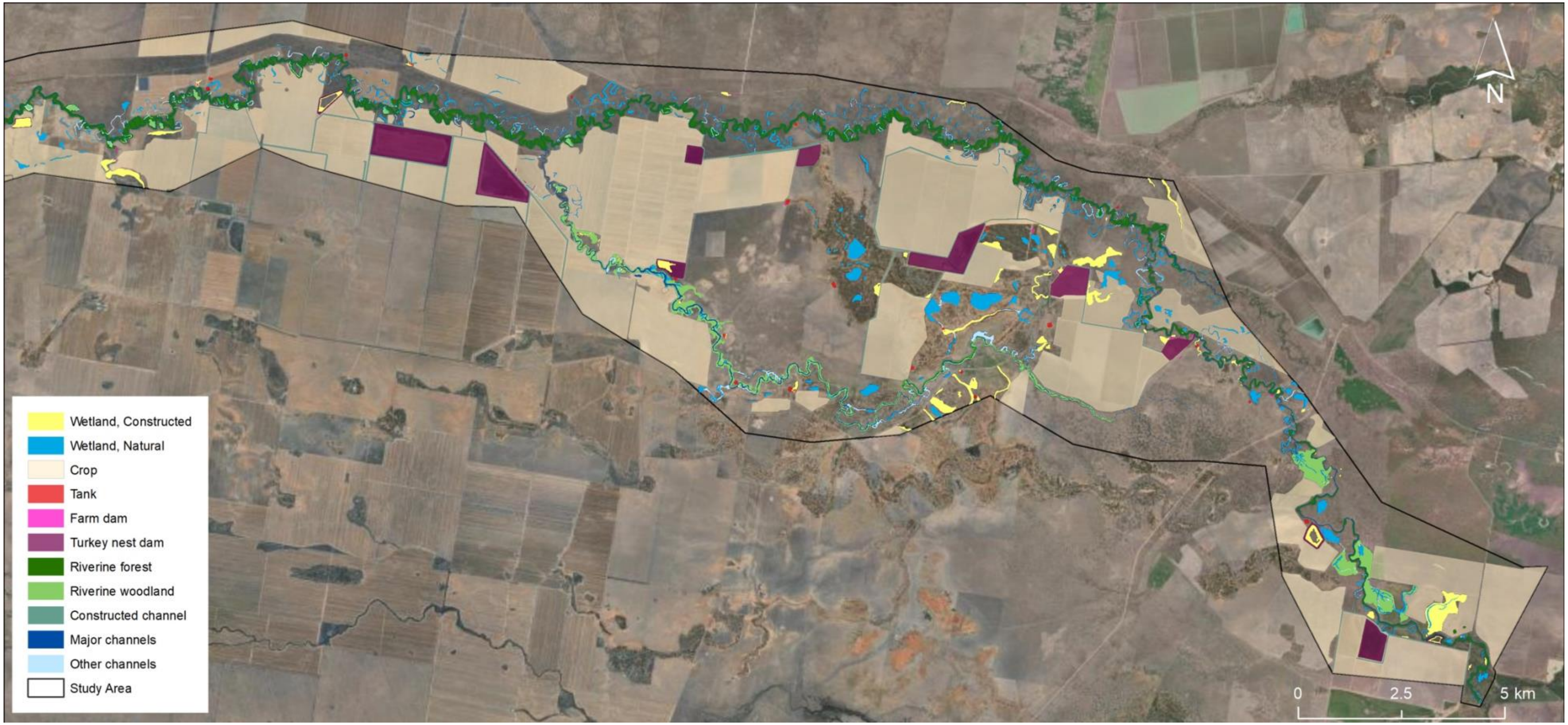


Figure 03-1. Distribution of features captured in the study region (eastern section)

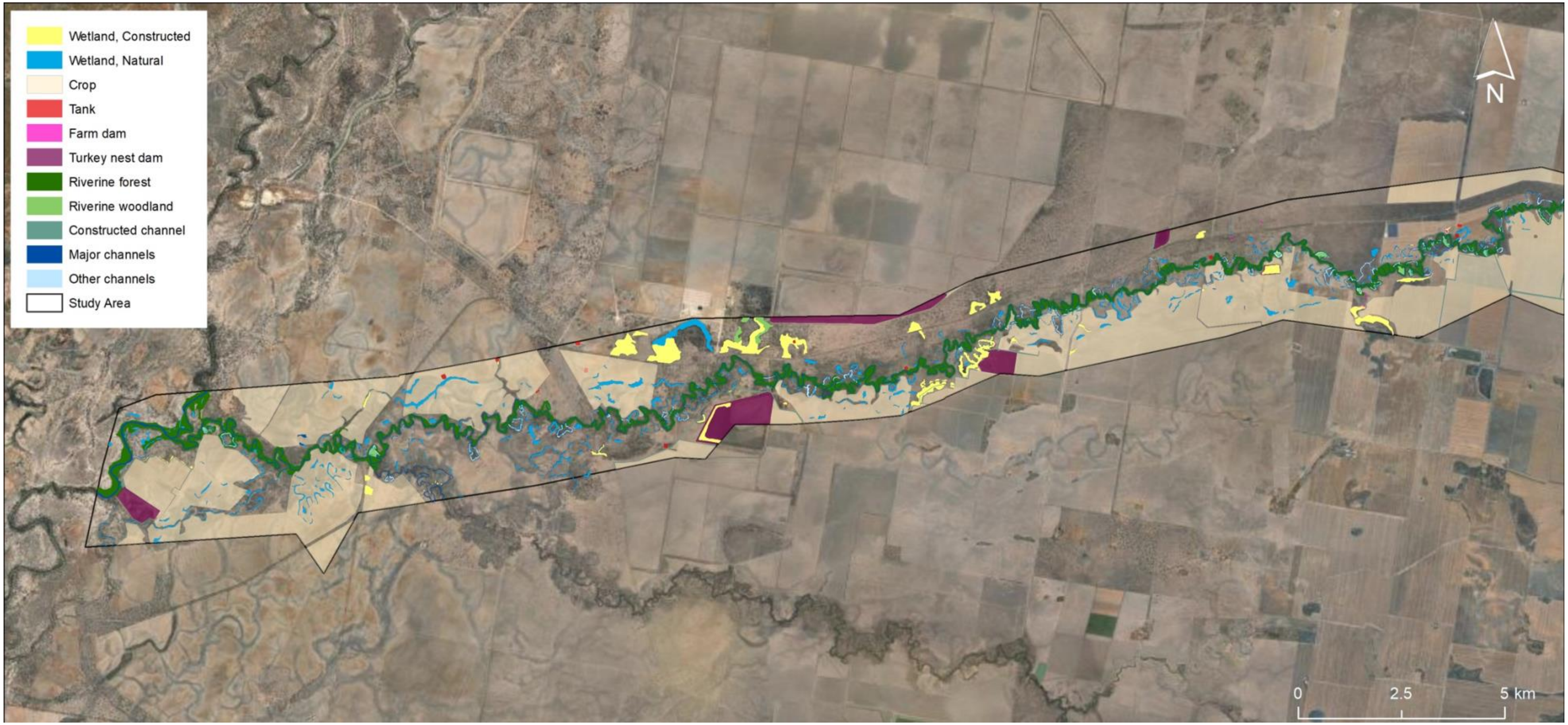


Figure 03-2. Distribution of features captured in the study region (western section)

Figure 03-3. Distribution of rapid plots completed during field reconnaissance

PCT 36 – River Red Gum woodland (Site J78)

PCT 39 – Coolibah woodland (Site J83)

PCT 53a – Ephemerally flooded wetlands (plot J173)

PCT 238b – Intermittently flooded oxbows

Figure 03-4. Examples of PCTs in the study region

03.3 Constraints

Building on initial constraints analyses undertaken by DPIE under the Gwydir CMP, this project identified additional physical constraints to flow along the Mehi and Ballin Boora channels (Figure 03-5). Each of these constraints could either impede or divert the passage of water and potentially compromise delivery of environmental flows to key assets. There were generally 2 types of constraints identified:

- Physical obstructions across the channel that hold water up but do not divert water away from the channel. These include road crossings and other structures
- Constructed channels that divert water from the channel into large storages on the floodplain. These may also act to alter flows in moderate to major flood events

As constraints were not able to be sampled during low flow/baseflow conditions, it was not possible to estimate the volume of water affected by each constraint. Nor was it possible to check the entire length of each channel to identify additional constraints due to some access difficulties. Nonetheless the evidence compiled provides a register of physical constraints that could each be addressed in future in consultation with landholders.

A total of 76 sites representing potential constraints to flow were assessed during field reconnaissance, including the 10 priority constraints identified by DPIE. The 76 sites included 28 road sites, 21 embankment sites, 13 channels, and 14 other features including weirs, drains and choked fence-lines. The construction material and dimensions of about 20 constraints were recorded. The distribution of all constraints surveyed in the study region is shown in Figure 03-5, while a summary of the 18 constraints for which dimensions and other features were surveyed is shown in Table 03-4. Details about all surveyed constraint features is summarised in Attachment C.

It was not possible to gauge the potential impact of each constraint on flows during low flow conditions (e.g. the volume of water each constraint impounded). It is thus reasonable to suggest that follow-up work be undertaken to determine the volume of water potentially held up or diverted by constraints. While beyond the scope of the current project, it may be possible to intersect inundation footprints before and after relatively small flows/freshes (including environmental releases) to assess the surface area of water retained upstream of crossings and other obstructions, and to relate this to volumes using the DEM.

