TECHNICAL PAPER

02

Post-wet aquatic ecology assessment

NARRABRI TO NORTH STAR—PHASE 2 ENVIRONMENTAL IMPACT STATEMENT

Inland Rail Phase 2 Narrabri to North Star Post Wet Aquatic Ecology Assessment

Prepared for Golder Associates Pty Ltd

ARTC Document Number: 3-0031-260-ESV-00-RP-0001

Contents

Tables

Figures

1. Introduction

The Australian Government has committed to delivering the Inland Rail programme, which is a high performance and direct interstate freight rail corridor between Melbourne and Brisbane, via central-west New South Wales (NSW) and Toowoomba in Queensland. Inland Rail is a major nation-building programme that will enhance Australia's existing national rail network and serve the interstate freight market. The Inland Rail route, which is about 1,700 kilometres (km) long, consists of 13 separate projects, seven of which are located within NSW. Each of these projects (and, in some cases as appropriate, separate work sites within a project) are subject to an assessment and, if required, approval, under the relevant planning or project laws in the relevant jurisdictions.

Australian Rail Track Corporation Ltd (ARTC) ('the proponent') is seeking approval to construct and operate the Narrabri to North Star (N2NS) section of Inland Rail. The N2NS section was declared a Critical State Significant Infrastructure (CSSI) project under the Environmental Planning and Assessment Act 1979 (NSW) (EP&A Act), and is currently undergoing the environmental impact assessment process under the EP&A Act, and bilateral assessment under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act).

The N2NS Project had an Environmental Impact Statement (EIS) prepared, which is currently undergoing assessment. Since that EIS was prepared and submitted in 2017, the alignment within what is now the N2NS Phase 2 area has changed. Specifically, ARTC has modified the N2NS Project to upgrade a section of approximately 15 km of the corridor running from Moree north to beyond the Camurra Bypass, including the Mehi-Gwydir River crossings. Consequently, this section of the N2NS alignment has been omitted from the original Project and as Phase 2, requires separate environmental impact assessment (EIA) under the EP&A Act, and assessment under the EPBC Act.

As part of the approvals process Freshwater Ecology Pty Ltd (Freshwater Ecology) was commissioned by Golder Associates Pty Ltd (Golder) to prepare an aquatic ecology assessment for Phase 2. This assessment will inform the impact assessment and identification of mitigation strategies.

2. Project activities, location and site selection

2.1. Overview of activities for Phase 2

The key activities associated with Phase 2 include:

- Upgrading approximately 13.4 km of track and track formation, and construction of approximately 1.6 km of new track and track formation, to bypass the Camurra hairpin.
- Replacing 8 under-bridges to meet structural design load requirements.
- Significant flood immunity improvements to the railway line in the Gwydir-Mehi floodplain, including extensive culvert banks.
- Upgrading, relocating or consolidating 9 level-crossings on the existing brownfield alignment, including changing property access and local road networks in some locations as a result of the rationalisation of level crossings.
- Local signalling works including upgrades to signalling systems for active level-crossings.
- Ancillary works such as improving stormwater and drainage, establishing or upgrading existing fencing of the rail corridor, potential construction of noise walls, and relocating impacted services and utilities.

Of these activities, the proposed bridge replacements for the Mehi and Gwydir Rivers, and activities impacting on other watercourses in the Phase 2 area, generally have the most potential to impact aquatic ecology values. This informed the sampling site selection, described in Section 2.3.

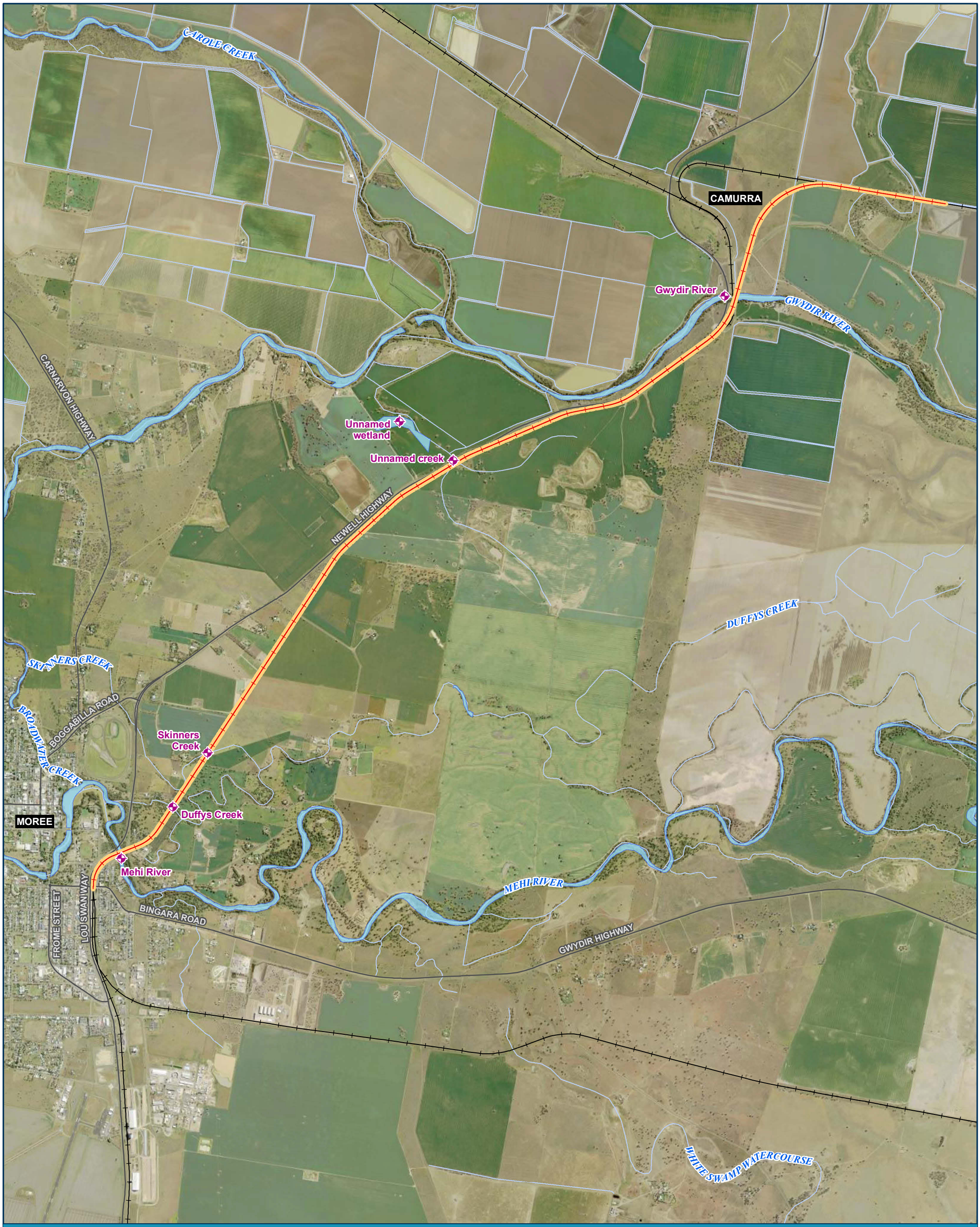
2.2. Project area

The project area transverses the Mehi-Gwydir floodplain which is part of the greater Gwydir River catchment (Figure 1). Stream flows in the Gwydir River catchment are regulated by Copeton Dam (approximately 200 km upstream of the alignment). The Phase 2 project area is located immediately north of the town of Moree in northern NSW.

The two major waterways which are located within the project area are the Gwydir and the Mehi Rivers. The Mehi River is a large anabranch of the Gwydir River. Several other smaller ephemeral waterways transverse the project area or are immediately downstream of it. These include Duffys Creek, Skinners Creek, as well as an unnamed creek and an unnamed ephemeral wetland to the north-west of the proposed alignment. Both the unnamed creek and unnamed ephemeral wetland flow towards the Gwydir River.

2.3. Site selection

Sites were selected on all waterways noted in the NSW Hydroline that crossed the proposed Phase 2 alignment and those which may hold water. A total of six sites were assessed (Figure 1). This included sites on both the larger permanent waterways of the Mehi and Gwydir Rivers as well as the smaller named and unnamed tributaries and the ephemeral wetland. The characteristics of all sampling sites, including coordinates, are described in Appendix A.



