Department of Science, Information Technology and Innovation

Mitchell River Future Hydrological Threat Assessment

Queensland Government

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Current hydrological threat to aquatic ecosystems

The Mitchell River catchment is covered by two Queensland Water Resource Plans (WRPs): the Mitchell Plan and the Barron Plan. The headwaters of the Walsh River are within the Barron WRP because there is an interbasin transfer of water from the Barron into the Walsh to support the Mareeba–Dimbulah Water Supply Scheme. This enters the Walsh River just downstream of Nullinga stream gauge and the hydrological impacts of this transfer are spatially constrained to the reach upstream of the Flatrock stream gauge (approximately 60 km downstream). Southedge Dam (Lake Mitchell) is not part of the scheme and is within the Mitchell WRP area, but receives tailwater from drainage features within the scheme. It has an active capacity of 129,000 ML, yet has remained unused for water supply since it was opened in 1987 and has no current allocations associated with it. Under the current Mitchell WRP 20,000 ML could be made available from Lake Mitchell from General Reserve.

Total surface water entitlements within the Mitchell WRP area are very low, totalling little over 5,000 ML per year (just over 7,000 ML/annum with groundwater and town water supply), and also with very low utilisation rates. There is also allowance in the current WRP for a 70,000 ML unallocated reserve, but little interest has been shown about access to this during the life of the plan to date. Due largely to these low levels of water resource development, a recent review undertaken by DNRM to inform their decision to either extend or review the current WRP when it expires in 2018 identified universally low risks to ecosystems from the current plan. This indicates that the plan is considered to be meeting all of its specified ecological outcomes.

Due to the relatively minor flow regime impacts from the operation of the Mareeba–Dimbulah Water Supply Scheme at Flatrock stream gauge and the minimal degree of water resource development in the Mitchell WRP area, it is expected that the hydrological threat at all output nodes in the current IQQM model (Table 1) for the Mitchell catchment is low.

Table 1. Output nodes in the Mitchell Catchment from the Mitchell and Barron IQQM models.

Mitchell IQQM Model

Node Number	Node Description	Gauging Station No	Lat.	Long.
033	Mitchell R just upstream of Rifle Ck confluence	na	-16.6899	145.2026
040	Mitchell R just d/s Rifle Ck confluence	na	-16.6427	145.1911
053	Mitchell R at Cooktown Crossing	919014A	-16.5630	144.8886
066	Mitchell R at OK Bridge	919003A	-16.4711	144.2892
073	Mitchell R at Gamboola	919011A	-16.5349	143.6775
088	End of system flows (whole Mitchell R Basin outflows)	na		
093	Mitchell R at Koolatah	919009A	-15.9509	142.3772
104	Palmer R at Drumduff	919204A	-16.0401	143.0380
209	Walsh R at Trimbles Crossing	919309A	-16.5479	143.7835
258	Lynd R at Torwood	919006A	-17.4351	143.8205
315	Rifle Ck at Fonthill	919005A	-16.6791	145.2286
343	Mary Creek at Mary Farms	919001 B/C	-16.5733	145.1871
361	Mcleod River at Mulligan Hwy	919013A	-16.4978	145.0017

Barron IQQM Model

IQQM Node No.	Node Description	Gauging Station No	Latitude	Longitude
454	Walsh River @ Nullinga	919 305B	-17.1794	145.3000
521	Walsh River @ Flatrock	919 311A	-17.1813	144.8991

Potential future hydrological threats to aquatic ecosystems

Preliminary information on some possible locations and modes of future water resource development scenarios were provided by CSIRO from the early stages of their Mitchell River water resource assessment in support of the federal government White Paper on agricultural development in northern Australia. This information was the basis for the subsequent hydrological threat assessment.