Table 03-4. Summary of constraint features for which specifications were recorded

Feature	Image	Description	X,Y,Z	Channel
Culvert	C08	Drain leading to supply channel. Concrete and circular with 65 cm diameter; length = 17.4 m.	149.275989; -29.539544 AHD 166.96 m	Mehi River
Road	C13	Two concrete, circular culverts associated with driveway across Ballin Boora Creek leading to 'Weetabella' homestead; each with length 6.8 m and diameter 46 cm.	149.155705; -29.527493 AHD 160.07 m	Ballin Boora Creek
Road	C14	Sluice gate at lower end of Ballin Boora Creek, associated with road to 'Coolibah' property. Concrete/metal construction, with length 11.4 m and diameter 87 cm.	149.099794; -29.498293 AHD 158.65 m	Ballin Boora Creek
Bridge	C16	Road over Mehi River north of 'Coolibah' property. Corrugated metal, with width bridge deck depth 26 cm, width 5.56 cm and length 22 m. Water appears to pass freely to either side of the central pier.	149.103088; -29.462135 AHD 157.13 m	Mehi River
Road	C22	Unusable road, washed away with river coursing around the end, as well as through the old culvert Old culvert > 2 m diameter, 6.5 m long.	148.824929; -29.495803 AHD 146.43 m	Mehi River

Feature	Image	Description	X,Y,Z	Channel
Road	C25 C74	Gravel and rock road crossing over Mehi River. 7.8 m width; 24.2 m length. Circular steel pipe built into embankment, 2.8 m diameter, 9.5 m length.	148.801842; -29.501933 AHD 142.50 m	Mehi River
Road	C32	Road over flood-runner south of Mehi River; circular metal culvert completely choked by earth; culvert dimensions 46 cm diameter, 11.7 m length.	148.994284; -29.463777 AHD 143.45 m	Mehi River
Road	C33	Road over anabranch to south of Mehi River; contains circular metal culvert with 46 cm diameter and 11.3 m length; water observed pooling upstream.	148.989858; -29.46544 AHD 152.95 m	Mehi River
Road	C42	Washed out road with circular concrete culvert; culvert dimensions 53 cm diameter, 7,6 m length.	149.203189; -29.521482 AHD 162.74 m	Ballin Boora Creek
Road	C48	Bronte Road over Ballin Boora Creek. Choked fence-lines span the creek on both sides of the bridge.	149.19779; -29.516592 AHD 163.71 m	Ballin Boora Creek
Bank	C54	Southern anabranch of Mehi River on ‘Bronte’ property; includes circular metal sluice gate of 120 cm diameter and 10.5 m length.	148.88039; -29.484604 AHD 150.13 m	Mehi River
Bank	C60	Southern anabranch of Mehi River on ‘Bronte’ property; 2 circular metal culverts, both sealed, resulting in what appears to be a series of modified lagoons.	148.872219; -29.489676 AHD 150.23 m	Mehi River
Weir	C64	Gundare Weir on Mehi River; concrete and rock construction with 2 box-shaped openings (each ~5.5 m width).	149.315952; -29.589339 AHD 200.59 m	Mehi River
Road	C66	Circular cement pipe under Bronte Road, 45 cm diameter and 14 m length	149.220106; -29.487503 AHD = 195.45 m	Mehi River
Road	C67	Circular fibreglass pipe under farm road, 25.5 cm diameter and 10.5m length.	149.204863; -29.498294 AHD = 194.75 m	Ballin Boora Creek
Road	C69	Circular steel pipe under farm road, 86 cm diameter and 11.4 length.	149.202059; -29.507825 AHD 194.79 m	Ballin Boora Creek
Road	C70	Bronte Road over Ballin Boora Creek; no pipes; dip in road with evidence of damage following high flows. Evidence of water accumulation on both sides.	149.175443; -29.527856 AHD 194.75 m	Ballin Boora Creek
Road	C71	Road crossing over rocky weir, Width 6 m and length 13 m. Water flowing over crossing	149.029544; -29.454713 AHD 172.75 m	Mehi River

03.3.1 Incidental observations

Various waterbird species were observed during surveys including royal and yellow-billed spoonbill, Australian wood and pacific black duck, grey teal, darter, red-necked stint and others. However no particular wetland was observed to support an abundance of waterbird species as the relatively wet conditions meant that populations were diffuse or dispersed. Two notable observations were:

- Active yellow-billed spoonbill nest on the Mehi River 5 km west of confluence of Ballin Boora Creek (latitude 29.4546622 S; longitude 149.0296791 E)
- Resident population of nankeen night-heron around Gundare Weir.

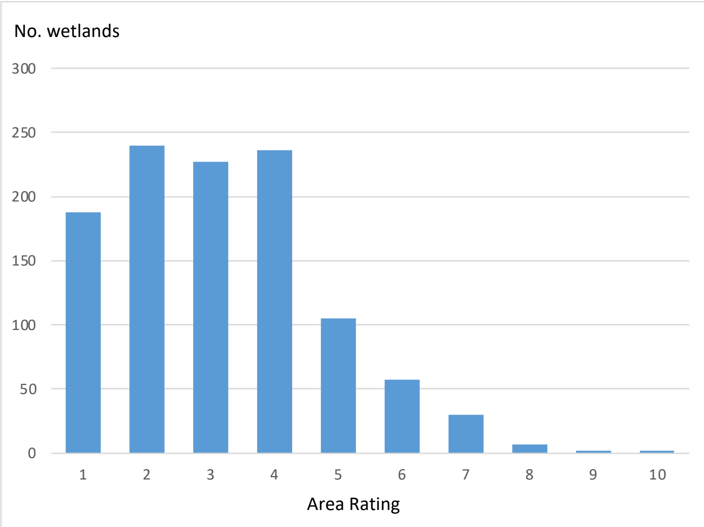
The owner of 'Bullarah' on the Ballin Boora Creek, Pat Johnston, has been recording native species on his property for many years. He lists at least 196 bird species (including 23 threatened bird species), as well as various mammals, reptiles and amphibians, on his website at https://www.bullarah-fauna.pictures. Some key wetland birds include Australian shoveller, black-fronted dotterel, black-necked stork, blue-billed duck, brolga, Caspian tern, eastern great egret, freckled duck, glossy ibis, great crested grebe, gull-billed tern, hardhead, hoary-headed grebe, Latham's snipe, little bittern, magpie goose, marsh sandpiper, musk duck, pink-eared duck, plumed whistling duck, red-necked avocet, whiskered tern, and white-bellied sea-eagle. Pat has also identified 22 frog and 27 reptile species, including 2 turtles (broad-shelled and Murray River).

Figure 03-5. Location of assessed constraints in the study region

03.4 Wetland prioritisation

Nine individual ratings and a final combined rating were assigned to each of the 1,094 mapped wetlands within the study region, all of which are connected to either the Mehi River or Ballin Boora Creek. Distribution of individual ratings are shown from Figure 03-6 to Figure 03-14. A summary of the findings is provided for each chart.

The distribution of the final wetland ratings is shown in Figure 03-15. The distribution shows ratings ranging from a low of 9 to a high of 74. A total of 153 mapped wetlands that are connected via flood channels to the Mehi or Ballin Boora channels (14% of all mapped wetlands) are assigned a rating of at least 50. Where commence-to-flow levels are achievable and constraints are manageable, these higher-rated wetlands should be the target of delivery of environmental water to maintain and improve their values.



Notes:

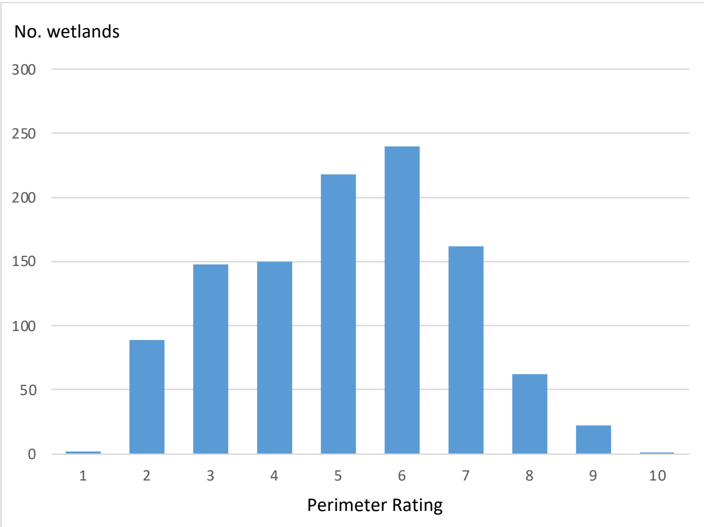
Over 90% of mapped wetlands# within the study region have a maximum inundation area < 1 ha, and these have a rating of 1 to 5.

Only 11 of the 1074 mapped wetlands# (about 1%) have a maximum inundation area of at least 5 ha, and each has a rating of 8 to 10 on account of the relatively large area of benthic habitat each contributes within the study area.

The area of mapped wetlands# ranges from 0.01 ha to 21.96 ha.

 # only including mapped wetlands directly connected to the Mehi River of Ballin Boora Creek via flood-runners and floodplain channels

Figure 03-6. Distribution of wetland area ratings (1 – 10) across 1094 mapped wetlands



Notes:

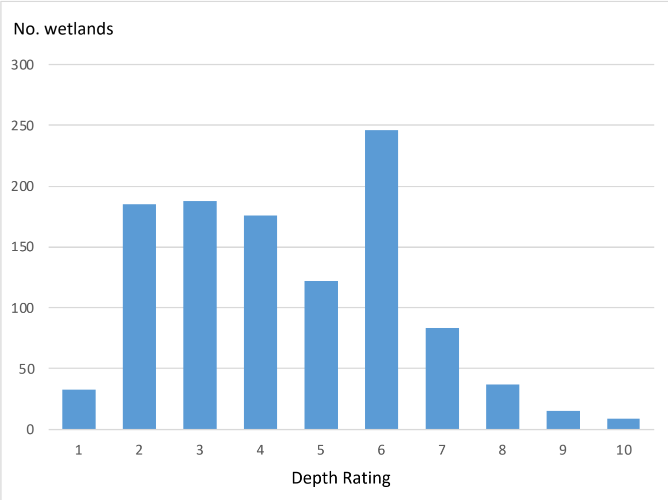
About 84% of mapped wetlands# within the study region have a maximum wetted perimeter of 100 to 1,000 m (rating of 3 to 7).

Roughly 8% of mapped wetlands# have a wetted perimeter of < 100 m (rating 1 or 2), while 8% have a wetted perimeter of > 1,000 m (rating 8 to 10).

The perimeter of mapped wetlands# ranges from 45 m to 7,735 m.