Narrabri to North Star

N2NS Phase 2 Aquatic Ecology Survey Sites

Map 1

0 0.5 1 Km

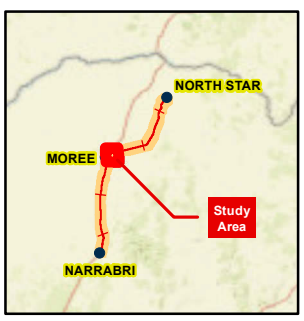
Coordinate System: GDA 1994 MGA Zone 55

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 12-05-2020
Author: HPB

Paper: A3
Scale: 1:40,000

Aquatic Ecology Survey Sites
ARTC Project Sections
N2NS Phase 2 Alignment
Railways
Main Roads
Waterways
Water Body



Data Sources: Project Centres: BaseMapStreetPro; N2NS Alignment: ARTC December 2019; All other data: NSW Clip 'N Ship,2020; Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

\\golder.gds\GAP\Brisbane\ComplexData\ARTC\P20139036 - Aquatic sampling\IR_GIS\Projects\002 - Aquatic Sampling\Documents\20139036-000-P-F001-Rev0-Aquatic-Ecology-Survey-Sites.mxd

3. Desktop assessment

3.1. Threatened species and communities

A literature review was undertaken to assess the environmental values and aquatic fauna species that could occur in and adjacent to the Phase 2 alignment. The online searches included an *Environment Protection and Biodiversity Conservation Act 1992* (EPBC Act) Protected Matters Report (Appendix C), a NSW Bionet search, an Atlas of Living Australia search, and a review of the aquatic species listed as threatened under the NSW *Fisheries Management Act 1994* (FM Act). These results, and discussion regarding the likelihood of occurrence, are summarised as follows:

EPBC Protected Matters

- Three Ramsar wetlands - the closest Ramsar wetland listed was the Gwydir wetlands that are located approximately 40 km west of Moree and therefore approximately 40 km downstream of the Phase 2 alignment. The Banrock Station wetland complex and the Coorong wetlands are more than 1,000 kilometres downstream.
- Murray Cod (*Maccullochella peelii*) – listed as vulnerable under the EPBC Act. This species is known to occur both upstream and downstream of the Phase 2 alignment.
- Bell's Turtle (*Wollumbinia belli*) – listed as vulnerable under the EPBC Act and endangered under the NSW *Biodiversity Conservation Act 2016* (BC Act). This species is known to occur in the upper reaches of the Gwydir River catchment but has not been recorded in proximity to the Phase 2 alignment.

FM Act

- Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River – listed as endangered under the FM Act. This community intersects the Phase 2 alignment in the regulated tributaries of the Darling River, including the Gwydir River downstream of Copeton Dam.
- Murray-Darling Basin population of the eel-tailed catfish (*Tandanus tandanus*) – listed as an endangered population in the FM Act. It is likely to be currently found in proximity to the Phase 2 alignment.
- Purple-spotted gudgeon (*Mogurnda adspersa*) – listed as endangered in the FM Act. It is considered unlikely to be found in proximity to the Phase 2 alignment as it has only been recorded more than 80 km upstream.
- Silver perch (*Bidyanus bidyanus*) - listed as vulnerable in the FM Act. It is considered unlikely to be found in proximity to the Phase 2 alignment as it has not been recorded in the immediate region for more than 100 years.
- Western New South Wales population of the Olive perchlet (*Ambassis agassizii*) - listed as an endangered population in the FM Act. It is considered unlikely to be found in proximity to the Phase 2 alignment as it has only been recorded more than 60 km downstream.

3.2. Flow

Based on streamflow data available from WaterNSW, there were no flows greater than 1,500 ML/day in the Gwydir and Mahi Rivers between October 2017 and mid-February 2020. In mid-February 2020 significant rainfall across the catchment combined with water releases from Copeton Dam upstream generated the first notable flows in several years through the system. The field sampling was undertaken approximately a month after these flows had subsided, therefore allowing time for the aquatic ecosystems to respond to the change in flow regime.

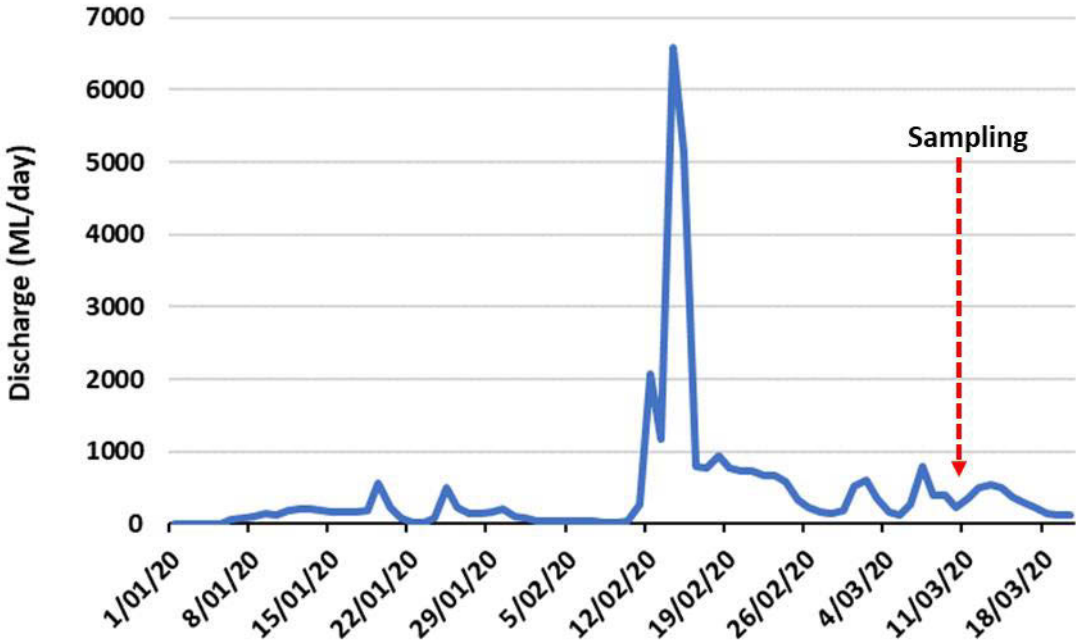


Figure 2: Stream flow in the Gwydir River downstream of Boolooroo (Flow gauge 418036) since 1/1/2020.

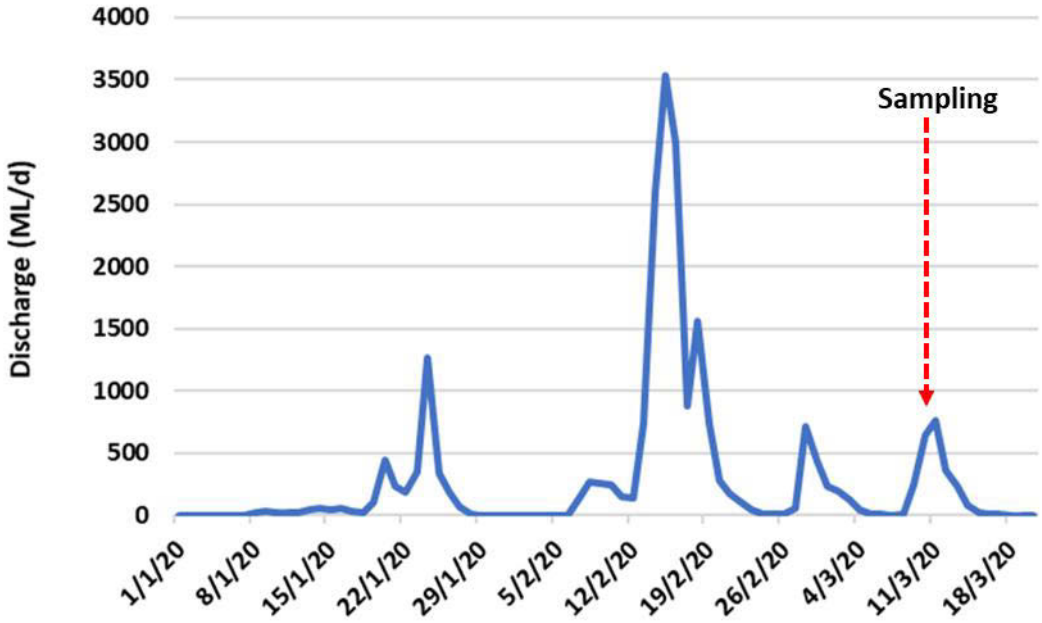


Figure 3: Stream flow in the Mehi River at Moree (Flow gauge 418002) since 1/1/2020.

4. Field sampling methodology

Sampling was undertaken from the 10th to the 12th of March 2020. The sampling techniques used at each site are summarised in Table 1.

Table 1: Sampling methods used at each site.

Location	Mehi River	Duffys creek	Skinners Creek	Unnamed waterway	Unnamed wetland	Gwydir River
Habitat assessment	✓	✓	✓	✓	✓	✓
In situ water quality	✓	✓	✓	✓	✓	✓
Macrophytes	✓	✓	✓	✓	✓	✓
Macroinvertebrates	✓	✓	✓	✓	✓	✓
Boat electrofishing	✓					✓
Backpack electrofishing		✓	✓	✓	✓	
Fyke nets	✓					✓

4.1. Surface water quality

In situ water quality data was recorded using a portable multiparameter water quality meter that had been calibrated in accordance with the manufacturer's specifications. Calibrations were regularly checked in the field. Parameters tested *in situ* included: temperature, electrical conductivity (EC), pH, turbidity and dissolved oxygen (DO). *In situ* water quality testing was undertaken to assist with the interpretation of ecological results. Water quality samples were also collected for analysis.

The results of both *in situ* and physical samples subsequently laboratory analysed are presented in detail under separate cover, being ARTC document number 3-3031-260-ESV-00-ME-0001 (*SP2 Water Quality Memo*, Golder Associates Pty Ltd, April 2020).