Relevant scenarios were drawn from early CSIRO consideration of case studies for the resource assessment. As the case studies and the data to support their development were at very early and preliminary stages of consideration, these outputs should be also considered to be preliminary and interim. Futhermore, the case studies are not necessarily representative of the most likely pathways of development nor are they CSIRO recommendation on how development should proceed. There were five types of potential development discussed:

1. Mareeba–Dimbulah expansion – this may involve utilisation of the existing 129,000 ML active capacity of Southedge Dam (Lake Mitchell) (including the 20,000 ML available from General Reserve under the current WRP), or efficiency improvements to utilise the 45,000 ML per year currently lost in transition through open channels.
2. Large dam or combination of dams – Potential dams considered 'most likely' were the proposed Nullinga Dam on the Walsh River, damsites labelled M6 (Figure 1) on the Mitchell River in the region of OK Bridge, M2 on the Mitchell River upstream of Gamboola and the site labelled M5 on the Palmer River (Figure 1). These sites, in particular, were identified because of favourable water yield to dam construction cost ratios and preliminary mapping that showed their proximity to soils potentially suitable for irrigated agriculture in the Mareeba–Dimbulah Water Supply Scheme, near Chillagoe, Wrotham and alluvial deposits of the Mitchell, Palmer and lower Walsh Rivers (Figure 2).
3. Water harvesting – licensed pumping and overland flow capture were considered to be potentially viable in all areas with alluvium suitable for agriculture (Figure 2). The lower Mitchell River alluvium downstream from approximately the junction of the Palmer River was excluded on the basis of preliminary flood mapping conducted by Griffith University which showed this area was seasonally inundated and thus less likely suitable for cropping.
4. Waterhole pumping – increased licenced extraction of water from waterholes during periods without flow was considered a possible future development wherever there was close proximity between large, persistent waterholes (after Lymburner and Burrows, 2008 and local expert knowledge) and soils potentially suitable for agriculture (Figure 2).
5. Hyporheic 'upside down' dams – these were considered as potential developments in regions with alluvium suitable for agriculture and thought to have both deep bedsands to contain hyporheic water and bedrock suitable for infrastructure to build 'upside down' dams. In general, the locations of such features are poorly known. Expert local knowledge identified Mitchell River in the regions of Gamboola, OK Bridge to Cooktown Crossing as possibly having this combination of features. However, knowledge of bedsand depth is generally lacking. There may possibly also be suitable reaches in the Walsh and Palmer rivers, but this requires further investigation.

By combining spatial information on likely developments (Figure 1 and descriptions above), suitable soils (Figure 2) and the locations of output nodes from the Mitchell and Barron IQQM nodes (Table 1), an expert workshop undertook a spatial threat assessment to complete a matrix

of threats by model nodes. The threats were based on those previously identified in the adjacent Flinders and Gilbert Rivers (DSITIA 2014) with some additions relevant to the Mitchell catchment by consensus of those present at the workshop. The resulting matrix (Table 2) provides a spatial overview of hydrological threats to aquatic ecosystems in the Mitchell catchment from plausible future water resource development. This is a worst case assessment, as it amalgamates all plausible future water resource developments.