 # only including mapped wetlands directly connected to the Mehi River of Ballin Boora Creek via flood-runners and floodplain channels

Figure 03-7. Distribution of wetland perimeter ratings (1 – 10) across 1094 mapped wetlands



Notes:

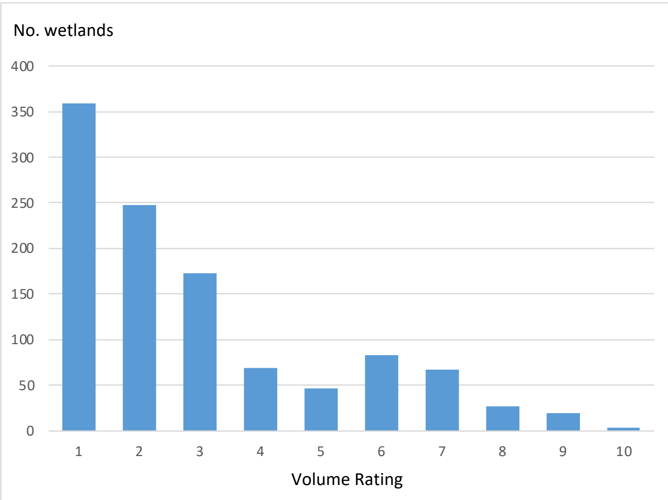
Most mapped wetlands# (84%) within the study region are relatively shallow at full capacity (< 0.75 m). These are assigned a rating of 1 to 6.

Only 2% of mapped wetlands# have a maximum depth > 1.5 m. These have a rating of 9 or 10 on account of their capacity to retain standing water in the landscape for relatively longer following a flood event.

The maximum depth of mapped wetlands# ranges from 0.1 m to 3.3 m.

 # only including mapped wetlands directly connected to the Mehi River of Ballin Boora Creek via flood-runners and floodplain channels

Figure 03-8. Distribution of wetland depth ratings (1 – 10) across 1094 mapped wetlands



Notes:

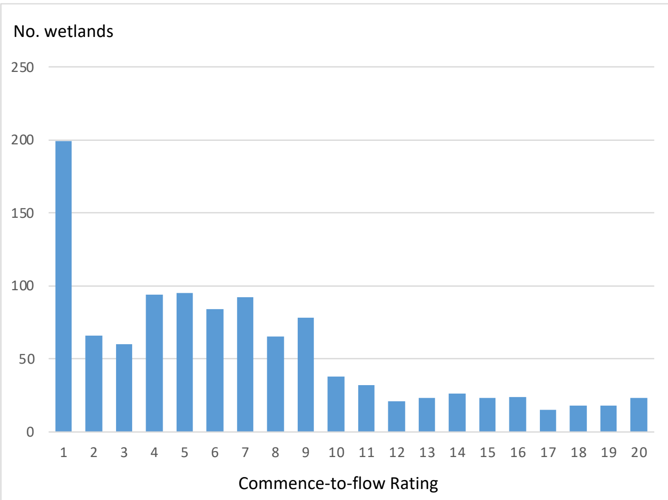
Most mapped wetlands# (71%) have a maximum capacity of < 0.5 ML (5,000 m^3). These are assigned a rating of 1 to 3.

Only 2% of mapped wetlands# have a maximum capacity of > 10 ML. These have a rating of 9 or 10 on account of the relatively large volume of stored water they support as aquatic habitat for many wetland-dependent species.

The maximum volume of mapped wetlands# ranges from 0.005 ML to 188 ML.

 # only including mapped wetlands directly connected to the Mehi River of Ballin Boora Creek via flood-runners and floodplain channels

Figure 03-9. Distribution of wetland volume ratings (1 – 10) across 1094 mapped wetlands



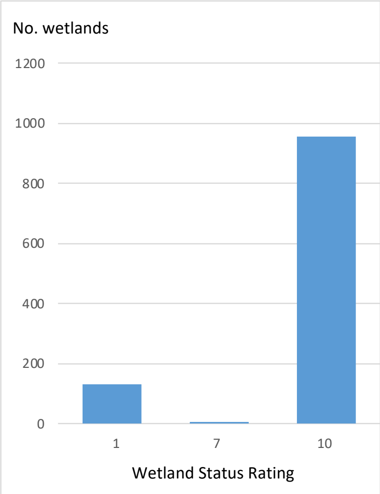
Notes:

A total 199 mapped wetlands# (18%) require a flood level of at least 4 m above baseflow to enable inundation. Each is assigned the lowest rating of 1. An additional 704 wetlands (64%) have a CTF level of between 2 and 4 m (each assigned a rating 2 to 11). Only 191 mapped wetlands# (18%) have a CTF level of < 2 m above river base flow, indicating that these wetlands will be inundated from relatively small flood events, including environmental flows for wetlands with the highest ratings (noting that low-CTF wetlands in Ballin Boora Creek will only be reached via piggy backing on large flows in the Mehi River)

The CTF heights of mapped wetlands# range from 0.03 m to 6.29 m above baseflow levels.

 # only including mapped wetlands directly connected to the Mehi River of Ballin Boora Creek via flood-runners and floodplain channels

Figure 03-10. Distribution of wetland CTF ratings (1 – 10) across 1094 mapped wetlands



Notes:

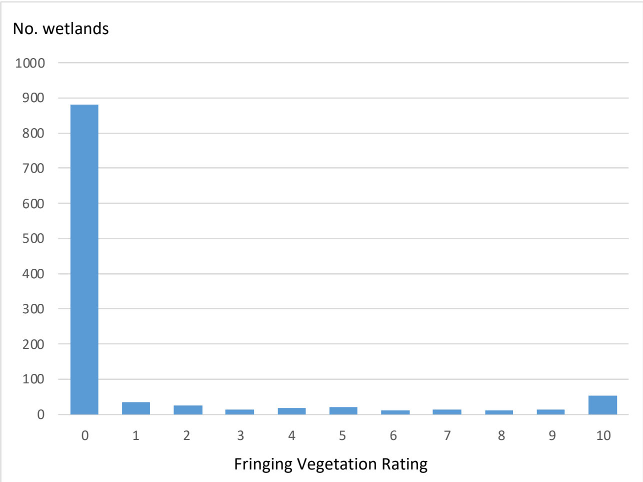
A total 957 mapped wetlands# (87%) that are connected to the Mehi and Ballin Boora channels are relatively intact, and each is assigned a rating of 10.

A further 7 mapped wetlands# (< 1%) are constructed but each has a reasonably high level of ecological significance. Each is assigned a rating of 7.

The remaining 131 mapped wetlands# (12%) are highly modified, occurring within cropped fields. While there may be potential to restore some of these in the future, they are currently assigned a rating of 1.

 # only including mapped wetlands directly connected to the Mehi River of Ballin Boora Creek via flood-runners and floodplain channels

Figure 03-11. Distribution of wetland status ratings (1,7,10) across 1094 mapped wetlands



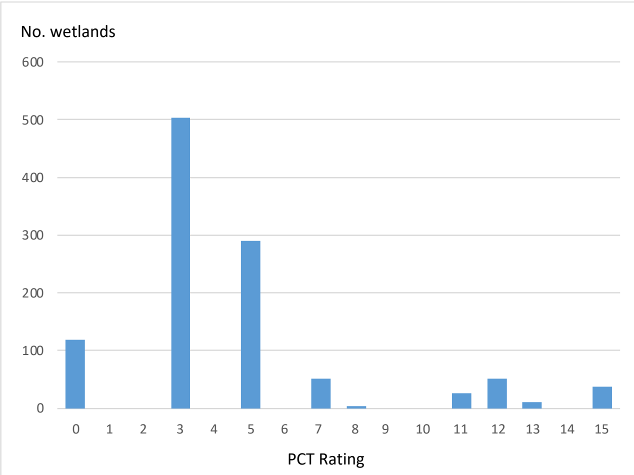
Notes:

A total 881 mapped wetlands# (81%) have no surrounding forest or woodland and each is assigned a rating of 0.

The remaining 213 wetlands (19%) has a proportion of its perimeter surrounded by fringing trees that could support roosting/nesting opportunities for wetland birds and a higher level of local habitat complexity. These are each assigned a rating > 0, including 54 wetlands (5%) that are entirely surrounded by forest (maximum rating 10).

 # only including mapped wetlands directly connected to the Mehi River of Ballin Boora Creek via flood-runners and floodplain channels

Figure 03-12. Distribution of wetland fringing vegetation ratings (0 – 10) across 1094 mapped wetlands



Notes:

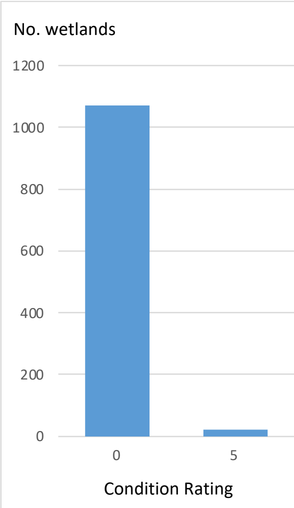
A total 119 mapped wetlands# (11%) were not allocated a PCT on account of them being modified, and these are each assigned a rating of 0.

An additional 793 wetlands (72%) are allocated a relatively common PCT (e.g. PCT 53a) and are thus assigned a relatively low rating (3 or 5).

The remainder are assigned ratings of 7 to 15 on account of them each being assigned a PCT that is relatively uncommon in the region.

