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*Marine and Freshwater Research*

### **Supplementary Material**

**Oil and gas exploration and development in the Lake Eyre Basin: distribution and consequences for rivers and wetlands, including the Coongie Lakes Ramsar Site**

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**Table S1. Wetlands of National Importance in the Lake Eyre Basin.**

Wetland number	Wetland name (ha)	Catchment (State)	Typology (freshwater ecosystems)	Potential impact of oil and gas development
1	Cauckingburra Swamp (782)	Cooper (Qld)	Episodic arid floodplain	None
2	Lake Buchanan (23212)		Ephemeral salt lake	None–low
3	Lake Galilee (25789)		Ephemeral salt lake	None–low
4	Aramac Springs (7068)		Permanent artesian springs	None
5	Mitchell Swamp (7068)		Episodic arid floodplain	None
6	Cooper Creek Overflow Swamps–Windorah (124893)		Episodic arid floodplain	Medium–high
7	Lake Cuddapan		Ephemeral freshwater lake	Low
8	Lake Yamma Yamma		Ephemeral freshwater lake	Low
9	Cooper Creek Swamps–Nappa Merrie (106384)		Episodic arid floodplain	Medium–high
10	Cooper Creek–Wilson River Junction (63961)		Episodic arid floodplain	High
11RS	Coongie Lakes (2177220)	Cooper, Diamantina (SA)	Episodic arid floodplain, Ephemeral freshwater lake, Ephemeral salt lake	High
12	Strzelecki Creek Wetland System (141007)	Cooper Creek, Lake Frome (SA)	Episodic arid floodplain	Low
13	Sturt National Park Wetlands (433)	Lake Frome, Lake Pinaroo (NSW)	Ephemeral freshwater lake, Ephemeral salt lake	None
14	Lake Eyre Mound Springs (23)		Permanent artesian springs	None
15	Inland Saline Lakes (307590)		Ephemeral salt lake	None
16	Lake Eyre (940626)		Ephemeral salt lake	None–low

Wetland number	Wetland name (ha)	Catchment (State)	Typology (freshwater ecosystems)	Potential impact of oil and gas development
17	Diamantina River Wetland System (937454)	Diamantina, Georgina, Hay (SA)	Episodic arid floodplain	Low
18	Birdsville–Durrie Waterholes Aggregation (32671)	Diamantina (Qld)	Episodic arid river	Low
19	Moonda Lake–Shallow Lake Aggregation (14748)		Ephemeral freshwater lake, Ephemeral salt lake	Low
20	Diamantina Overflow Swamp–Durrie Station (29217)		Episodic arid floodplain, Episodic arid river	Low
21	Lake Constance (1843)		Episodic arid floodplain, Episodic arid river	Low
22	Diamantina Lakes Area (393)		Episodic arid floodplain, Episodic arid river	Low
23	Elizabeth Springs (399)		Permanent artesian springs	None
24	Muncoonie Lakes Area (88715)		Episodic arid floodplain, Ephemeral freshwater lake	None
25	Lake Mipia Area (69712)		Episodic arid floodplain, Ephemeral freshwater lake	None
26	Lake Torquinie Area (15235)		Ephemeral salt lake	None
27	Lake Phillipi (16083)		Ephemeral freshwater lake	None
28	Georgina River–King Creek Floodout (138398)		Episodic arid floodplain	None
29	Mulligan River–Wheeler Creek Junction (17004)		Episodic arid floodplain	None
30	Toko Gorge and Waterhole (243)		Episodic arid river	None
31	Austral Limestone Aggregation (69335)		Episodic arid floodplain	None

Wetland number	Wetland name (ha)	Catchment (State)	Typology (freshwater ecosystems)	Potential impact of oil and gas development
32	Dalhousie Springs (19)		Permanent artesian springs	None
33	Finke River Headwater Gorges System (0.1)		Episodic arid river	None

Listing of their area, location (numbers match locations on Fig. 1), catchment, typology (Keith *et al.* 2020) and likely effect of current or future oil and gas development. The categories of potential impact of oil and gas development are dependent on location of current or future projects in relation to the wetland: low-downstream of the current or potential development, medium-future oil and gas development, high-current and future oil and gas development. RS, Ramsar Site.

**Table S2. Floodplain layer (including other wetlands) of the rivers of the Lake Eyre Basin.**

Catchment	State	Areas (ha) of floodplains (including all wetlands)	Number (area, ha) of wetlands in the Directory of Important Wetlands
Cooper Creek	Queensland	4410048	10 (440808)
	South Australia	562293	2 (1987051)
	New South Wales	304	0
	Subtotal	4972646	12(2427859)
Georgina River	Queensland	4434726	8 (414725)
	South Australia	18781	1 (3788)
	Subtotal	4453508	9(418513)
Diamantina River	Queensland	3845431	6 (79271)
	South Australia	763346	2 (1171585)
	Subtotal	4608777	8(125085)
Lake Frome	South Australia	1779587	4 (1350252)
	New South Wales	25963	1 (433)
	Subtotal	1805550	5(1350685)
Hay River	South Australia	293185	1 (2895)
Finke River	South Australia	73065	1 (19)
All catchments	All	32047211	33 (5450827)

These included the catchments of Cooper Creek, Georgina River, Diamantina River, Lake Frome, Hay River and Finke River (Geoscience Australia 2019), areas within each of the states and number and area of wetlands in the Directory of important wetlands. No area data were available for floodplains or other wetlands on the rivers of the Northern Territory.