4.2. Aquatic habitat

An aquatic habitat inventory was undertaken at each monitoring location to assist in the interpretation of ecological data. This inventory included a general description of the environment within, and immediately surrounding each site, including:

- Channel characteristics
    - reach length, bankfull bank height, bankfull stream width, mean water depth, mean wetted width, mean water velocity (where possible).
- Riparian vegetation characteristics
    - riparian vegetation height (max.), riparian zone width (both banks), bare ground, grass, shrubs, trees (< 10 m and > 10 m), canopy cover.
- Mesohabitat composition (%)

    - riffle, run, rocky pool, sandy pool, dry.
- Substrate composition (%)
    - bedrock, boulder (>256 mm), cobble (64-256 mm), pebble (4-64 mm), gravel (2-4 mm), sand (2-4 mm), silt/clay (<0.05 mm).
- Macrophytes (None, Little 1-10%, Some 10-50%, Moderate 50-75%, Extensive >75%)
    - free floating, attached floating, submerged, emergent (as per section 4.3).
- In-stream wood (None, Little 1-10%, Some 10-50%, Moderate 50-75%, Extensive >75%)
    - detritus (leaves etc), sticks (<2 cm diameter), branches (<15 cm diameter), logs (>15 cm diameter).
- Microhabitat (None, Little 1-10%, Some 10-50%, Moderate 50-75%, Extensive >75%)
    - periphyton, filamentous algae, submerged macrophytes, bank overhang vegetation, trailing bank vegetation, blanketing silt, substrate anoxia, bank undercuts.

4.3. Aquatic flora

Macrophyte surveys were undertaken following completion of the fish surveys to increase the chance of observing submerged macrophytes that were not abundant throughout the reach. All native and exotic macrophyte species at the site were recorded. Species were identified using Sainty & Jacobs (2003), Grantley *et al*. (2009), and MacDonald & Haslam (2016). The approximate area covered by each macrophyte species was recorded. Free-floating, floating, attached and submerged macrophyte percentage coverage was based on stream wetted area across the reach, whereas emergent macrophyte coverage was recorded as a percentage of the riparian zone (note that non-macrophyte species also contributed to riparian vegetation but were not assessed within the scope of this project).

Macrophyte species were categorised by growth form in accordance with definitions provided in Sainty and Jacobs (2003), as follows:

- **Free floating** – Species that are normally unattached and float on the surface but may become attached and rooted in drying mud when water levels drop.
- **Floating attached** – Species that are rooted in the substrate but normally have at least the mature leaves floating on the water surface.
- **Submerged**– Species rooted in the substrate or free-floating submerged.
- **Emergent** – Species rooted in the bank substrate with stems, flowers and most of the mature leaves projecting above the water surface.

4.4. Aquatic macroinvertebrates

Macroinvertebrate samples were collected at each monitoring location in line with the NSW Australian River Assessment System (AusRivAS) *Sampling and Processing Manual* (Turak et al. 2004). All sampling was undertaken by suitably trained and experienced field operators.

The sites located on the Mehi and Gwydir Rivers were larger bodies of water and relatively deep, therefore replicates of edge samples were collected at these sites. All other sites were located in highly ephemeral streams with little permanent water. Consequently, a single composite sample (covering all available habitats) was collected from these sites. Following the AusRivAS conventions, macroinvertebrate samples were collected at each site using a standard 250 µm mesh AusRivAS dip net.

Samples were "live picked" on site following the AusRivAS protocols and animals collected were preserved in 70 percent alcohol. In the laboratory, macroinvertebrates were sorted, identified to the family taxonomic level and relative abundance enumerated. Organisms were identified to family level with the exception of lower phyla (e.g. porifera, nematoda), oligochaetes (freshwater worms), acarina (freshwater mites) and microcrustacea (ostracoda, copeopoda and cladocera). Chironomids were identified to sub-family level in accordance with standard AusRivAS protocols (Turak et al. 2004).

Enumeration and identification of macroinvertebrate samples was conducted by Christopher Pietsch, an experienced AusRivAS accredited ecologist. Sorting, enumeration and data entry was cross-checked by a second, AusRivAS accredited ecologist for 10% of the samples.

The data was analysed for a number of key macroinvertebrate indices (abundance, taxonomic richness, Plecoptera, Ephemeroptera, and Trichoptera (PET) richness and SIGNAL 2 scores). It is important to note that abundance values are not absolute, instead reflecting the AusRivAS style live picking protocols (Turak et al. 2004). All multivariate analyses were undertaken using a square root transformation of the raw data to minimise the influence of highly abundant species. Non-metric multidimensional scaling (NMDS) plots were produced for macroinvertebrate communities from all sites and habitats to visualise the differences in macroinvertebrate community composition between sites (Clarke & Warwick 2001).

4.5. Fish

Backpack and boat electrofishing were the primary fish survey techniques. In the larger, more permanent waterways (i.e. the Mehi and Gwydir Rivers), boat electrofishing was the primary sampling method with fyke netting used as a supplementary sampling technique. In the smaller, ephemeral waterways, backpack electrofishing was the primary sampling method.

Backpack electrofishing was undertaken using a Smith-Root LR20B backpack electrofisher. Settings for the backpack electrofisher varied between sites, depending on water conductivity, depth, fish size and species. Backpack electrofishing was conducted from downstream to upstream, covering all mesohabitats present within each reach. Boat electrofishing was undertaken with a Smith-Root 7.5 GPP electrofishing unit. Boat electrofishing was conducted from downstream to upstream in a zig-zag motion while ensuring that bank habitat was suitably surveyed. Electrofishing 'on-time' varied between 857 and 1,256 seconds and was determined by the appropriate amount of time required to adequately sample each reach. It also aimed to minimise unnecessary electrofishing effort that could cause harm to fish within the reach, particularly any fish that may have been trapped in complex habitat and unable to be observed.

All electrofishing was undertaken in compliance with the Australian Code of Electrofishing Practice (NSW Fisheries, 1997) with the minimum power setting used to effectively attract and stun the fish.

Fine mesh (6mm) fyke nets were baited, deployed and left overnight within the main rivers. Single and double wing configurations were used depending on the nature of the site. Fyke nets were set with the cod end buoyed or otherwise suspended to prevent accidental drowning of platypus, turtles or water rats.

At each site, abundance was recorded for each fish species for which identification was verified. Native fish were returned to the water, while exotic species were euthanized humanely in accordance with permit conditions and disposed of in an environmentally sensitive manner.

5. Results

5.1. Surface water quality

The *in situ* water quality parameters recorded in March 2020 are presented in Table 2. A full discussion of water quality results is provided in ARTC document number 3-3031-260-ESV-00-ME-0001 *SP2 Water Quality Memo*, Golder Associates Pty Ltd, April 2020.

Temperature varied from 19.3 – 26.4ºC. Dissolved oxygen fluctuated between sites ranging from 15.0 – 62.8 % saturation. The pH of the surface waters ranged from slightly acidic (in the Mehi River and unnamed waterway) to moderately alkaline (in the Gwydir River, Skinners Creek and Duffys Creek). The pH at the bottom of the water column in the Mehi was more acidic than any other recording, possibly due to disturbed organic matter in the high flow events that had occurred prior to sampling. Conductivity was generally low at all sites, with the highest results recorded in the Gwydir River. Turbidity was relatively high at all sites but lowest in the Gwydir River.

Table 2: *In situ* water quality in March 2020

Site	Time	Depth (M)	Temperature (°C)	Electrical conductivity (µS/cm)	pH	Dissolved oxygen (% saturation)	Turbidity (NTU)
Mehi River (surface)	08:15	0.1	20.4	95	6.6	26.1	>800
Mehi River (bottom)	08:15	3.6	20.4	95	5.2	26.2	>800
Duffys Creek	08:45	0.1	19.3	92	7.5	15.0	>800
Skinners Creek	12:15	0.1	22.1	125	7.5	62.8	>800
Unnamed waterway	09:15	0.1	20.0	20	6.7	30.1	705
Unnamed wetland	12:00	0.1	22.3	28	7.0	34.5	510
Gwydir River (surface)	14:45	0.1	26.4	316	8.1	46.1	202
Gwydir River (bottom)	14:45	1.2	23.7	333	7.7	40.0	225

5.2. Aquatic habitat

Full descriptions of physical parameters and habitat for each site are provided in **Appendix A**, and are summarised as follows:

- Mehi River – a mean water depth of 3.2 m was recorded at this location, with a maximum riparian vegetation height of 30 m. The mesohabitat composition was noted as 98% deep pool (soft substrate). Extensive detritus was noted.
- Duffys Creek – a mean water depth of 0.6 m was recorded at this location, with a maximum riparian vegetation height of 25 m. The mesohabitat composition was noted as 60% shallow pool. Moderate detritus was noted.

- Skinners Creek – a mean water depth of >1.2 m was recorded at this location, with a maximum riparian vegetation height of 30 m. The mesohabitat composition was noted as 90% deep pool (soft substrate). Moderate detritus was noted.
- Unnamed creek – a mean water depth of 44 cm was recorded at this location, with a maximum riparian vegetation height of 15 m. The mesohabitat composition was noted as 40% deep pool (soft substrate) and 40% shallow pool. Some detritus was noted.
- Ephemeral wetland – a mean water depth of 0.3 m was recorded at this location, with a maximum riparian vegetation height of 30 m. The mesohabitat composition was noted as 100% shallow pool. Some detritus was noted.
- Gwydir River – a mean water depth of 1.2 m was recorded at this location, with a maximum riparian vegetation height of 28 m. The mesohabitat composition was noted as 75% deep pool (soft substrate). Little detritus was noted.