 # only including mapped wetlands directly connected to the Mehi River of Ballin Boora Creek via flood-runners and floodplain channels

Figure 03-13. Distribution of wetland PCT ratings (0 – 15) across 1094 mapped wetlands



Notes:

A total 22 mapped wetlands# (2%) were identified in the field as a wetland of particularly high value in terms of its floristic diversity and structure, and absence of weeds. These were each assigned a condition rating of 5. All others were assigned a rating of 0 (it is acknowledged that many wetlands were not visited as part of the fieldtrip, and that some may have been assigned a condition rating if they had been observed)

 # only including mapped wetlands directly connected to the Mehi River of Ballin Boora Creek via flood-runners and floodplain channels

Figure 03-14. Distribution of wetland condition ratings (0,5) across 1094 mapped wetlands

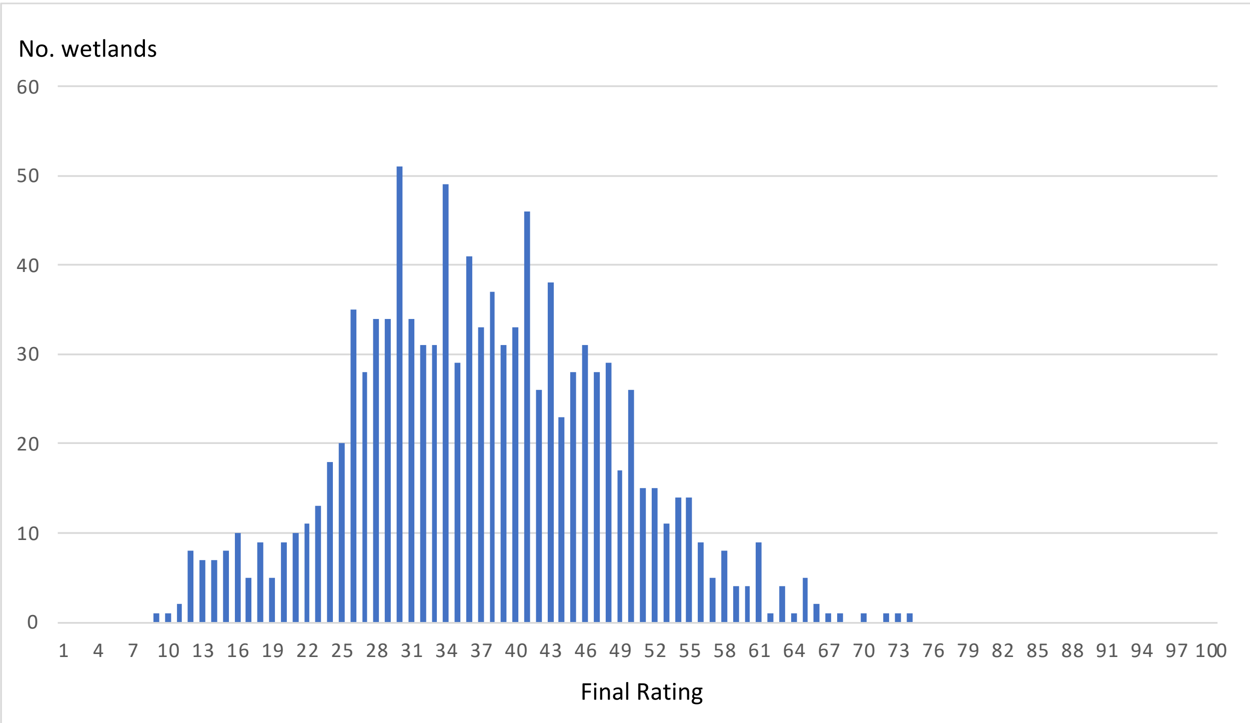


Figure 03-15. Distribution of overall ratings (1-100) across 1094 mapped wetlands

Distribution of the final wetland ratings is shown in Figure 03-16 for the eastern part of the study region and Figure 03-17 for the western part. A total of 153 wetlands had a rating ≥ 50 and these were considered to be 'high priority' wetlands for the purpose of analyses. Most of these wetlands are generally relatively large, are fringed by forest, and occur close to the main channel. Of the 32 highest priority wetlands (rating ≥ 60), 15 are connected to Ballin Boora Creek, including 2 very large wetlands in the upper part of the catchment, and 17 are connected to Mehi River. It is important that environmental water delivery target high priority wetland assets in both catchments.

Figure 03-16. Distribution of wetlands of different priority across the Mehi – Ballin Boora region (eastern section)

Figure 03-17. Distribution of wetlands of different priority across the Mehi – Ballin Boora region (western section)

03.5 Cross-validation with inundation layers

Results of the inundation analysis (Section 02.2.3) are illustrated in Figure 03-18 for five sequential images from February to June 2021. The catchment was relatively dry in February, with 251 ha inundated (1% of the study region; principally the main channels and a few large storages). The second image on 02 April catches the peak of inundation, with 11,986 ha inundated (43% of the study region). The third image on 07 April indicates that the main flood peak had moved downstream and floodwaters had begun to recede from the floodplain. Most of the wetlands remained inundated. Three weeks later (27 April) flooding is no longer occurring, although many wetlands remained inundated. Six weeks later (06 June), the inundated footprint has retracted further, with some wetlands likely to have dried (although all major water storages remain full).

By intersecting the spatial extent of mapped wetlands with the inundation footprint, an indication of pre-flood inundation and post-flood inundation retreat was determined across different wetland types and priority classes. Figure 03-19 shows the number of mapped wetlands that registered different levels of inundation in each period. These levels included:

- dry (no evidence of inundation)
- >0-50% of wetland area inundated
- 50-75% of wetland area inundated
- >75% of wetland area inundated

In February 2021 prior to flooding, 1042 of the 1071 mapped wetlands (97%) were dry. Of the 29 wetlands that showed any evidence of inundation only 2 were >50% inundated (by surface area) and none were >75% inundated. In contrast, at the height of the flood in early April a total 1,004 mapped wetlands (94%) showed evidence of inundation, of which 925 mapped wetlands (86%) were >75% inundated by area. The number of wetlands >75% inundated declined rapidly from 02 April to 06 June (from 925 to 43 wetlands). Over half of the mapped wetlands also appeared to have dried over this period, although by 06 June a total of 421 wetlands (39%) still retained some standing water.

For the subset of 952 relatively unmodified wetlands in the study region (i.e. wetlands that are neither constructed nor cropped), those that retained some level of inundation during drier conditions (i.e. 21 February and 06 June) had a higher average rating than those that were dry. This observation is supported by Figure 03-20 which shows the proportion of high priority wetlands (rating $\geq$ 50) in different classes of inundation, before, during and after the flood. During the driest time in February 2021, almost 70% of wetlands with evidence of persistent standing water were high priority, while only 15% of wetlands showing no evidence of inundation were high priority. As floodwaters receded from early April to June 2021, a greater proportion of high priority wetlands remained inundated, suggesting that standing water is more persistent within wetlands identified as high priority for this project.