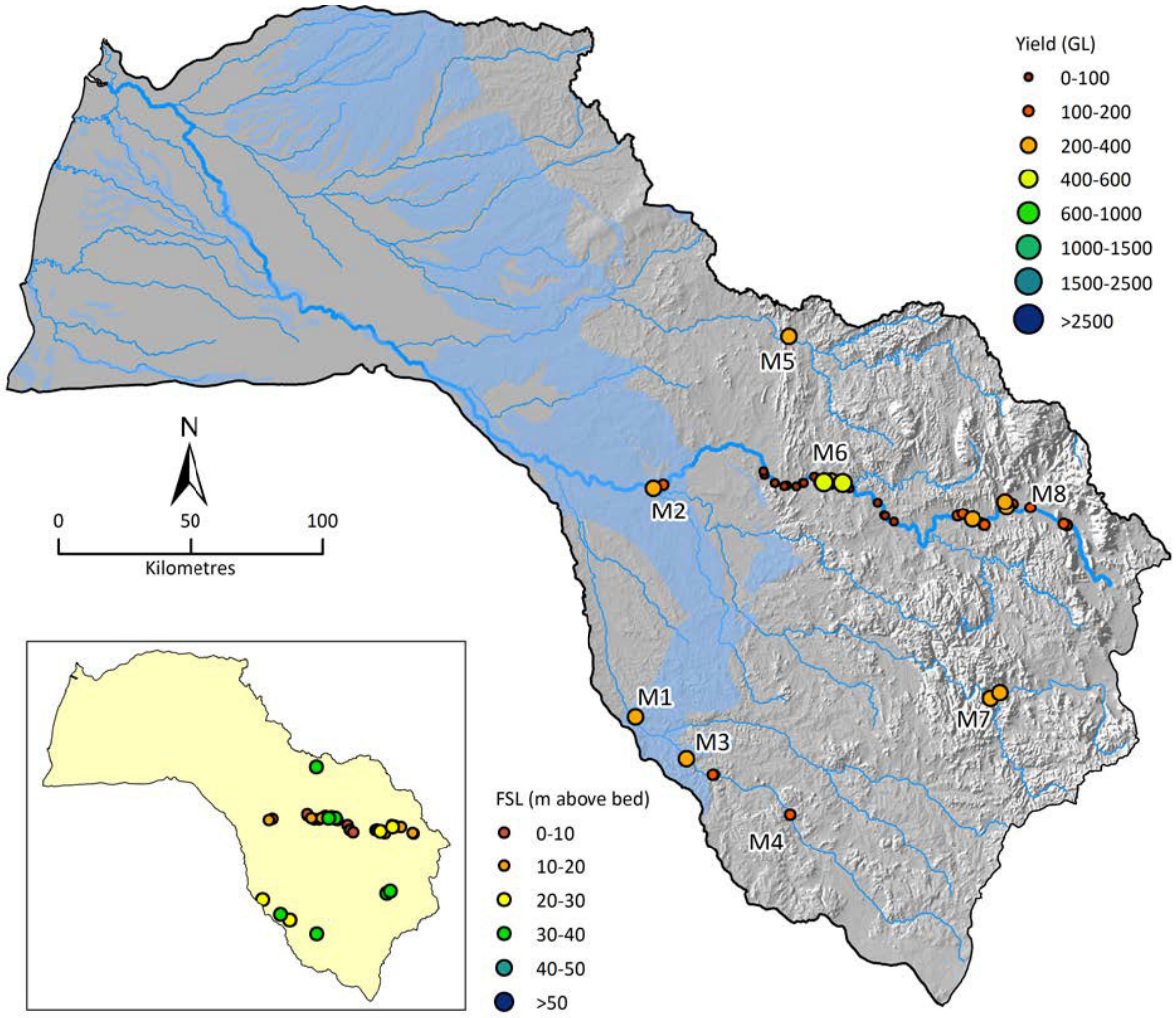

Figure 1. Preliminary information on potential new dam locations and their yields (at 85% annual time reliability) in the Mitchell Catchment from the early stages of CSIRO resource assessment of the catchment.