5.3. Aquatic flora

A total of 11 species of aquatic macrophyte were recorded across the six sites in March 2020 (Table 3). All macrophyte species recorded are widespread and abundant along eastern Australia and none are listed under state or federal legislation as threatened. The highest diversity of aquatic macrophytes was at the site on the Mehi River with seven species recorded from four functional groups. All other sites had a low species diversity with only a single emergent species recorded at the unnamed wetland. Similarly, there was moderate coverage of two species on the Mehi River but at all other sites aquatic macrophyte coverage was low.

Table 3: Aquatic macrophytes recorded and relative coverage (L – low, M – moderate)

Functional group	Scientific name	Common name	Mehi River	Duffys Creek	Skinners Creek	Unnamed creek	Unnamed wetland	Gwydir River
Floating	*Lemna spp.*	Duckweed	L	L	L			
Floating attached	*Ludwigia peploides*	Water primrose	L					L
	Marsilea mutica	Nardoo		L	L	L		
Submerged	*Vallisneria spp.*	Ribbonweed						L
Emergent	*Bolboschoenus spp.*	Marsh club rush	M					
	Cyperus difformis	Dirty dora		L			L	
	Cyperus spp.	sedge species		L	L	L		L
	Juncus usitatus	Common rush	L					
	Persicaria attenuata	White smartweed	M		L	L		
	Phragmites australis	Common reed	L					L
	Typha spp.	Bullrush	L					
		Species richness	**7**	**4**	**4**	**3**	**1**	**4**

5.4. Aquatic macroinvertebrates

A total of 610 aquatic macroinvertebrate individuals from 44 taxa (mainly family level) were collected from the six sites sampled in March 2020. In addition, three groups of microcrustacean were recorded across the sites with the highest diversity in the ephemeral sites (Duffys Creek, Skinners Creek, unnamed waterway and unnamed wetland).

A NMDS provides a visual representation of the aquatic macroinvertebrate assemblages across all sites (Figure 4). There was a notable difference in the macroinvertebrate assemblages between the edge habitats in the larger streams and the smaller ephemeral waterways. The majority of this difference was driven by the higher diversity and abundance of decapods (shrimps, prawns and crayfish) in the larger streams and the higher abundance of coleoptera (beetles), diptera (flies) and hemiptera (true bugs) in the ephemeral streams.

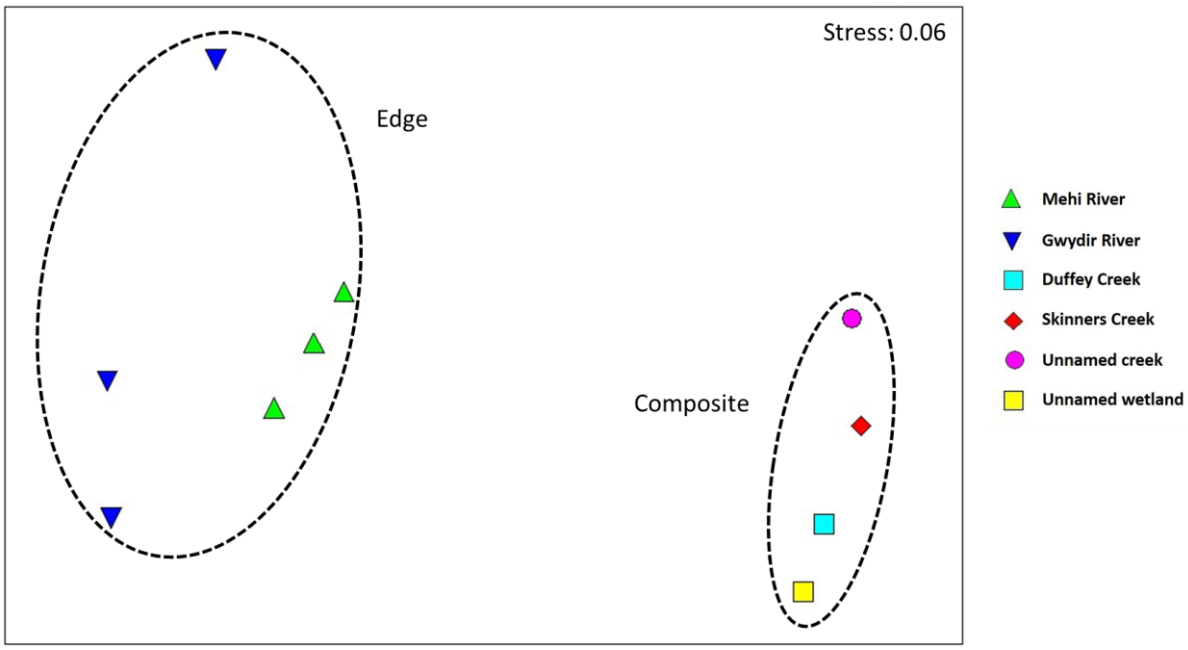


Figure 4: NMDS Ordination of macroinvertebrate assemblages across the project area in March 2020

Macroinvertebrate relative abundance for all sites sampled in March 2020 is presented in Figure 5. Abundance values were not absolute but in line with the live picking procedures of the AusRivAS methodology (Turak et al. 2004). Abundance varied across all sites and samples, ranging from 23 to 1331, with the lowest abundances recorded in the larger river samples. The lower abundances in the larger rivers may have been due to the higher flow experienced during flooding prior to the survey program, and the limited time since to allow the re-establishment of macroinvertebrate population sizes.

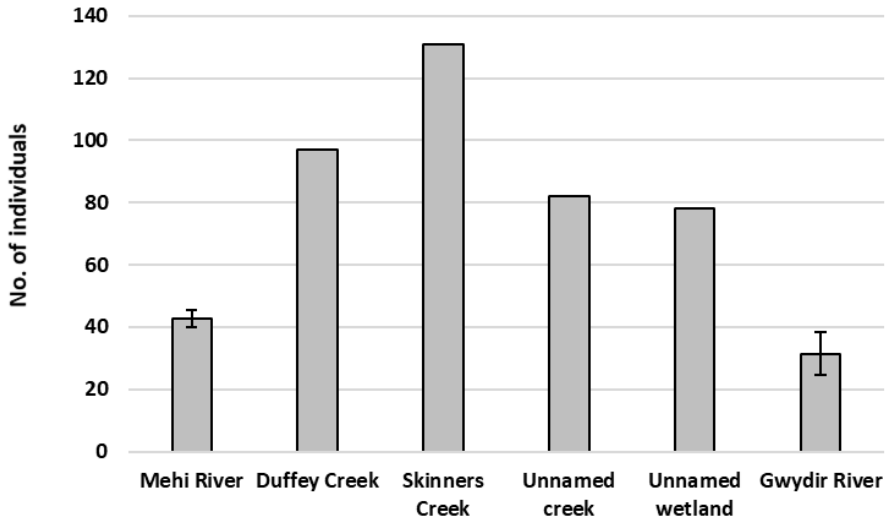


Figure 5: Abundance of macroinvertebrates recorded at each site in March 2020
Note: Mehi and Gwydir River sites shown with mean values and standard error bars

The number of taxa collected at each site is presented in Figure 6. Taxa diversity across all samples ranged from 6 to 20 with mean values for each site ranging from 8.3 mean taxa to 20 mean taxa. Taxa richness was lowest in all Gwydir River and unnamed wetland samples (6-10 taxa) and highest at Skinners Creek, unnamed creek and one of the edge samples in the Mehi River (18-20 taxa).

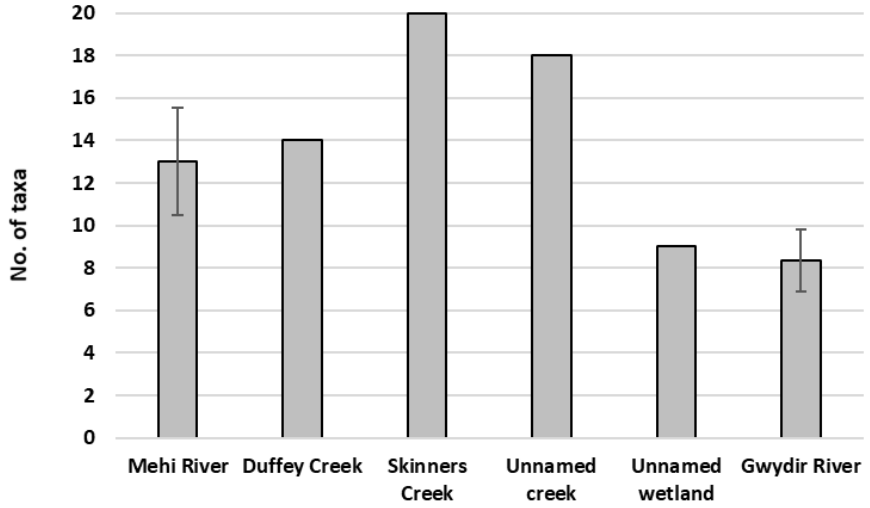


Figure 6: Macroinvertebrate taxa richness (typically family level) recorded at each site in March 2020
Note: Mehi and Gwydir River sites shown with mean values and standard error bars

Only two families of PET taxa were recorded and were absent from 40% of sites, therefore no further examination of PET richness was used as a means to compare between sites. The percentage of tolerant taxa across all sites was high (between 60-89%) (Figure 7).