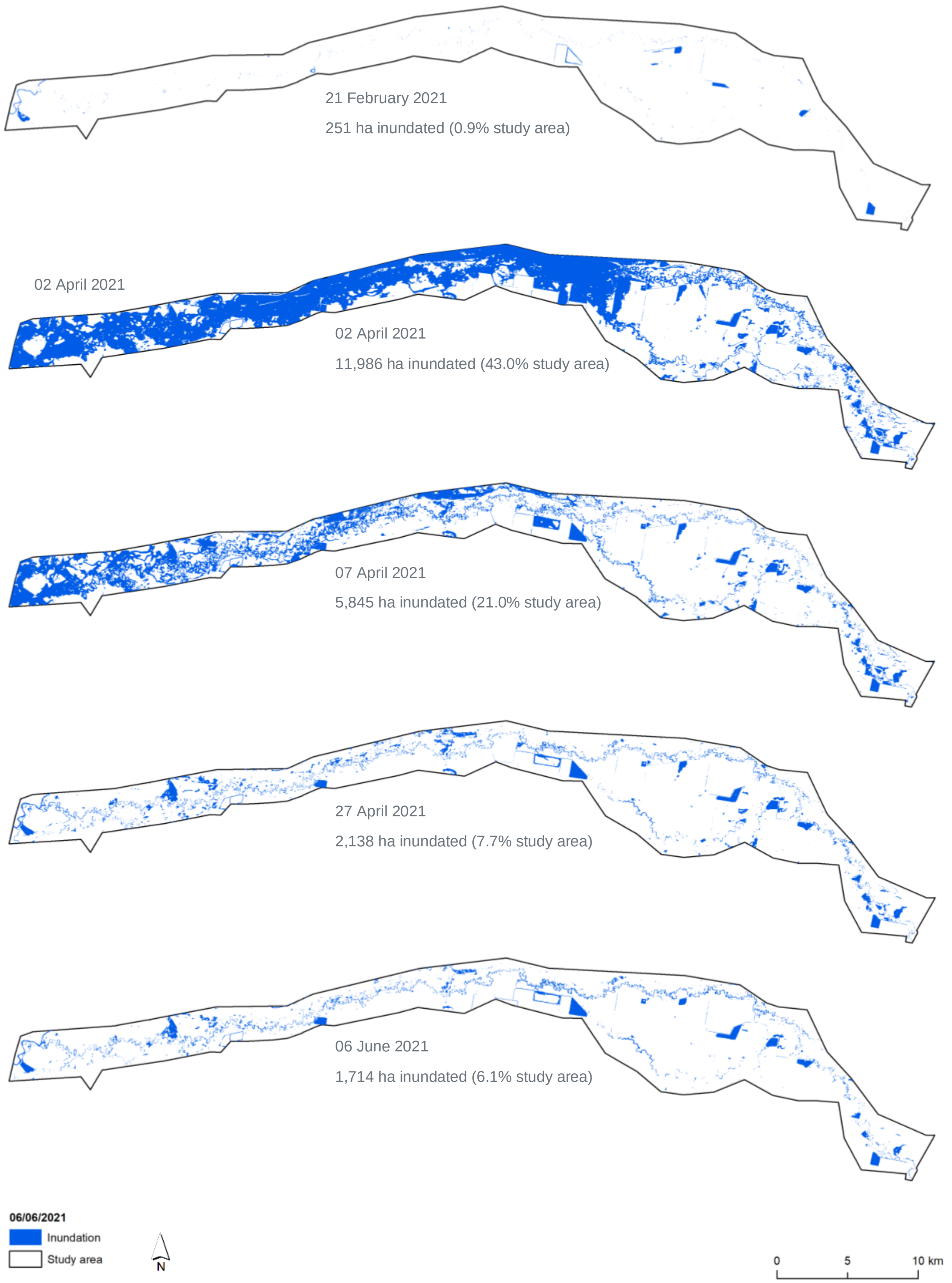


Figure 03-18. Inundated areas before, during and after the April 2021 flood

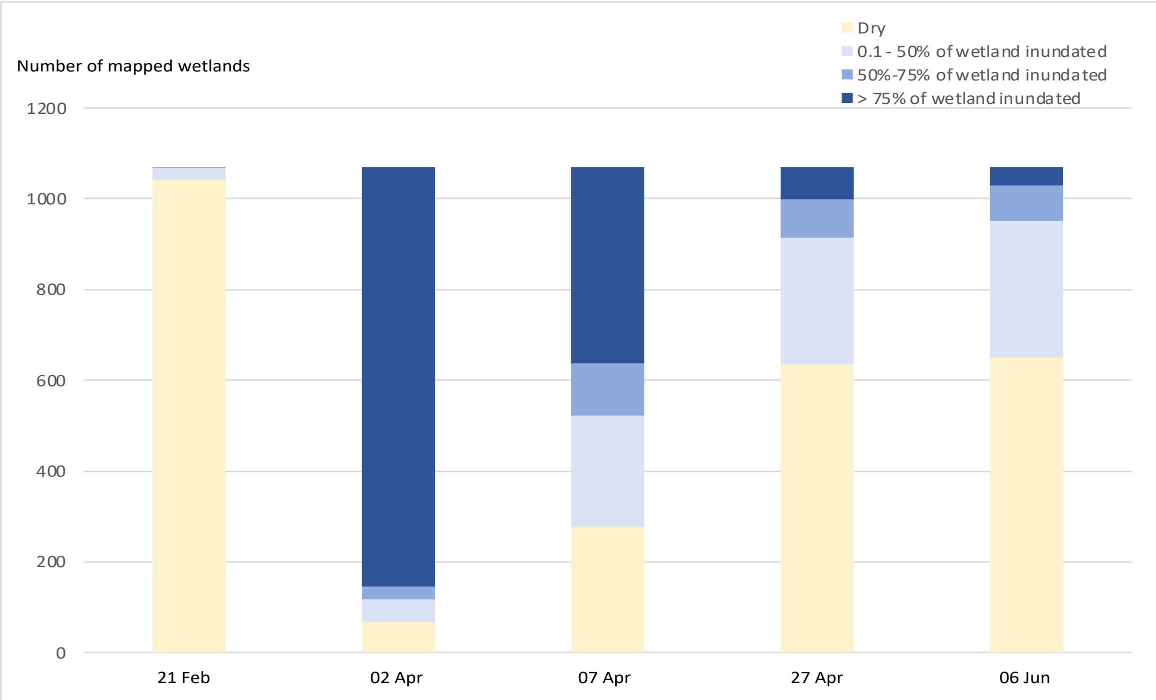


Figure 03-19. Number of mapped wetlands showing evidence of inundation before, during and after 2021 flooding

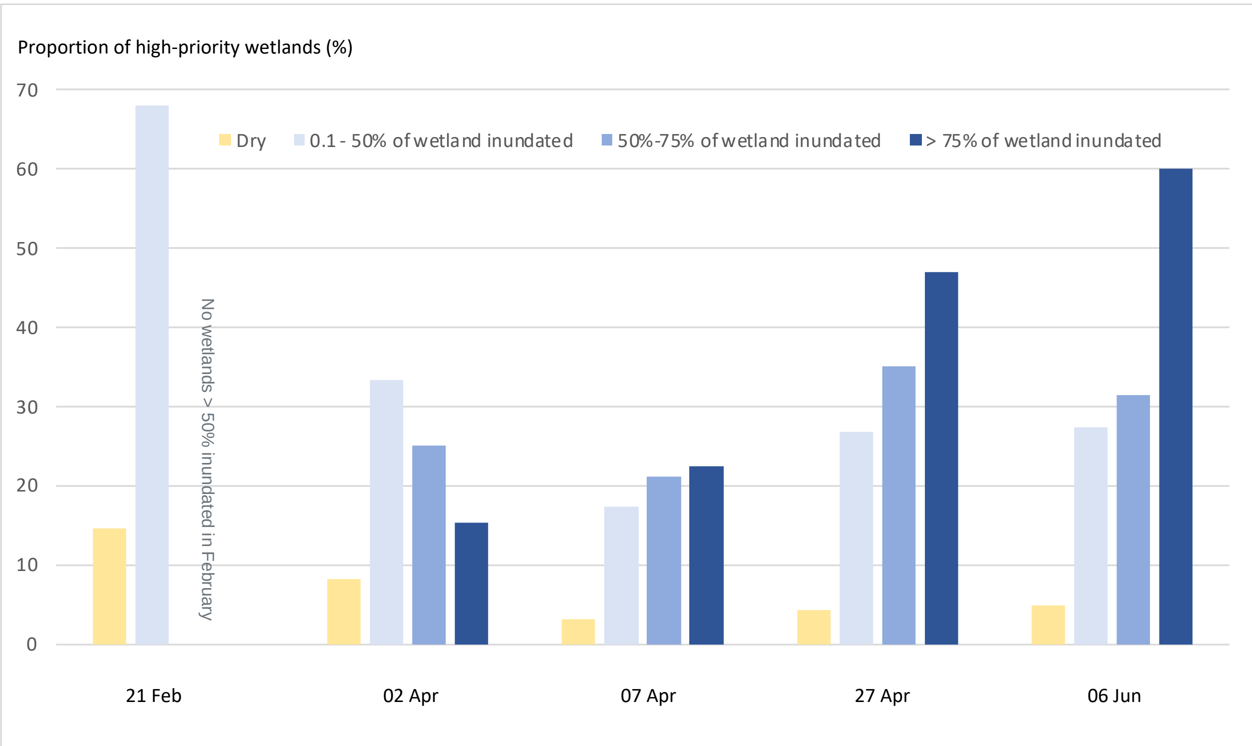


Figure 03-20. Proportion of high-priority wetlands (rating ≥ 50) within four classes of inundation before, during and after the 2021 flood event

03.6 Environmental water priorities

03.6.1 Climatic setting

A respite from the severe drought conditions that occurred in northern NSW from 2016 to 2019 provides the NSW Government with time to continue to plan for ongoing improvement in wetland health and resilience in the Gwydir catchment, consistent with the NSW wetlands policy[55], floodplain management plan[56], long-term water plan[57], and water sharing plans[58]. In late 2021 Copeton Dam reached 100% capacity and the Bureau of Meteorology announced that Australia had entered a period of La Nina which is likely to bring above average rainfall for northern and eastern parts of the continent over summer 2021-2022, and possibly beyond. As the Gwydir River system (including the Mehi River and Ballin Boora Creek) has received a sequence of floods since early 2020, the current outlook is favourable for the potential recovery of floodplains and wetlands in the foreseeable future, both in terms of additional flood events likely in the short-term, and the capacity to deliver environmental flows in the medium to longer term from Copeton Dam, when conditions begin to dry.

03.6.2 Wetland assets

Over 1,000 individual wetlands were mapped in the study region, including many oxbow and other near-channel wetlands as well as flood-runner and floodplain wetlands that occur further from the main channels. Each mapped wetland that is connected to the Mehi River or Ballin Boora Creek was rated using nine criteria that include area, perimeter, commence-to-flow height, and fringing vegetation (Table 02-7), and a final priority score was assigned to each wetland. This information can be used by DPIE to help plan delivery options for environmental flows released from Copeton Dam.

An analysis of the indicative volume of water required to inundate groups of lower-lying wetlands along the Mehi River is shown in Figure 03-21, guided by flow requirements set under the Gwydir LTWP[59] as summarised in Section 01.3 above. The following broad assumptions are made:

- Average conveyancing losses associated with evaporation, transpiration and seepage = 25% of total flow[60]
- Average loss of water due to impoundment of water within constraints = 10% of total flow
- Average width of Mehi River bed between Gundare regulator and Barwon River = 15 m
- Average baseflow depth = 0.1 m
- Channel width increase of 1 m per 0.2 m water level rise, to 2.0 m above baseflow level
- Channel width increase of 1 m per 0.1 m water level rise, between 2.0 and 3.1 m above baseflow level
- Total length of Mehi River between Gundare regulator and Barwon River = 166 km

---

[55] DECCW (2010). *NSW Wetland Policy.* NSW Department of Environment, Climate Change and Water. DECCW 2010/39. March 2010.

[56] DPI-Water (2015). *Rural Floodplain Management Plans. Background document to the floodplain management plan for the Gwydir Valley Floodplain 2015 Volume 1.* NSW Department of Primary Industries – Water.

[57] DPIE (2020). *Gwydir Long Term Water Plan. Part A: Gwydir Catchment.* NSW Department of Planning, Industry and Environment. EES 2020/0083. July 2020.

[58] Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/178780/gwydir-schedule-a-draft-wsp-regulated-river-surface-water-source.pdf

[59] DPIE (2020). *Gwydir Long Term Water Plan. Part A: Gwydir Catchment.* NSW Department of Planning, Industry and Environment. EES 2020/0083. July 2020.

[60] Chartres, C. and Williams, J. (2006). Can Australia overcome its water scarcity problems? *Journal of Developments in Sustainable Agriculture.* 1: 17-24.

This chart shows that some high-priority wetlands can be inundated even during small freshes (< 1,000 ML/day), although an increasing number can be inundated from larger freshes and bankfull flows. At full bankfull flow for example (~ 15,000 ML/day delivered via gauges 418002 (Moree) and 418085 (Gundare), roughly equivalent to a flow depth of ~2.35 m), about 85 ML of water would fill 202 mapped wetlands including 47 high priority wetlands (rating ≥ 50). These are mainly oxbow and other near-channel wetlands close to the Mehi channel. These wetlands would be expected to support many of the key environmental assets outlined in Section 01.4.

The number of wetlands and volume of water delivered to wetlands increases markedly once overbank floods occur (> 15,000 ML/day delivered via gauges 418002 and 418085). For example, flows of 25,000 ML/day would be expected to inundate almost 500 wetlands including 100 priority wetlands (about 2.4 times as many as a bankfull flow), and would deliver almost 600 ML of water into wetlands (about 7 times the volume delivered via a bankfull flow). Larger floods would be required to inundate more elevated flood-runner wetlands and floodplain wetlands. Wetlands with a CTP of > 3.1 m (requiring flows of more than 25,000 ML/day) are not included in Figure 03-21.

Evidence in Figure 03-21 shows that even minor flows will deliver water to wetlands along the river. It also supports the importance of pigging-backing environmental water delivery on natural flows or delivered flows. For example, piggy-backing an environmental flow of 2,000 ML/day onto a flow of 3,000 ML/day would double the number of priority wetlands that receive water.

A similar analysis of the indicative volume of water required to inundate groups of wetlands along Ballin Boora Creek was not undertaken here, given a high level of uncertainty associated with the relatively poorly formed channel of Ballin Boora Creek and the potential for breakouts to the floodplain at relatively low flows (>3,000 ML event will create a small overbank flow in Ballin Boora Creek[61]). Nonetheless, it is likely that a moderate flow event of 1,200 - 3,000 ML via gauge 418068 will inundate up to 24 low-lying wetlands along Ballin Boora Creek (all within-bank) including 19 high priority wetlands. A flow event of 10,000 ML would likely inundate all wetlands connected to Ballin Boora Creek, with >100 ML of floodwaters captured within approximately 80 individual wetlands. As with the Mehi River, piggy-backing environmental flows on natural flows via gauge 418068 will also be important for inundating wetland assets along Ballin Boora Creek.