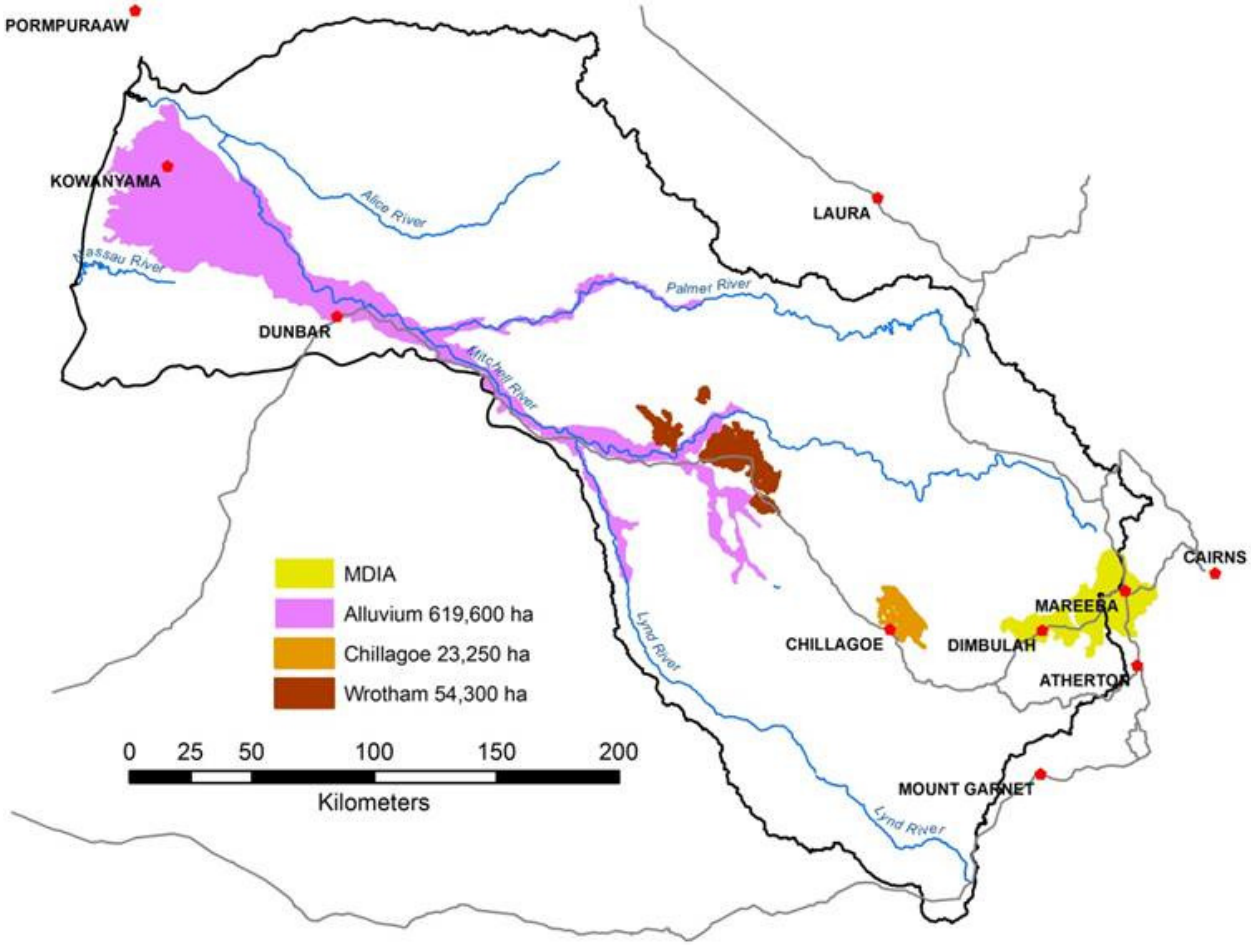

Figure 2. Preliminary information on the location of large contiguous areas of soils that could have potential for irrigated agriculture in the Mitchell Catchment from the early stages of CSIRO resource assessment of the catchment.

Table 2. Hydrological threats from potential future water resource development in the Mitchell River catchment.