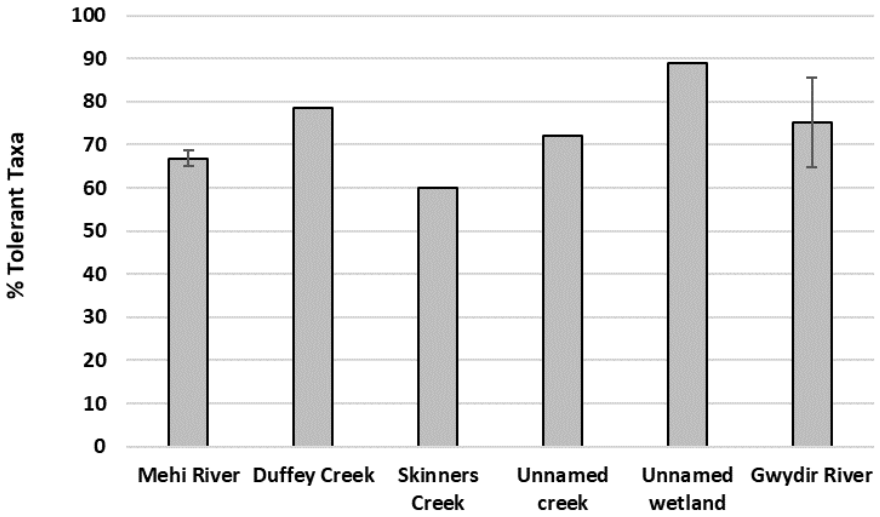


Figure 7: **Percentage of tolerant taxa recorded at each site in March 2020**
Note: Mehi and Gwydir River sites shown with mean values and standard error bars

The Signal2 scores for each site are presented in Figure 8. The Signal2 scores were relatively low ranging from 2.22 to 3.10.

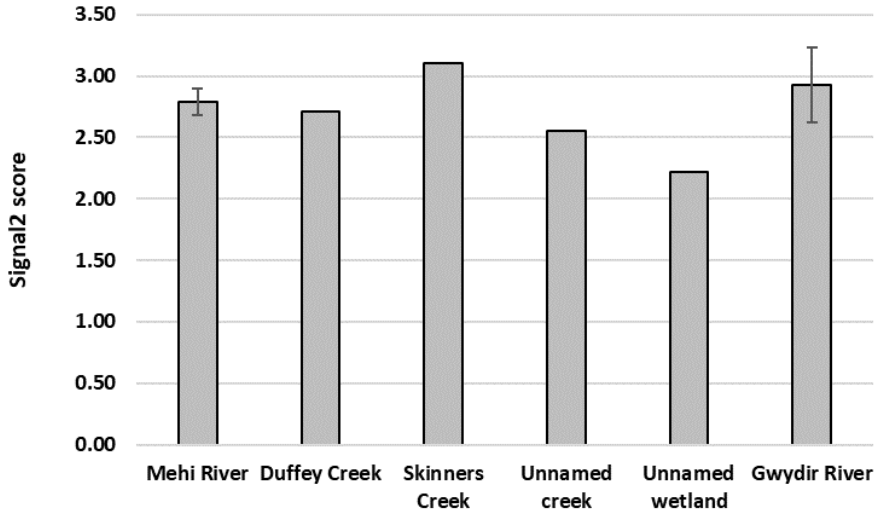


Figure 8: **Signal2 scores recorded at each site in March 2020**
Note: Mehi and Gwydir River sites shown with mean values and standard error bars

5.5. Fish

A total of 2,747 fish from 11 species were recorded from the two main river sites surveyed in March 2020 (Table 4). No fish were recorded in the four ephemeral creeks or wetland. The absence of fish in these sites appears to be due to a combination of a blackwater event (large amounts of organic matter being mobilised in a high flow event that consumes dissolved oxygen creating fish kills) (as described by a local farmer as occurring several days prior to sampling) and lack of connectivity of some sites to the larger, more permanent waterways. Of the fish recorded, 2,618 were from eight native species and 128 were from three exotic species (identified in red in Table 4 below). The most abundant species was bony bream (*Nematalosa erebi*) which accounted for 92% of all fish recorded. Species richness was slightly higher in the Mehi River (11 species) than in the Gwydir River (nine species). The EPBC-listed Murray Cod and the FM Act listed eel-tailed catfish were recorded in both the Mehi and the Gwydir Rivers.

Table 4: Fish species and abundance recorded in March 2020

Scientific name	Common name	Mehi River	Duffey Creek	Skinners Creek	Unnamed creek	Unnamed wetland	Gwydir River	Grand Total
Craterocephalus fulvus	Unspecked hardyhead	6	-	-	-	-	5	**11**
Hypseleotris spp.	Carp gudgeon species	23	-	-	-	-	28	**51**
Leiopotherapon unicolor	Spangled perch	5	-	-	-	-	-	**5**
Macquaria ambigua	Golden perch	1	-	-	-	-	5	**6**
Maccullochella peelii	Murray cod[1]	1	-	-	-	-	13	**14**
Melanotaenia fluviatilis	Murray River rainbowfish	3	-	-	-	-	-	**3**
Nematalosa erebi	Bony bream	511	-	-	-	-	2,016	**2,527**
Tandanus tandanus	Eel-tailed catfish[2]	1	-	-	-	-	1	**2**
Carassius auratus	Goldfish	3	-	-	-	-	6	**9**
Cyprinus carpio	Carp	10	-	-	-	-	15	**25**
Gambusia holbrooki	Gambusia	70	-	-	-	-	24	**94**
	Totals	**634**	**0**	**0**	**0**	**0**	**2,113**	**2,747**

[1] Listed as vulnerable under the EPBC Act.

[2] Listed as an endangered population under the FM Act.

5.6. Incidental observations

Eighteen Murray short neck turtles (*Emydura macquarii*) and nine broad-shelled turtles (*Chelodina expansa*) were recorded in the fyke nets and released unharmed. Neither of these species are listed under NSW or Commonwealth legislation.

6. Impact Assessment

6.1. Potential impacts

The key potential impacts on aquatic ecosystems in the Phase 2 alignment include:

- Removal of riparian vegetation on the banks of watercourses to build the new bridges over the Mehi and Gwydir rivers, and to replace some of the culverts on the ephemeral waterways.
- Removal of existing crossings and construction of new crossings has the potential to temporarily impact on water quality on the permanent watercourses of the Gwydir and Mehi Rivers.
- Temporary obstruction of fish passage associated with bridge and culvert works, and any vehicle access across watercourses.
- Any impacts to water quality during construction has the potential to impact on aquatic ecology in receiving watercourses.

The aquatic ecology assessment (Umwelt, 2017) prepared for the entire N2NS alignment was reviewed as part of undertaking the impact assessment. In particular, the Umwelt (2017) assessment considered potential impacts along the entire N2NS alignment (including the general Phase 2 area) for matters listed under the FM Act and the EPBC Act (identified in Section 3). The Umwelt (2017) assessment noted that:

- The proposal is unlikely to have a significant impact on matters listed under the FM Act with the adoption of appropriately designed fish friendly crossing structures and other relevant mitigation measures.
- The proposal is unlikely to have a significant impact on the Murray Cod given that the proposal is unlikely to disrupt breeding habitat, habitat removal or isolation is unlikely, the number/distribution of introduced fish species is not likely to increase, alien species are unlikely to be introduced and flow regimes in the main rivers where the species was found are unlikely to be altered.

The assessment results from the aquatic ecology survey undertaken in March 2020 for the Phase 2 alignment are generally consistent with those noted in Umwelt (2017). Specifically, the Murray Cod and eel-tailed catfish were both found in the main rivers, with more individuals found in the Gwydir River. Given the types of impacts discussed and assessed in the Umwelt (2017) report will also occur for Phase 2 (albeit with a significantly reduced extent), it is concluded that activities associated with Phase 2 are unlikely to result in significant impacts to listed species (Section 3), with the adoption of appropriate mitigation measures.