Delivery of environmental water into Ballin Boora Creek may be improved in future via engineered diversion of water from Mehi River, either into the upland part of the Ballin Boora catchment from flow directed westward from the Mehi River, and/or into the mid and lower parts of the catchment from flow directed northward from a natural channel further south that is itself fed by the Mehi River further upstream. An engineering solution that facilitates delivery into the upper reaches is ideal, as several large, high priority assets are identified in this part of the Ballin Boora catchment. Commitment to these strategies requires that the behaviour of flows in and around each constraint (particularly constraints that divert water) be better understood.

[61] DPIE (2020). *Gwydir Long Term Water Plan. Part A: Gwydir Catchment.* NSW Department of Planning, Industry and Environment. EES 2020/0083. July 2020.

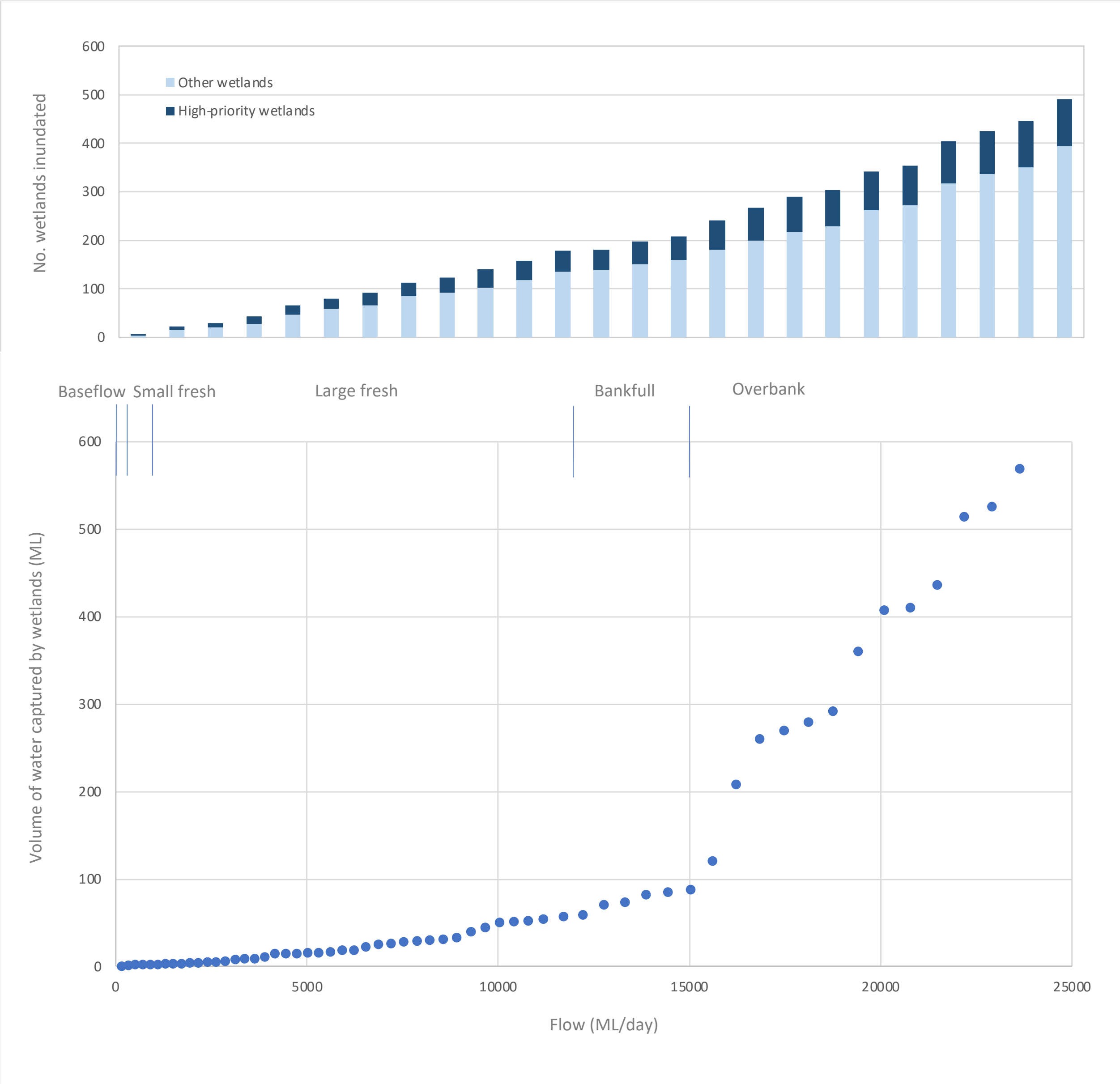


Figure 03-21. Number of wetlands inundated (bar chart) and volume of water captured (scatterplot) by wetlands in relation to Mehi River flow events of 0 – 25,000 ML/day (delivered via gauges 418002 and 418085)

04 CONCLUSIONS AND RECOMMENDATIONS

Fine-resolution elevation models derived from LiDAR data and associated aerial images were employed to map wetland vegetation and other features in the lower Mehi catchment in north-west NSW. A total of 2,511 features were mapped across 14,400 ha. These features included river and creek channels, flood-runners, oxbows, wetlands (oxbow, near-channel, flood-runner, and floodplain), riverine forest and woodland, as well as constructed features and croplands.

DEM data were also used to estimate commence-to-flow river levels, and wetland depths and volumes. These metrics and others have been used to assign wetland priority ratings to 1,071 mapped wetlands connected to the Mehi River channel or Ballin Boora Creek channel. A total 153 wetlands were identified as high-priority, some of which occur in relatively low-lying situations that could be directly targeted with environmental flows in drier periods. Others could be watered by releasing environmental flows to 'top-up' other flows.

Several constraints to flow exist within both Mehi River and Ballin Boora Creek, including various impoundments. These were having no demonstrated impact on flows at the time of survey, as flows were generally high. However, they are likely to have some impact on delivery of environmental allocations during low flow conditions.

Three recommendations are made following this project.

Recommendation 1

Fine-resolution LiDAR data provide excellent micro-topographic information that facilitated wetland mapping and assessment for this project, with complete coverage of LiDAR and associated DEM-derived data across the study region. However, where such data are not currently available in other parts of the Gwydir Catchment (and other inland waterways) known to support a complex of near-channel wetlands, it is recommended that targeted LiDAR capture be undertaken to facilitate improved mapping and survey in future. Capture should be undertaken during seasonally dry periods when water levels and ground cover vegetation levels are relatively low.

Recommendation 2

This project focussed on the lower reaches of the Mehi River below Gundare regulator. The upper reaches of the Mehi River, between its diffluence with the Gwydir River west of Pallamallawa to the Gundare regulator, is about the same length as the lower section. A project to map all wetlands and flood-runners along this length of the Mehi, as well as Moomin and Mallowa Creeks, would provide a more complete picture of the distribution of wetland assets associated with the Mehi River system. It would provide extra context around appropriate allocation of environmental flows to Mehi River, Moomin Creek and Mallowa Creek.

Recommendation 3

A large proportion of wetlands and flood-runners in the study region have been heavily modified by cropping. These assets no longer retain their former structure or function. All cropped wetlands connected to the Mehi River or Ballin Boora Creek via flood-runners were mapped as part of this project. It is recommended that a scoping project be initiated that identifies a cropped wetland (or series of connected wetlands) to be restored in consultation with the landholder. The wetland would be relatively low-lying and would be directly connected to the main channel via a viable flood-runner, to ensure delivery of environmental water Rehabilitation would require cessation of cropping and planting of fringing canopy species. The study would also involve long-term monitoring of wetland recovery.

ATTACHMENT A: PMST REPORT

Australian Government
Department of Agriculture, Water and the Environment

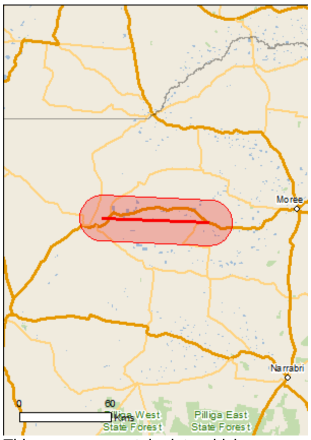
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

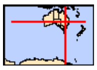
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 14/07/21 08:53:43



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 15.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	15
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	3
Commonwealth Heritage Places:	None
Listed Marine Species:	14
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	23
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar)	[Resource Information]
Name	Proximity
Banrock station wetland complex	900 - 1000km upstream
Gwydir wetlands: gingham and lower gwydir (big leather) watercourses	Within 10km of Ramsar
Riverland	800 - 900km upstream
The coorong, and lakes alexandrina and albert wetland	1000 - 1100km

Listed Threatened Ecological Communities

[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community likely to occur within area
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	Critically Endangered	Community likely to occur within area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community likely to occur within area

Listed Threatened Species

[Resource Information]

Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Fish		

Name	Status	Type of Presence
Maccullochella peelii		
Murray Cod [66633]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Nyctophilus corbeni		
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Lepidium monoplocoides		
Winged Pepper-cress [9190]	Endangered	Species or species habitat may occur within area
Swainsona murrayana		
Slender Darling-pea, Slender Swainson, Murray Swainson-pea [6765]	Vulnerable	Species or species habitat likely to occur within area
Tylophora linearis		
[55231]	Endangered	Species or species habitat may occur within area
Reptiles		
Anomalopus mackayi		
Five-clawed Worm-skink, Long-legged Worm-skink [25934]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus		
White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Australian Telecommunications Corporation
Commonwealth Land - Telstra Corporation Limited

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-29.5316 149.319,-29.5075 148.6892

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

ATTACHMENT B. SUMMARY OF SPATIAL DATA WITHIN GEODATABASE

Shapefile name: Rapids_Jan2022_v1

Field	Description
OBJECTID *	Object ID Number
Shape *	Shape type (point)
Trip	Field trip number (1 or 2) (Trip 1 = 17-20 May 2021; Trip 2 = 13-19 October 2021)
Rapid_ID	Rapid survey number
photo_nos	Photo number
Images	Image embedded in attribute table. Attached images can be opened in Arc software by clicking on them in the attribute table. Only one photo was attached to each point, but some points have been duplicated to capture more than 1 image.
PCT	Plant Community Type (PCT) number
PCT_label	PCT name
latitude	Coordinates
longitude	Coordinates