**Table S3. Applications for oil and gas production works under the *Environment Protection and Biodiversity Conservation Act 1999* for the rivers of the Lake Eyre Basin.**

Catchment	Date	Reference number	Description	Commonwealth decision
Cooper Creek	05/09/2002	2002/797	Construction of a 10-km pipeline within the Cooper Creek–Wilson River Junction floodplain to transport natural gas from the Psyche to Winninia gas fields in southwest Queensland, buried to a depth of ~1 m, disturbing less than 0.15 km <sup>2</sup> (or 0.03%) of this particular land system.	Not a controlled action.
	09/09/2003	2003/1178	3-D seismic survey over 65.74 km <sup>2</sup> , including 19.59 km <sup>2</sup> (30%) of floodplain in the Cooper Creek–Wilson River Junction floodplain.	Not a controlled action.
	05/01/2004	2004/1321	3-D seismic survey at Cooper Creek-Wilson River Junction, over 126 km <sup>2</sup> of floodplain	Not a controlled action.
	04/04/2012	2012/6335	Six wells drilled in Eromanga–Cooper Basin, for petroleum exploration for conventional oil and gas resources within Authority to Prospect (ATP) 732, included 6.32 ha of drill sites and camp, 7.93 ha new access tracks 32.29 ha of existing disturbed seismic line, access tracks and workers' camp.	Not a controlled action if undertaken in a particular manner.

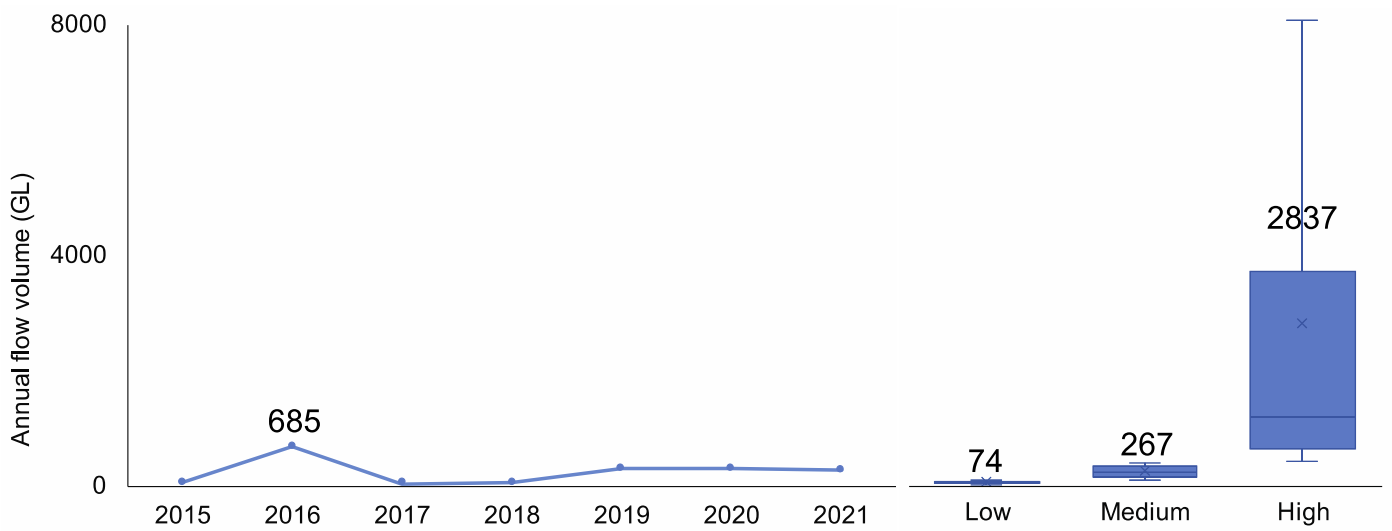
Catchment	Date	Reference number	Description	Commonwealth decision
	07/04/2014	2014/7175	Cooper to Abbot Point LNG Plant Facility, gas pipeline, ancillary infrastructure (referral specifies distance of ~1000 km).	Controlled action, requiring assessment and approval under the EPBC Act.
Diamantina River	15/01/2008	2008/3963	Gas compressor station (including temporary construction camp, a materials laydown area at Davenport Downs Scrapper Station on the Carpentaria Gas Pipeline (CGP).	Not a controlled action.
Georgina River <sup>A</sup>	04/06/2013	2013/6890	Exploration for conventional oil and gas, shale oil and gas and tight gas across three Authority to Prospect tenements in the South Georgina Basin, south-west of Boulia, Queensland, including ~1100 km of 2-D seismic surveys, eight core (exploration) wells, temporary rig camps, pre-clearance environmental and cultural heritage surveys and the rehabilitation of areas (where required) following these activities.	Not a controlled action if undertaken in a particular manner.
	07/03/2014	2014/7153	Exploration for conventional oil and gas, shale oil and gas and tight gas across three Authority to Prospect (ATP) tenements in the South Georgina Basin, south-west of Boulia, Queensland, including ~970 km of 2-D seismic surveys (now completed), establishment of up to eight exploration wells (including	Not a controlled action.