6.2. Mitigation and management

A range of mitigation and management measures should be used to minimise impacts. These include those recommended in Umwelt (2017). These are summarised as follows:

Design and construction

- Replacement watercourse structures should be designed to maintain flows and avoid blockage of fish passage. These structures should also minimise disturbance of remnant vegetation upstream and downstream of the work areas, and minimise changes to the morphology of the watercourse.
- Specifically to manage impacts to the aquatic ecological community and the eel-tailed catfish, as well as impacts more broadly, the watercourse structures should be designed and constructed in accordance with the national guideline *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (Fairfull and Witheridge 2003), and the NSW Guideline *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation* (NSW Department of Primary Industries, 1999). Reference should also be had to *Fish Passage requirements for Waterway Crossings - Engineering Guidelines* (Witheridge, 2002).
- Works should be undertaken in accordance with standard sediment and erosion controls to manage and minimise further siltation.
- In order to maintain/enhance habitat features, any large woody debris in the proposal site should be relocated upstream or downstream in consultation with an appropriately qualified ecologist. Alternatively, ARTC may also consider re-establishing the debris in its original location once works are concluded, if feasible to do so.
- Employee education and training including inductions for relevant staff, contractors and visitors to the site to inform personnel of the aquatic ecological issues present at the site and so they know their role and responsibilities in relation to the protection and/or minimisation of impacts.
- Preserve any existing vegetation and minimise disturbance within the riparian zone.
- Plan to undertake works in the Mehi and Gwydir Rivers for forecasted dry weather periods to keep any impacts on water quality localised.
- Ensure designs for works within or near ephemeral watercourses provide for the retention of natural functions and maintenance of fish passage, and regularly inspect and maintain to minimise blockage that could impede on fish passage.
- A soil and water sub-plan should be prepared as part of the project's Construction Environmental Management Plan that identifies and minimises impacts on water quality.
- Work compounds and stockpile sites should be located an appropriate distance from riparian vegetation to avoid indirect impacts on aquatic habitat values. As a guide, riparian buffer zones as recommended by DPI (1999) are: 100m for type 1 class 1 watercourses (Mehi River and Gwydir River), 50m for type 2 class 2 -3 watercourses and 10 to 50m for type 3 class 2 -4 watercourses.
- To avoid any unnecessary clearance of established trees and native vegetation on the banks of watercourses and in-stream vegetation upstream and downstream of the rail corridor it is recommended that the native vegetation within a 25 m buffer of watercourses

be demarcated prior to clearing. This would assist in avoidance of impacts on any established trees and native vegetation outside of the area cleared for construction works.

- To minimise loss of fish within any semi-permanent pools in the impact zone, it is recommended that a dewatering procedure be developed and included in the biodiversity management sub-plan in the CEMP. The dewatering procedure would outline methods for collection and relocation of protected fish and euthanasia of pest species.

Operations

- Continuation of general mitigation measures for relevant maintenance staff to inform personnel of aquatic ecological values, roles and responsibilities in relation to the protection of watercourses and riparian vegetation.
- Ongoing weed management.
- Regular inspection and maintenance of structures to ensure functionality and minimise blockage of fish passage.
- Management of spills.

7. Conclusion

Freshwater Ecology was commissioned by Golder to prepare an aquatic ecology assessment for the Phase 2 portion of the N2NS section of Inland Rail, in order to inform the impact assessment and identification of mitigation strategies for the project.

A desktop assessment and field investigation were undertaken as part of this assessment, with the key results summarised as follows:

- A total of 11 species of aquatic macrophyte were recorded across the six sites in March 2020. All macrophyte species recorded are widespread and abundant along eastern Australia and none are listed under state or federal legislation as threatened.
- A total of 610 aquatic macroinvertebrate individuals from 44 taxa (mainly family level) were collected from the six sites sampled in March 2020. In addition, three groups of microcrustacean were recorded across the sites with the highest diversity in the ephemeral sites (Duffys Creek, Skinners Creek, unnamed waterway and unnamed wetland).
- A total of 2,747 fish from 11 species were recorded from the two main river sites surveyed in March 2020. No fish were recorded in the four ephemeral creeks or wetland. Of the fish recorded, 2,618 were from eight native species and 128 were from three native species. The EPBC-listed Murray Cod and the FM Act listed eel-tailed catfish were recorded in both the Mehi and the Gwydir Rivers.

The aquatic ecology assessment (Umwelt, 2017) prepared for the entire N2NS alignment was reviewed as part of undertaking the impact assessment. The assessment results from the aquatic ecology survey undertaken in March 2020 for the Phase 2 alignment are generally consistent with those noted in Umwelt (2017).

Given the types of impacts discussed and assessed in the Umwelt (2017) report will also occur for Phase 2 (albeit with a significantly reduced extent), it is concluded that activities associated with Phase 2 are unlikely to result in significant impacts to listed species, with the adoption of appropriate mitigation measures.

8. References

AS/NZS (1998) Australian / New Zealand Standard. Water quality—Sampling. Part 6: Guidance on sampling of rivers and streams.

Clarke, K.R., Warwick, R.M. (2001). Change in Marine Communities: An Approach to Statistical Analysis and Interpretation. PRIMER-E, Plymouth, U.K. 38pp.

Grantley, J., McPherson, F. and Petroeschevsky, A. (2009). Recognising water weeds. Plant identification guide. Industry and Investment NSW.

NSW Fisheries (1997). The Australian Code of Electrofishing Practice. NSW Fisheries Management Publication No. 1.

Sainty, G. and Jacobs, S. (2003). Waterplants In Australia: A Field Guide. Sainty and Associates.

Turak, E., Waddell, N. & Johnstone, G. (2004). New South Wales (NSW) Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual 2004. Natural Heritage Trust.

Umwelt (2017). Inland Rail Programme. Narrabri to North Star Project. Environmental Impact Statement. Technical Report 3: Aquatic Ecology Assessment.

TECHNICAL PAPER

02

Post-wet aquatic ecology assessment

Appendix A Monitoring site profiles

NARRABRI TO NORTH STAR—PHASE 2 ENVIRONMENTAL IMPACT STATEMENT

Mehi River 10-11/3/2020		**Co-ordinates (UTM 55J) E 776513 N 6736800**	
 **Upstream of alignment**		 **Downstream of alignment**	
Channel characteristics		**Mesohabitat composition**	
Reach length	200 m	Riffle	-
Bankfull bank height	10 m	Run	-
Bankfull stream width	85 m	Shallow pool	2 %
Mean water depth	3.2 m	Deep pool (soft substrate)	98 %
Maximum water depth	5.0 m	Deep pool (hard substrate)	-
Mean wetted width	30 m	Dry	
Riparian characteristics		**Microhabitat present**	
Riparian veg height (max)	30 m	Periphyton	little
Riparian width (left bank)	20 m	Filamentous algae	-
Riparian width (right bank)	40 m	Submerged macrophytes	-
Bare ground	-	Bank overhang veg	moderate
Grass	95 %	Trailing bank veg	moderate
Shrubs	5 %	Blanketing silt	extensive
Trees < 10 m	10 %	Substrate anoxia	little
Trees > 10 m	60 %	Bank undercuts	little
Canopy cover	10 %		
Instream wood		**Macrophyte coverage**	
Detritus (leaves etc)	extensive	Emergent	moderate
Sticks (<2cm diam)	little	Floating	little
Branches (<15cm diam)	little	Floating attached	little
Logs (>15cm diam)	little	Submerged	-
***In situ* water quality**		**Biological summary**	
Temperature	20.4 °C	Macrophytes species	7
Conductivity	95 µS/cm	Macroinvertebrate taxa	24
Dissolved oxygen	26.1%	Fish species	11
pH	6.6		
Turbidity	>800 NTU		
General Comments			
Clay/silt substrate.			

Duffys Creek 12/3/2020		**Co-ordinates (UTM 55J) E 777126 N 6737349**	
 **Upstream of alignment**		 **Downstream of alignment**	
Channel characteristics		**Mesohabitat composition**	
Reach length	100 m	Riffle	-
Bankfull bank height	4 m	Run	-
Bankfull stream width	42 m	Shallow pool	60 %
Mean water depth	0.6 m	Deep pool (soft substrate)	30 %
Maximum water depth	1.2 m	Deep pool (hard substrate)	-
Mean wetted width	12 m	Dry	10 %
Riparian characteristics		**Microhabitat present**	
Riparian veg height (max)	25 m	Periphyton	-
Riparian width (left bank)	20 m	Filamentous algae	-
Riparian width (right bank)	20 m	Submerged macrophytes	-
Bare ground	30 %	Bank overhang veg	little
Grass	40 %	Trailing bank veg	some
Shrubs	50 %	Blanketing silt	extensive
Trees < 10 m	50 %	Substrate anoxia	moderate
Trees > 10 m	30 %	Bank undercuts	-
Canopy cover	40 %		
Instream wood		**Macrophyte coverage**	
Detritus (leaves etc)	moderate	Emergent	little
Sticks (<2cm diam)	some	Floating	little
Branches (<15cm diam)	little	Floating attached	little
Logs (>15cm diam)	little	Submerged	-
***In situ* water quality**		**Biological summary**	
Temperature	19.3 ^{o}C	Macrophytes species	4
Conductivity	92 µS/cm	Macroinvertebrate taxa	14
Dissolved oxygen	15.0 %	Fish species	0
pH	7.5		
Turbidity	>800 NTU		
General Comments			
Comments from local farmer. Anecdotally normally dry. Last connected to Mehi River in 2012. Blackwater event following the recent flow event that pushed through (black water and strong anoxic smell). Silty substrate. River Red Gums present.			