Shapefile name: Obs_all_v1

Field	Description
OBJECTID *	Object ID Number
Shape *	Shape type (point)
Trip	Field trip number (1 or 2)
Recordno	Record number
latitude	Coordinates
longitude	Coordinates
PCT	Plant Community Type (PCT) number
Photo	Photo number/s associated with the point (not all points had photos)
Images	Image embedded in attribute table. Attached images can be opened in Arc software by clicking on them in the attribute table. Only one photo was attached to each point, but some points have been duplicated to capture more than 1 image.
Comment	Field notes
Comment2	Field notes 2

Shapefile name: Constraints_Jan2022_v1

Field	Description
OBJECTID_1 *	Object ID Number
Shape *	Shape type (point)
OBJECTID	Object ID Number for each constraint
Photo_no	Photo number
Images	Image embedded in attribute table. Attached images can be opened in Arc software by clicking on them in the attribute table. Only one photo was attached to each point, but some points have been duplicated to capture more than 1 image.
Images_Names	Image file names DWN = downstream UP = upstream N = direction North NW = direction North-west NE = direction North-east S = direction South SE = direction South-east SW = direction South-west
CreationDa	Date created
Location	Description of locality
Photo_no_1	Duplicate photo number
Photo_ori	Direction (orientation) photo was taken
Notes	Field notes about the site
Waterway_o	Waterway opening type
Descriptio	Description of constraint
Geometry	Shape opening
Material	Construction material
Dimensions	Dimensions of opening
Length	Length of opening
No_opening	Number of openings
Guardrail_	Bridge guardrail material
Bridge_det	Bridge detail
Height_AHD	Height measurement (Australian Height Datum (AHD) recorded at the centre line of the cease to flow point of constraint).
Constraint	Type of constraint
POINT_X	Longitude
POINT_Y	Latitude

Shapefile name: Wetland_Veg_Final_v1

Field	Description
OBJECTID *	Object ID Number
Shape *	Shape type (polygon)
Wetland_ID	Wetland ID number (same as in *Channel_Points_v1*)
Name	Name of asset (e.g. Ballin Boora creek bed; constructed channel; floodrunner wetland)
Area_ha	Area (hectares)
Feature	Broad feature (e.g. wetland)
Channel	Channel name
Type	Type of wetland (natural, modified, constructed)
Cropland	Is the area cropped? (yes/no)
Verified	Field-checked (yes/no)
Height_CTF	Approximate height (m) river needs to rise to inundate wetland. Calculated as the difference in elevations between the CTF point and the Outflow point. Only calculated for wetlands connected to either Mehi River or Ballin Boora Creek.
MaxVol_ML	Maximum volume (ML) of each wetland, calculated from LiDAR-derived DEM data supplied by DPIE
MaxDepth_m	Maximum depth of each wetland (m), calculated from LiDAR-derived DEM data supplied by DPIE
Perimete_m	Perimeter (m) of each mapped wetland
Per_fringi	Perimeter (m) of each mapped wetland that contains fringing vegetation (calculated using adjacency to PCT 36 and other forest/woodland PCTs)
Area_ratin	Wetland area rating (min = 1; max = 10 – refer to Table 02-7)
Perimeter	Wetland perimeter rating (min = 1; max = 10 – refer to Table 02-7)
Depth_rati	Wetland depth rating (min = 1; max = 10 – refer to Table 02-7)
Volume_rat	Wetland volume rating (min = 1; max = 10 – refer to Table 02-7)
CTF_rating	Wetland CTF rating (min = 1; max = 10 – refer to Table 02-7)
Wetland_St	Wetland status (1 = modified (cropped); 7 = constructed; 10 = natural)
Fringing_v	Wetland fringing vegetation rating (min = 0; max = 10 – refer to Table 02-7)
PCT	Wetland PCT rating (min = 1; max = 15 – refer to Table 02-7)
Condition	Field condition tag (0 or 5)
TOTAL_rati	Total wetland rating (= *Area_ratin* + *Perimeter* + *Depth_rati* + *Volume_rat* + *CTF_rating* + *Wetland_St* + *Fringing_v* + *PCT* + *Condition*)
Rating_Cla	Wetland rating class (< 20; 20 – 29; 30 – 39; 40 – 49; 50 – 59; ≥ 60)
Shape_Length	Polygon perimeter length (m), automated in ArcGIS
Shape_Area	Polygon area (m^2), automated in ArcGIS

Shapefile name: Channel_Points_v1

Field	Description
OBJECTID *	Object ID Number
Shape *	Shape type (point)
Feature	Feature types (breakout point, inlet, outlet, outflow point)
Wetland_ID	Wetland ID number (same as in *Wetland_Veg_Final_v1*)
Flow_Dir	Direction of flow
Outflow_ID	Outflow ID number for the outflow point (numbers increase from east to west along Mehi River then Ballin Boora Creek). More than one CTF point can be associated with an outflow point.
CTF_ID	Commence-to-flow (CTF) number. Several wetlands will share the same CTF_ID if they share the same flood-runner or other channel.

ATTACHMENT C: CONSTRAINTS SURVEYED

FID	Date	Feature	DPIE priority	Description and notes, and structure specifications (where measured)	Image ID	X	Y	Height (AHD_m)
0	17/6/21	Channel		South bank Mehi R, East of Gundare Rd, Boonaldoon.	C01	149.312757	-29.575686	168.978
1	17/6/21	Other		Mehi R, east of Gundare Rd, Boonaldoon; choked fence line.	C02	149.313093	-29.575836	
2	17/6/21	Channel		Mehi R south bank, Boonaldoon, Gundare, east of Gundare Rd, pump linking channel to storage seemingly in state of disuse.	C03	149.306249	-29.575202	171.199
3	17/6/21	Drain		Mehi R south bank, Gundare Boorilook west; small offtake feeding pasture supply channels; in use.	C04	149.293981	-29.573292	167.854
4	17/6/21	Road		50 m south of Mehi R, Poison Gate Rd; road impeding floodplain flow 50 m south of Mehi R.	C05	149.267335	-29.529745	168.91
5	17/6/21	Other		East of Poison Gate Rd bridge crossing Mehi R; choked fence line.	C06	149.268246	-29.529459	
6	18/6/21	Road		Road / bridge spanning the Mehi R, Poison Gate Rd; Concrete box bridge; metal guard-rails	C07	149.26819	-29.529297	169.566
7	18/6/21	Drain		South bank of Mehi R, Drain leading to supply channel which runs through coolibah floodplain; Circular, concrete culvert D = 65cm; L = 17.4m	C08	149.275989	-29.539544	166.957
8	18/6/21	Bank	Yes	North bank of Ballin Boora Ck; bank sits between creek and flood-runner modifying lateral movement of water.	C09	149.152396	-29.525511	162.654
9	18/6/21	Bank	Yes	North bank of Ballin Boora Ck; earthen bank sitting between creek and flood-runner modifying lateral movement of water.	C10	149.152226	-29.525451	163.373
10	18/6/21	Bank	Yes	Ballin Boora Ck; bank spanning the width of Ballin Boora Ck diverting water / flow to flood-runner to the north.	C11	149.151828	-29.525407	163.192
11	18/6/21	Dam		Ballin Boora Ck, just west of Weetabella homestead; dam holding back flow, channel at lesser height (partially broken wall) than banks but still completely impeding flow.	C12	149.156478	-29.524253	160.431
12	18/6/21	Road	Yes	Ballin Boora Ck, road / driveway leading to Weetabella homestead; 2x culverts / pipes at varied heights transporting water up- to downstream; 2 x circular, concrete culverts; D = 46cm; L = 6.8	C13	149.155705	-29.527493	160.072
13	18/6/21	Road	Yes	West end of Ballin Boora Ck, Coolibah property; Concrete/metal sluice gate; D = 87cm; L = 11.4 m	C14	149.099794	-29.498293	158.653
14	18/6/21	Channel		Mehi R south bank; north-eastern end of Coolibah property; open channel leading to storage; at current water levels flow was moving freely up through channel.	C15	149.119567	-29.46889	
15	18/6/21	Road		Mehi R north of Coolibah property; water may pass freely to either side of central metal slab / pier. Corrugated metal bridge; deck depth 26 cm; width 556 cm; 1 span; 1 central pier (inverted trapezium); length 22 m.	C16	149.103088	-29.462135	157.125
16	18/6/21	Channel		Southern banks of Mehi R, northern end of property: The Valley; water flowing over rocky river crossing road,	C17	149.15102	-29.469786	
17	19/6/21	Road	Yes	Mehi R crossing; mapped as weir impacting low flows; water level too high to determine.	C34	149.029679	-29.454662	