Catchment	Date	Reference number	Description	Commonwealth decision
			hydraulic fracturing and gas testing of these wells), temporary rig camps, pre-clearance environmental and cultural heritage surveys and the rehabilitation of areas (where required) following these activities. The Project area totals 1 432 249.9 ha.	

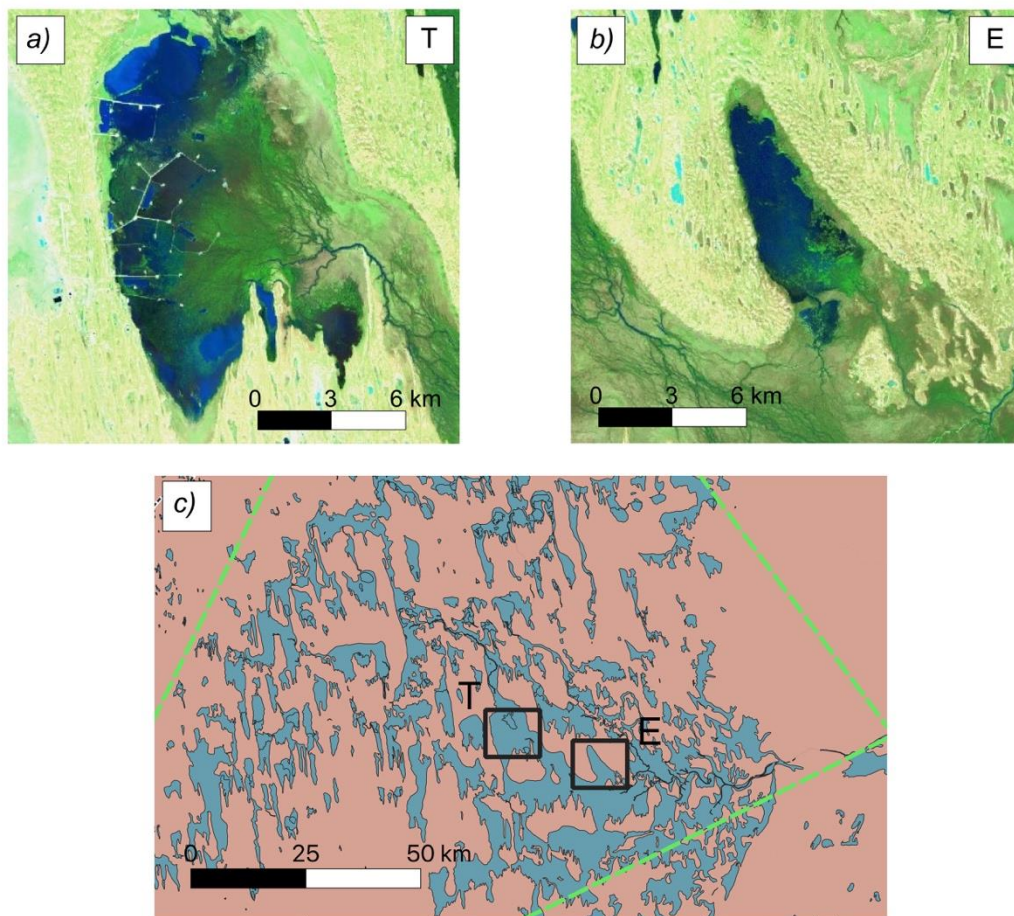
Each application listed under catchment, chronological date, reference numbers, description of works and Commonwealth decision (data from <http://epbcnotices.environment.gov.au/referralslist/>). Descriptions are adapted from the description in the referrals, focusing only on the type of development.

<sup>A</sup>Two referrals appeared to be related, with the latter including hydraulic fracturing and gas testing and reduced distance of seismic surveys





**Fig. S1.** Annual flows in Cooper Creek, measured at Nappa Merrie (Fig. 1, 2015–2021), coinciding with availability of Sentinel imagery, with box plots indicating average low, medium and high annual flows (numbers are averages and flow volume for 2016), over the full period of record for flows (1967–2021). Data were missing for 1984 and 1988–2000.



**Fig. S2.** Comparison of two proximate floodplain areas on the Coongie Lakes Ramsar Site, (a) Tirrawarra Swamp (T) and (b) eastern floodplain (E) showing flooding on 12 December 2016 from a false colour Sentinel image (Sentinel Hub) within c) the Coongie Ramsar Site and its floodplains (blue). The imagery is displayed with band 12 (shortwave infrared), band 8A (near infrared), and band 4 (red) as red, green and blue, with vegetation following flooding showing green due to its high reflectance in the near infrared, while water is blue and black with its low reflectance in both near and shortwave infrared.

## References

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