Skinners Creek 12/3/2020	**Co-ordinates (UTM 55J) E 777490 N 6737919**
 **Upstream of alignment**	 **Downstream of alignment**

Channel characteristics		**Mesohabitat composition**	
Reach length	100 m	Riffle	-
Bankfull bank height	1.0 m	Run	-
Bankfull stream width	80 m	Shallow pool	10 %
Mean water depth	> 1.2 m	Deep pool (soft substrate)	90 %
Maximum water depth	> 1.2 m	Deep pool (hard substrate)	-
Mean wetted width	40	Dry	
Riparian characteristics		**Microhabitat present**	
Riparian veg height (max)	30 m	Periphyton	-
Riparian width (left bank)	20 m	Filamentous algae	-
Riparian width (right bank)	10 m	Submerged macrophytes	-
Bare ground	5 %	Bank overhang veg	some
Grass	60 %	Trailing bank veg	moderate
Shrubs	30 %	Blanketing silt	extensive
Trees < 10 m	10 %	Substrate anoxia	-
Trees > 10 m	60 %	Bank undercuts	likely*
Canopy cover	10 %		
Instream wood		**Macrophyte coverage**	
Detritus (leaves etc)	moderate	Emergent	little
Sticks (<2cm diam)	little	Floating	little
Branches (<15cm diam)	some	Floating attached	little
Logs (>15cm diam)	little	Submerged	-
***In situ* water quality**		**Biological summary**	
Temperature	22.1 ^{o}C	Macrophytes species	4
Conductivity	125 µS/cm	Macroinvertebrate taxa	20
Dissolved oxygen	62.8 %	Fish species	0
pH	7.5		
Turbidity	>800 NTU		

General Comments

Hard clay substrate. River Red Gums present.

* Water level high above normal bank levels, difficult to determine undercut bank presence or extent.

Unnamed creek 11/3/2020		**Co-ordinates (UTM 55J) E 780339 N 6741306**	
			
Upstream of alignment		**Downstream of alignment**	
Channel characteristics		**Mesohabitat composition**	
Reach length	100 m	Riffle	-
Bankfull bank height	2.5 m	Run	-
Bankfull stream width	54 m	Shallow pool	40 %
Mean water depth	44 cm	Deep pool (soft substrate)	40 %
Maximum water depth	64 m	Deep pool (hard substrate)	-
Mean wetted width	44 m	Dry	20 %
Riparian characteristics		**Microhabitat present**	
Riparian veg height (max)	15 m	Periphyton	-
Riparian width (left bank)	5 m	Filamentous algae	-
Riparian width (right bank)	5 m	Submerged macrophytes	-
Bare ground	10 %	Bank overhang veg	-
Grass	50 %	Trailing bank veg	some
Shrubs	40 %	Blanketing silt	moderate
Trees < 10 m	5 %	Substrate anoxia	-
Trees > 10 m	5 %	Bank undercuts	-
Canopy cover	5 %		
Instream wood		**Macrophyte coverage**	
Detritus (leaves etc)	some	Emergent	little
Sticks (<2cm diam)	-	Floating	-
Branches (<15cm diam)	-	Floating attached	little
Logs (>15cm diam)	-	Submerged	-
***In situ* water quality**		**Biological summary**	
Temperature	20.0 ^{o}C	Macrophytes species	3
Conductivity	20 µS/cm	Macroinvertebrate taxa	18
Dissolved oxygen	30.1 %	Fish species	0
pH	6.7		
Turbidity	705 NTU		
General Comments			
Clay/silt substrate.			

Unnamed wetland 11/3/2020		**<u>Co-ordinates (UTM 55J)</u> E 779506 N 6741690**	
 **Upstream (monitoring site situated entirely downstream of alignment)**		 **Downstream (monitoring site situated entirely downstream of alignment)**	
Channel characteristics		**Mesohabitat composition**	
Reach length	100 m	Riffle	-
Bankfull bank height	0.5 m	Run	-
Bankfull stream width	80 m	Shallow pool	100 %
Mean water depth	0.3 m	Deep pool (soft substrate)	-
Maximum water depth	0.5 m	Deep pool (hard substrate)	-
Mean wetted width	60	Dry	
Riparian characteristics		**Microhabitat present**	
Riparian veg height (max)	30 m	Periphyton	-
Riparian width (left bank)	15 m	Filamentous algae	-
Riparian width (right bank)	5 m	Submerged macrophytes	-
Bare ground	5 %	Bank overhang veg	little
Grass	40 %	Trailing bank veg	some
Shrubs	40 %	Blanketing silt	extensive
Trees < 10 m	10 %	Substrate anoxia	-
Trees > 10 m	10 %	Bank undercuts	-
Canopy cover	2 %		
Instream wood		**Macrophyte coverage**	
Detritus (leaves etc)	some	Emergent	little
Sticks (<2cm diam)	little	Floating	-
Branches (<15cm diam)	-	Floating attached	-
Logs (>15cm diam)	-	Submerged	-
***In situ* water quality**		**Biological summary**	
Temperature	22.3 ^{o}C	Macrophytes species	1
Conductivity	28 µS/cm	Macroinvertebrate taxa	9
Dissolved oxygen	55.5 %	Fish species	0
pH	7.0		
Turbidity	510 NTU		
General Comments			
River Red Gums present.			

Gwydir River 10-11/3/2020		**Co-ordinates (UTM 55J) E 783401 N 6743104**	
 **Upstream of alignment**		 **Downstream of alignment**	
Channel characteristics		**Mesohabitat composition**	
Reach length	200 m	Riffle	-
Bankfull bank height	12 m	Run	5 %
Bankfull stream width	102 m	Shallow pool	10 %
Mean water depth	1.2 m	Deep pool (soft substrate)	75 %
Maximum water depth	2 m	Deep pool (hard substrate)	10 %
Mean wetted width	80 m	Dry	-
Riparian characteristics		**Microhabitat present**	
Riparian veg height (max)	28 m	Periphyton	-
Riparian width (left bank)	20 m	Filamentous algae	-
Riparian width (right bank)	20 m	Submerged macrophytes	little
Bare ground	5 %	Bank overhang veg	little
Grass	90 %	Trailing bank veg	moderate
Shrubs	5 %	Blanketing silt	moderate
Trees < 10 m	20 %	Substrate anoxia	-
Trees > 10 m	70 %	Bank undercuts	little
Canopy cover	10 %		
Instream wood		**Macrophyte coverage**	
Detritus (leaves etc)	little	Emergent	little
Sticks (<2cm diam)	little	Floating	-
Branches (<15cm diam)	little	Floating attached	little
Logs (>15cm diam)	little	Submerged	little
***In situ* water quality**		**Biological summary**	
Temperature	26.4 ^{o}C	Macrophytes species	4
Conductivity	316 µS/cm	Macroinvertebrate taxa	16
Dissolved oxygen	46.1 %	Fish species	9
pH	7.7		
Turbidity	202 NTU		
General Comments			

TECHNICAL PAPER 02

Post-wet aquatic ecology assessment

Appendix B Macroinvertebrate raw data

NARRABRI TO NORTH STAR—PHASE 2 ENVIRONMENTAL IMPACT STATEMENT

	Site name		Mehi Rv.	Mehi Rv.	Mehi Rv.	Gwydir Rv.	Gwydir Rv.
	Habitat type	SIGNAL 2	EDGE 1	EDGE 2	EDGE 3	EDGE 1	EDGE 2
	o. Cladocera		P				
	s.c. Copepoda		P	P		P	P
	cl. Ostracoda						
ph. Platyhelminthes	cl. Temnocephalidea	5	2	4	2	13	
	s.c. Oligochaeta	2		2			
cl. Bivalvia	Corbiculidae	4					
	s.c. Acarina	6		1			
o. Isopoda	Corallanidae	2		2		5	1
	Scyphacidae	2		1			
	o. Anostraca	1					
o. Decapoda	Atyidae	3	17	14	15	5	12
	Palaemonidae	4		2	4	10	3
	Parastacidae	4	1	2		1	
	s.c. Collembola	1	5	2	1		2
o. Lepidoptera	Crambidae	2					
o. Coleoptera	Carabidae	3				1	
	Curculionidae	2					
	Dytiscidae	2	1				
	Gyrinidae	4					
	Haliplidae	2					
	Hydraenidae	3					1
	Hydrophilidae	2		1			
	Nanophyidae	3		1			
	Spercheidae	2		2			
	Staphylinidae	3				3	
	Ceratopogonidae	4		1			
	s.f. Chironominae	3		3	3	1	1
	s.f. Tanypodinae	4					
	Culicidae	1					
	Simuliidae	5				1	
	Stratiomyidae	2					
	Syrphidae	2					
	Tabanidae	3					
o. Ephemeroptera	Baetidae	5	2		2	4	
o. Hemiptera	Corixidae	2			1		
	Gerridae	4	1	1			
	Mesoveliidae	2			2		
	Micronectidae	2	3	3	5	1	1
	Nepidae	3	1				
	Notonectidae	1	4	5	7		
	Ochteridae	2					
	Veliidae	3		1			2
s.o. Zygoptera	Coenagrionidae	2	1				
	Lestidae	1					
s.o. Epiprocta	Hemicorduliidae	5					
	Libellulidae	4					
o. Trichoptera	Leptoceridae	6					
	Taxa count		**11**	**18**	**10**	**11**	**8**
	No. Individuals		**38**	**48**	**42**	**45**	**23**
	PET taxa		**1**	**0**	**1**	**1**	**0**
	SIGNAL 2 average (Family)		**2.91**	**2.94**	**2.80**	**3.55**	**2.63**
	Tolerant taxa (≤3)		**7**	**12**	**7**	**6**	**7**
	% tolerant taxa		**64**	**67**	**70**	**55**	**88**