FID	Date	Feature	DPIE priority	Description and notes, and structure specifications (where measured)	Image ID	X	Y	Height (AHD_m)
18	19/6/21	Road		Mehi R, Baroona Rd crossing; Concrete bridge; concrete blocks - dimensions: (Guardrails H21 cm x L135 cm) x17 per side; deck depth 43 cm; 3x bridge spans: width 540 cm; 6x rectangular piers supporting 2 rectangular slabs; length (abutment to abutment) 29.4 m	C18	149.029544	-29.454713	182.754
19	19/6/21	Road		Mehi R, adjacent to Baroona Rd crossing; old road largely submerged at current water levels.	C19	148.902634	-29.477578	151.893
20	19/6/21	Channel		South bank Mehi R, northern end of property: Dunbar; large channel feeding storage for Dunbar property - at current water levels flow seemingly as wide as river flow although channel depth cannot be determined	C20	148.902828	-29.477623	
21	19/6/21	Weir	Yes	Mehi R, TSR; rock and concrete weir; at current water levels, water almost free flowing over constraint; large embankment to the north encouraging southern lateral water movement.	C21	149.037879	-29.46496	
22	19/6/21	Road	Yes	Mehi R, TSR, road would have led to Taroo; broken road with river flow through culvert but also finding new path around it; Circular metal culvert; D = 20-25 cm; L = 6.5 m	C22	148.882019	-29.482717	147.81
23	19/6/21	Road		Mehi R, TSR; road spanning anabranch of Mehi; old pipe in disuse / half buried - less than half the length of constraint.	C23	148.824929	-29.495803	146.433
24	19/6/21	Road		Mehi R anabranch / extended wetland, TSR	C24	148.825047	-29.494298	144.452
25	19/6/21	Road	Yes	Mehi R crossing; flow over road at current water levels	C25	148.802478	-29.499929	143.076
26	19/6/21	Road		Wetlands to the north of main channel of Mehi R, TSR; road impeding lateral flow of water to wetland channels to the south.	C26	148.801842	-29.501933	142.503
27	19/6/21	Channel		Northern bank of Mehi R, TSR; channel leading to pump which feeds dam storage north of the Gwydir Highway	C27	148.801842	-29.501933	170.163
28	19/6/21	Other		North of Gwydir Highway, TSR; supply channel fed from pumps south of highway, leading to dam storage.	C28	148.800956	-29.500689	
29	19/6/21	Nil		Mehi R, north bank TSR; Old dam and evidence of pump structure no longer in use; NO CONSTRAINT.	none	148.921942	-29.469824	
30	20/6/21	Road		Donny Boland's property, Mehi R crossing; single lane bridge used when water is flowing; road (C30) used when dry; Corrugated metal bridge; Guardrail incorporates 26 square posts in total, 100 cm x 5 cm; distance between posts 145 cm; Deck depth 70 cm; 2x bridge spans (total bridge width 540 cm); 4x hexagonal piers; bridge length (abutment to abutment) 24.8 m.	C29	148.91997	-29.465279	
31	20/6/21	Road		Donny Boland's property; Mehi R; road used when dry.	C30	148.935231	-29.466908	
32	20/6/21	Other		Donny Boland's property, Mehi R; choked fence line spanning river.	C31	148.993417	-29.461117	152.682
33	20/6/21	Road		Flood-runner south of Mehi R; road crosses flood-runner / anabranch to the south of the Mehi; culvert completely choked by earth at its western opening; fence borders road on each side; Circular metal culvert, D = 46 cm, L = 11.7 m.	C32	148.993309	-29.461187	
34	20/6/21	Nil		South bank Mehi R, Wirra; pump site confirmed	OBJECTID36	148.9938	-29.460934	
35	20/6/21	Road		Southern side of Mehi R; anabranch / flood-runner; water could be seen pooling 40 m to the east of the constraint - no water to the west; Circular metal culvert, D = 46 cm, L = 11.3 m.	C33	148.994284	-29.463777	153.45
36	20/6/21	Weir	Yes	Northern end of Kurrabooma property, Mehi R; weir banks water upstream.	C35	149.005099	-29.464709	
37	20/6/21	Channel		South bank of Mehi R; north-eastern end of Kurrabooma property; channel runs adjacent to water storage; water levels would have to be flooding to connect Mehi to channel.	C36	148.989858	-29.46544	152.953

FID	Date	Feature	DPIE priority	Description and notes, and structure specifications (where measured)	Image ID	X	Y	Height (AHD_m)
38	20/6/21	Channel		South bank of Mehi R; north-east Kurrabooma property; channel leading to water storage.	C37	149.197095	-29.478433	159.899
39	21/6/21	Road		Erinvale, Mehi R; possible road crossing when dry	C38	149.24329	-29.511322	165.233
40	21/6/21	Channel		West bank Mehi R, Erinvale; at current water levels constraint is flowing into Mehi; channel to the NW of Mehi used to be the main flow path - got cut off years ago and is now largely separated from main Mehi channel (pers. comms. Henry Moses, Erinvale landholder)	C39	149.240892	-29.510637	166.117
41	21/6/21	Bank		Old main channel cut off from current main channel of river by bank at this point.	C40	149.233345	-29.501713	
42	21/6/21	Channel		Natural water course (branch of Ballin Boora) feeds supply channel three times along its length.	C41	149.231991	-29.502397	164.513
43	21/6/21	Road		Kurrabooma southern border, Ballin Boora Ck; washed out road with concrete culvert; lowest point of channel (currently dry) has circumnavigated road and culvert; concrete circular culvert D = 53 cm, L – 7.6 m.	C42	149.232809	-29.501768	155.942
44	21/6/21	Bank		Southern border of Kurrabooma, Ballin Boora Ck, east of Bronte Rd; washed out bank once would've impeded flow of Ballin Boora - now funnels the channel.	C43	149.202908	-29.514471	
45	21/6/21	Bank		The Glen, Ballin Boora Ck; instream bank spanning nearly the entire width of creek; small channel left open at NW bank approx. 3m wide.	C44	149.203189	-29.521482	162.764
46	21/6/21	Bank		Southern end of the Ballin Boora Ck, The Glen.	C45	149.217712	-29.527703	163.344
47	21/6/21	Bank		Ballin Boora Ck; bank on eastern side of creek diverting lateral flow south and west.	C46	149.184406	-29.517683	161.027
48	21/6/21	Bank		Ballin Boora Ck, TSR; instream broken bank; 8.6 m wide	C47	149.180354	-29.518322	160.945
49	21/6/21	Road		Bronte Rd, Ballin Boora Ck crossing; choked fence lines span the BB creek on either side of the constraint. Bridge with concrete square block guard rails x15 per side (1450 cm x 15 cm); Concrete bridge deck depth 70 cm; 2x bridge spans (total bridge width 540 cm); 4x hexagonal piers; bridge length (abutment to abutment) 24.8 m.	C48	149.170625	-29.523141	162.833
50	21/6/21	Road		Southern end of The Valley, Ballin Boora Ck	C49	149.174489	-29.524671	161.07
51	21/6/21	Bank		Southern end of The Valley, Ballin Boora Ck; washed out instream bank causing flow to funnel; currently some flow upstream - pooling downstream; dam storage to the west fed by pump upstream of constraint.	C50	149.19779	-29.516592	163.712
52	22/6/21	Bank		Southern end of The Valley, Ballin Boora Ck; washed out in stream bank causing funnel of flow; flow upstream - pooling downstream.	C51	149.127328	-29.524033	157.921
53	22/6/21	Road		Western edge of Dunbar, Ballin Boora Ck; water pooling on southern side / upstream of road crossing - no surface water evident on northern side / downstream.	C52	149.129239	-29.523387	158.711
54	22/6/21	Channel		Northern end of Garelema, south bank of Mehi R; constraint feeds water storage to the south.	C53	149.132939	-29.524861	159.358
55	22/6/21	Nil		Southern end of Garemela; NO CONSTRAINT – drain line feeds from supply channel back into Mehi R.	OBJECTID57	149.087145	-29.489549	157.034
56	22/6/21	Bank		Southern anabranch of the Mehi R, Bronte property; instream bank cutting Mehi anabranch connected by sluice gate; metal sluice gate D = 120, L = 10.5 m	C54	149.065082	-29.469228	
57	22/6/21	Bank		South banks of Mehi R, northern end of Bronte property; bank separating pooling water; as mapped by DPIE - seemingly a localised series of modified lagoons.	C55	149.073652	-29.471632	

FID	Date	Feature	DPIE priority	Description and notes, and structure specifications (where measured)	Image ID	X	Y	Height (AHD_m)
58	22/6/21	Bank		South banks of Mehi R, northern end of Bronte property; bank separating pooling water; as mapped by DPIE - seemingly a localised series of modified lagoons.	C56	148.88039	-29.484604	150.126
59	22/6/21	Bank		South banks of Mehi R, northern end of Bronte property; bank separating pooling water; as mapped by DPIE - seemingly a localised series of modified lagoons.	C57	148.876926	-29.485625	150.269
60	22/6/21	Bank		Northern end of Bronte property, south of Mehi R; bank separating pooling water; as mapped by DPIE - seemingly a localised series of modified lagoons.	C58	148.876115	-29.487133	150.763
61	22/6/21	Bank		Southern side of Mehi R, Bronte property; bank separating pooling water; as mapped by DPIE - seemingly a localised series of modified lagoons.	C59	148.875902	-29.488409	150.037
62	22/6/21	Bank		Southern anabranch of Mehi R, Bronte property; bank separating anabranch; as mapped by DPIE - the area seemingly consists of a localised series of modified lagoons; 2x sealed culverts each D = 610 cm; L = 12.5 m.	C60	148.873307	-29.488241	150.155
63	22/6/21	Bank		South of Mehi R, Bronte property; bank separating dried out depressions.	C61	148.872877	-29.488774	150.533
64	22/6/21	Bank		Bronte property, southern anabranch of Mehi R. bank separating anabranch from pooling water / floodplains to the south.	C62	148.872219	-29.489676	150.225
65	20/10/21	Bridge		Gundare bridge; Concrete box bridge with metal guardrails; L = 24.5 m.	C63	148.871997	-29.491232	150.408
66	20/10/21	Weir	Yes	Gundare weir; banks water upstream	C64	148.872443	-29.49246	150.293
67	20/10/21	Channel	Yes	Off take	C65	149.316269	-29.588781	204.46
68	20/10/21	Road		Pipe under road, Bronte Rd; Concrete circular pipe D = 45 cm, L = 14 m.	C66	149.315952	-29.589339	200.587
69	20/10/21	Road		Pipes under side road, Bronte Rd; Fibreglass circular pipe D = 24.5 cm, L = 10.5 m.	C67	149.264582	-29.521709	
70	20/10/21	Road		Pipes under Bronte Rd; L = 26.7 and 18.2 m.	C68	149.220106	-29.487503	195.451
71	20/10/21	Road		Bronte Rd, side road; Steel circular pipe D = 86 cm; L = 12.7 m.	C69	149.204863	-29.498294	194.749
72	20/10/21	Road		Bronte Rd, Ballin Boora Ck crossing; dip in road, no pipes + evidence of water accumulation on both sides, water damage to road.	C70	149.20592	-29.504439	194.335
73	20/10/21	Road	Yes	Gwydir Highway**;** Road rock crossing; width = 6m; length = 13m	C71	149.202059	-29.507825	194.794
74	22/10/21	Channel		Barrier to oxbow, Bronte Rd; Road Barrier to oxbow, no dip in road, evidence of water logging on Esther side of road,	C72	149.175443	-29.527856	194.749
75	22/10/21	Bank		Lagoon near to river; large channel linking lagoon and river.	C73	149.18198	-29.520309	193.478
76	22/10/21	Bank	Yes	MH010; bank with pipe; Large embankment spanning 24.5 m; Contains circular steel pipe, D = 2.8 m and L = 9.5 m.	C74	148.802404	-29.502481	

This page left intentionally blank