Water Management Process	Hydrological Threat	Mitchell R just upstream of Rifle Ck confluence	Mitchell R just d/s Rifle Ck confluence	Mitchell R at Cooktown Crossing	Mitchell R at OK Bridge	Mitchell R at Gamboola	End of system flows (whole Mitchell R Basin outflows)	Mitchell R at Koolatah	Palmer R at Drumduff	Walsh R at Trimbles Crossing	Lynd R at Torwood	Rifle Ck at Fonthill	Mary Creek at Mary Farms	Mcleod River at Mulligan Hwy	Walsh River @ Nullinga	Walsh River @ Flatrock	Count
		na	na	919014A	919003A	919011A	na	919009A	919204A	919309A	919006A	919005A	919001 B/C	919013A	919 305B	919 311A	
1. Pumping from waterholes during spells without flow	a. Reduced waterhole persistence time (no flow)		x	x	x	x			x		x						6
	b. Reduced water quality as water level falls (no flow)		x	x	x	x			x		x						6
	c. Increased rate of water depth change (no flow)		x	x	x	x			x		x						6
	c. Increased rate of water depth change (no flow)		x	x	x	x			x		x						6
2. Flow harvesting (in-channel flows)	a. Increased frequency and duration of no-flow spells (no flow)			x		x		x	x								4
	b. Reduced frequency, duration and extent of hydrologic connectivity events (low and medium flows)			x		x		x	x								4
	c. Increased rate of recession (low and medium flows)			x		x		x	x								4
	d. Reduced frequency and duration of bankfull flow events (medium flows)			x		x		x	x								4
3. Flood harvesting	a. Reduced frequency, duration and extent of floodplain inundation and alluvial aquifer recharge (high flows)			x		x		x	x								4
	b. Impacts to water quality (rising salinity, exposure of acid sulphate soils in coastal alluvial floodplains) (high flows)			?		?		?	?								0
4. Pumping bed-sand hyporheic water during spells without	a. Reduced pool depth and persistence time (no flow)				x	x			x	x							4
	b. Increased rate of dry season hyporheic water depth reduction (no flow)				x	x			x	x							4
5. Dam operation	a. Seasonal reversal with un-natural dry season events created by demand-driven releases (no flows, low and medium flows)	x		x	x				x	x							6
	b. Increased rate of water depth change (low and medium flows)	x		x	x				x	x							6
	c. New barriers to movement of biota (low and medium flows)			x	x				x	x							5
	d. Reduced magnitude and duration of flow events (medium and high flows)	x		x	x				x	x							6
	e Converting intermittent reaches to perennial (no flows)									x							1
6. "Upside down dam' in bedsands	a. Loss of downstream flow of hyporheic water			x	x	x											3
	b. Increased hyporheic water level upstream			x	x	x											3
																	0
7 Overall take	a. Reduced end of system discharges to estuaries						x										1
TOTAL		**3**	**3**	**14**	**11**	**12**	**1**	**5**	**14**	**7**	**3**	**0**	**0**	**0**	**4**	**0**	