	Site name		Gwydir Rv.	Duffey Ck.	Skinners Ck.	Unnamed	Wetland
	Habitat type	SIGNAL 2	EDGE 3	COMP	COMP	COMP	COMP
	o. Cladocera			P	P	P	P
	s.c. Copepoda			P	P	P	
	cl. Ostracoda			P	P	P	P
ph. Platyhelminthes	cl. Temnocephalidea	5					
	s.c. Oligochaeta	2				1	
cl. Bivalvia	Corbiculidae	4				1	
	s.c. Acarina	6		6	3		
o. Isopoda	Corallanidae	2					
	Scyphacidae	2					
	o. Anostraca	1				1	
o. Decapoda	Atyidae	3	18				
	Palaemonidae	4	1				
	Parastacidae	4					
	s.c. Collembola	1	1			2	
o. Lepidoptera	Crambidae	2			1		
o. Coleoptera	Carabidae	3					
	Curculionidae	2				1	
	Dytiscidae	2		20	5	10	13
	Gyrinidae	4		1	2	1	1
	Haliplidae	2			1		
	Hydraenidae	3				2	8
	Hydrophilidae	2		14	4	1	1
	Nanophyidae	3					
	Spercheidae	2		3	2		3
	Staphylinidae	3					
	Ceratopogonidae	4			1	3	
	s.f. Chironominae	3		31	27	24	35
	s.f. Tanypodinae	4			1		
	Culicidae	1			7		3
	Simuliidae	5					
	Stratiomyidae	2		2			
	Syrphidae	2					
	Tabanidae	3			2		
o. Ephemeroptera	Baetidae	5		1	9	9	
o. Hemiptera	Corixidae	2		5	12	10	
	Gerridae	4					
	Mesoveliidae	2	2	1			
	Micronectidae	2		8	26		5
	Nepidae	3					
	Notonectidae	1	3	3	9	10	9
	Ochteridae	2				1	
	Veliidae	3	1	1		1	
s.o. Zygoptera	Coenagrionidae	2		1	3		
	Lestidae	1				2	
s.o. Epiprocta	Hemicorduliidae	5			3		
	Libellulidae	4			5	2	
o. Trichoptera	Leptoceridae	6			8		
	Taxa count		**6**	**14**	**20**	**18**	**9**
	No. Individuals		**26**	**97**	**131**	**82**	**78**
	PET taxa		**0**	**1**	**2**	**1**	**0**
	SIGNAL 2 average (Family)		**2.33**	**2.71**	**3.10**	**2.56**	**2.22**
	Tolerant taxa (≤3)		**5**	**11**	**12**	**13**	**8**
	% tolerant taxa		**83**	**79**	**60**	**72**	**89**

TECHNICAL PAPER

02

Post-wet aquatic ecology assessment

Appendix C EPBC Protected Matters Report

NARRABRI TO NORTH STAR—PHASE 2 ENVIRONMENTAL IMPACT STATEMENT

Australian Government
Department of the Environment and Energy

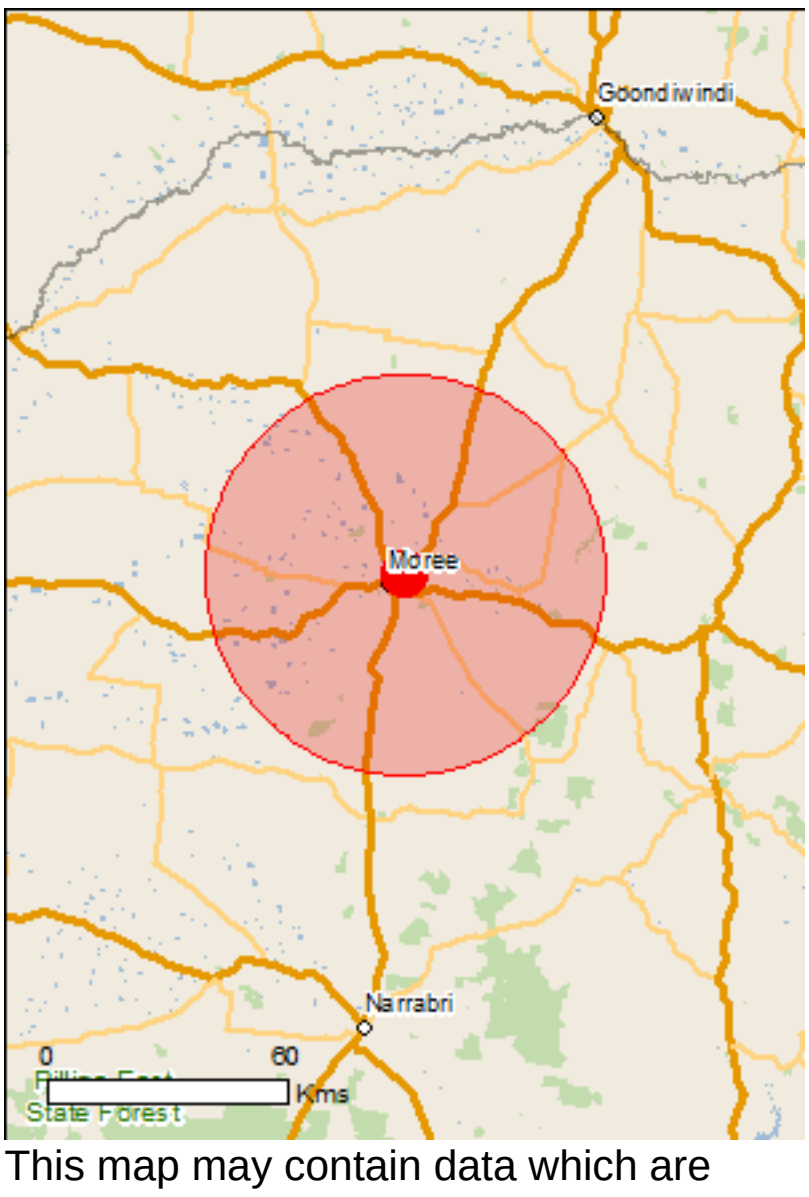
EPBC Act Protected Matters Report

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.

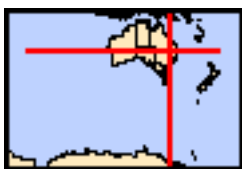
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

Report created: 18/03/20 21:04:30



Coordinates
Buffer: 50.0Km



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:	1
Wetlands of International Importance:	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	8
Listed Threatened Species:	28
Listed Migratory Species:	12

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:	5
Commonwealth Heritage Places:	None
Listed Marine Species:	18
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:	4
Regional Forest Agreements:	None
Invasive Species:	29
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

National Heritage Properties		[Resource Information]
Name	State	Status
Indigenous		
Moree Baths and Swimming Pool	NSW	Listed place

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	900 - 1000km upstream
The coorong, and lakes alexandrina and albert wetland	1100 - 1200km

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
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
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
New England Peppermint (Eucalyptus nova-anglica) Grassy Woodlands	Critically Endangered	Community may occur within area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat may occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Fish		
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 likely to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	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 known to 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 known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Plants		
Androcalva procumbens [87153]	Vulnerable	Species or species habitat likely to occur within area
Cadellia pentastylis Ooline [9828]	Vulnerable	Species or species habitat likely to occur within area
Dichanthium setosum bluegrass [14159]	Vulnerable	Species or species habitat known to occur within area
Homopholis belsonii Belson's Panic [2406]	Vulnerable	Species or species habitat may occur within area
Lepidium aschersonii Spiny Pepper-cress [10976]	Vulnerable	Species or species habitat likely to occur within area
Prasophyllum sp. Wybong (C.Phelps ORG 5269) a leek-orchid [81964]	Critically 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

Name	Status	Type of Presence
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may 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 known to occur within area
Aprasia parapulchella Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat may occur within area
Uvidicolus sphyrurus Border Thick-tailed Gecko, Granite Belt Thick-tailed Gecko [84578]	Vulnerable	Species or species habitat may occur within area
Wollumbinia belli Bell's Turtle, Western Sawshelled Turtle, Namoi River Turtle, Bell's Saw-shelled Turtle [86071]	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 known to 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 likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		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 known 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
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Pandion haliaetus		
Osprey [952]		Species or species habitat may occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat may 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 -
Commonwealth Land - Australian Postal Commission
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 alba		
Great Egret, White Egret [59541]		Breeding known 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 known 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

Name	Threatened	Type of Presence within area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
[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 known to 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 likely to occur within area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat may occur within area
[Rhipidura rufifrons](#) Rufous Fantail [592]		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
[Tringa nebularia](#) Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Bullala	NSW
Careunga	NSW
Kirramingly	NSW
Midkin	NSW

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
Anas platyrhynchos Mallard [974]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		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
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat may occur within area
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
Oryctolagus cuniculus Rabbit, European Rabbit [128]		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		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
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
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		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

Nationally Important Wetlands	[Resource Information]
Name	State
Gwydir Wetlands	NSW

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

-29.4423 149.8737

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 the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111