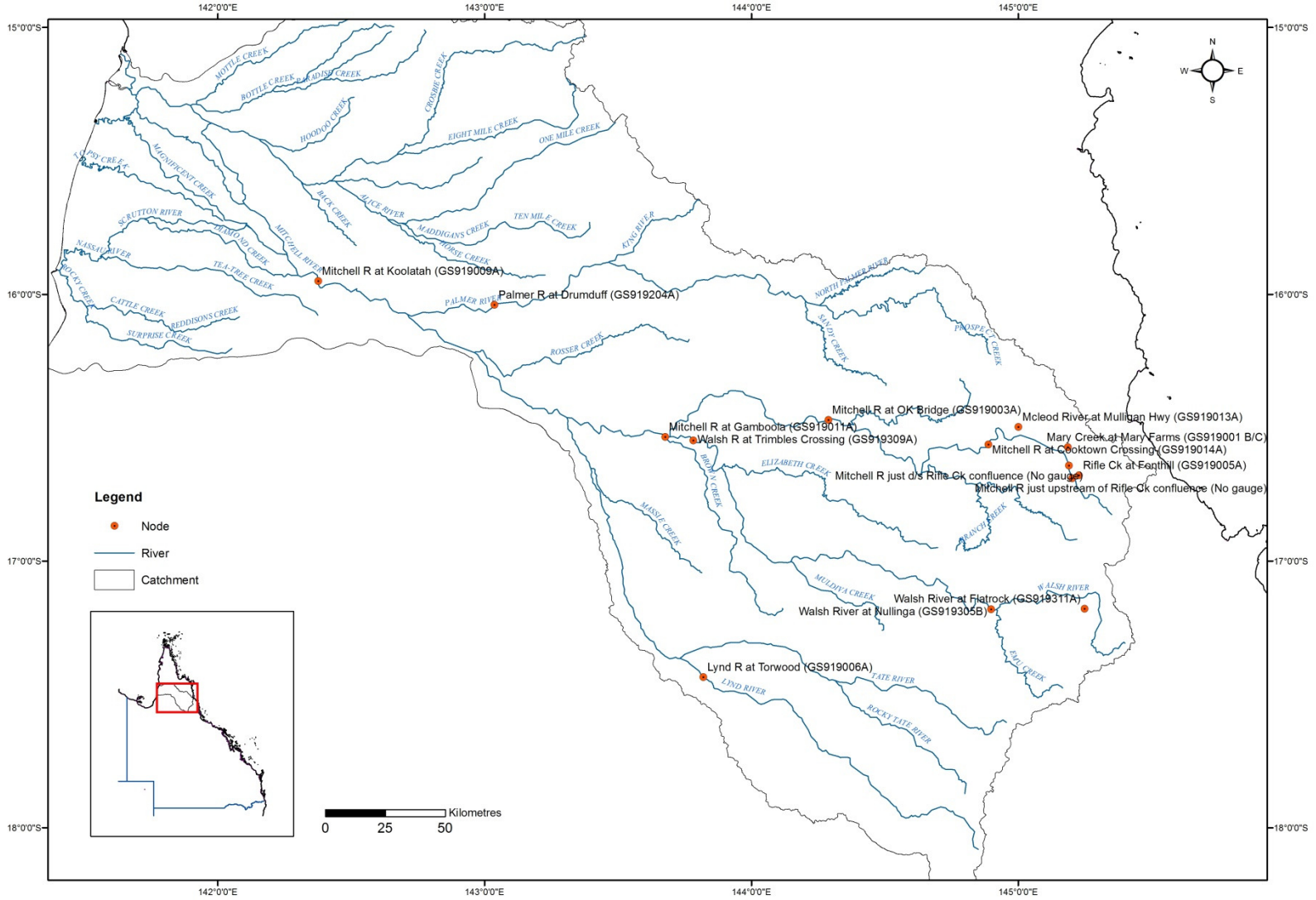

Figure 3. Locations of flow output nodes from the Mitchell and Barron IQQM models.

Results indicate that the two potential future threats with the greatest spatial extent are pumping from waterholes during spells without flow and dam operation. Locations with the greatest number of potential threats are the Palmer River at Dumdruff and the Mitchell River between Gamboola and Cooktown Crossing, including OK Bridge (Table 2, Figure 3).

Table 3. Potential ecological assets associated with dominant hydrological threats

Water Management Process	Hydrological Threat	Potential ecological assets
Pumping from waterholes during spells without flow	a. Reduced waterhole persistence time (no flow)	Waterhole refugia
	b. Reduced water quality as water level falls (no flow)	Waterhole refugia
	c. Increased rate of water depth change (no flow)	• Stable low-flow spawning fish • Primary production (turbid sites)
Dam operation	a. Seasonal reversal with un-natural dry season events created by demand-driven releases (no flows, low and medium flows)	• Flow spawning fish • Migratory fish • Riffle function
	b. Increased rate of water depth change (low and medium flows)	• Migratory fish • Riffle function
	c. New barriers to movement of biota (low and medium flows)	• Migratory fish
	d. Reduced magnitude and duration of flow events (medium and high flows)	• Migratory fish • Flow spawning fish • River forming processes

Ecological assets for the Mitchell WRP are not yet finalised but are under development by Queensland Department of Natural Resources and Mines (DNRM). The suggestions made here are informed by preliminary lists provided by DNRM and the assets that were recently used in the adjacent Flinders and Gilbert Rivers.

The locations of persistent waterholes in the catchment have been identified by satellite image analysis (Lymburner and Burrows, 2008), but scene selection in relation to hydrological conditions is not clear, meaning it is unclear if ‘persistent’ relates to length of period without flow. Furthermore, the analysis used a water mask that was not optimised for water identification at a scale relevant to small features like waterholes. At the same time the map of soil suitability (Figure 2) is highly preliminary. This suggests that further mapping is necessary to better resolve the spatial extent of this threat.

Hydrological threats associated with pumping from waterholes during spells without flow were considered to be reduced waterhole persistence time, reduced water quality as water levels and increased rate of water depth change. Potential ecological assets associated with these threats include the function of waterholes as dry season refugia and stable low-flow spawning fish

(Table 3). For turbid sites where light for primary production is limiting, increased rates of depth change may also impact primary production supporting dry season food-webs.

Dam operation could potentially result in several different threats (Table 2). Of these, the likely occurrence of converting intermittent reaches to permanent was limited and so is not considered further. All of the widespread potential threats from dam operation have possible impacts on migratory fish (Table 3); either by imposing barriers, generating false cues for movement or by truncating events leading to stranding. Other possible assets include flow spawning fish, with impacts to life history cues or access to required habitats, and river forming processes especially the provision of flows to transport sediments.

Threats related to groundwater extraction were also identified, but these are not associated with specific IQQM model nodes, and so are not included in Table 2. Groundwater dependent ecosystems were considered to be threatened in two ways: by lowering of the watertable; and by loss of surface expression of groundwater. Three (non-GAB) regions within the Mitchell catchment were identified where these threats could potentially manifest (Table 4). There has not been systematic mapping of GDEs within the catchment so understanding of their locations is based on the observations of local agency staff.

Table 4. Details of regions where groundwater extraction has potential to pose threats to dependent ecosystems

Region	Details
Top of the Lynd at Einasleigh Uplands, near Mount Garnet	• Unmanaged groundwater • Basalt plateau with springs • Limited soil suitability for agriculture • A few observation bores are present
Julatten area near Rifle Creek	• Unmanaged groundwater • Fertile soils present suitable for agriculture • Provides baseflow to upper Mitchell River • A few observation bores are present
Chillagoe Groundwater Management Area	• Managed groundwater with specific WRP outcomes • Used mainly for stock and domestic purposes • Managed to preserve ecological values

Research priorities

Research already underway by the Northern Australia Environmental Resources Hub (Northern Hub) of the National Environmental Science Programme (NESP) is targeting threats to floodplain inundation and associated primary and secondary productivity of the Mitchell River. This is associated with the threats identified here related to overall take and flood harvesting. Priorities for additional research should therefore target other hydrological threats.

Based on this assessment, it is recommended that additional ecological research to support future water planning decisions in the Mitchell catchment focus on hydrological threats associated with pumping from waterholes during spells without flow and dam operation upon the function of waterholes as dry season refugia and opportunities for movement for migratory fish. Riffle function may also be impacted by dam operation with consequences for passage by vagile biota and the provision of spawning and nursery habitat for some species. Priority locations for this research

should be the Palmer River near Dumdruff and the Mitchell River between Gamboola and Cooktown Crossing.

It is further recommended that mapping be undertaken of the locations and persistence of waterhole refugia and of GDEs in support of ecological research and WRP review. Waterhole refugia mapping should follow the approach utilised by Queensland Government in other parts of the state, which uses optimised water masks for application to Landsat image time series, coupled with scene selection informed by gauged hydrology and rainfall. GDE mapping should conform to the Queensland GDE mapping program methods so that products align with state needs and can be integrated with existing mapping in other parts of the state. This mapping is also now the basis for updating the National GDE Atlas for Queensland.

Finally, investigations should be made into the location, depth, hydrology and ecological dependencies of deep in-channel sand/gravel deposits that may be suitable for hyporheic ‘upside down’ dams.

References

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