Foundation Report Update 2020: Vegetation Diversity

Commonwealth Environmental Water Office (CEWO): Monitoring, Evaluation and Research Program

Australian Government
Commonwealth Environmental Water Office

FLOW Monitoring Evaluation Research

The Flow-MER Program

Flow-MER is the Commonwealth Environmental Water Office's (CEWO) on-ground Monitoring, Evaluation and Research Program. The Program's objective is to monitor and evaluate the delivery of Commonwealth environmental water in the Murray-Darling Basin. It provides the CEWO with evidence to inform our understanding of how water for the environment is helping maintain, protect, and restore the ecosystems and native species across the Murray-Darling Basin. This work will support environmental water managers, demonstrate outcomes, inform adaptive management, and fulfil the legislative requirements associated with managing Commonwealth owned environmental water.

The Flow-MER Program is being undertaken from 2019 to 2022 and is led by CSIRO in partnership with the University of Canberra, and collaborating with Charles Sturt University, Deakin University, University of New England, SARDI, Arthur Rylah Institute, NSW Department of Primary Industry, Australian River Restoration Centre and Brooks Ecology & Technology. The Program delivers to the Commonwealth Environmental Water Office, Department of Agriculture, Water and the Environment.

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Cover photograph

Nardoo growth at Yanga National Park, NSW during the 2010-2012 flood period.
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Foundation Report Update 2020

This report was prepared for the Commonwealth Environmental Water Office as part of the Flow-MER Program. It is to be read in conjunction with the published Basin Matter Foundation Reports 2019. The Report Updates outline key changes in the adopted Evaluation approach for the Flow-MER Program. Unless otherwise stated, the Evaluation is conducted as reported in the original Foundation Reports 2019.

Changes in approach have only been adopted where there have been significant advances in methodology and available data, or where unmonitored areas were not previously evaluated. In all other cases, the approach is intended to be consistent with the Evaluation conducted under the Long-Term Intervention Monitoring Project (LTIM).

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Abbreviations and acronyms

Abbreviation/acronym	Definition
ALA	Atlas of Living Australia
ANAE	Australian National Aquatic Ecosystem
CEWO	Commonwealth Environmental Water Office
EWKR	Environmental Water Knowledge and Research Project (2014-2019)
Flow-MER	The CEWO Monitoring, Evaluation and Research Program (2019-2022)
LTIM	Long-Term Intervention Monitoring Project (2015-2019)
MDB	Murray-Darling Basin
MER	Monitoring, Evaluation and Research Program (2019-2022)
NSW	New South Wales
OEH	Office of Environment and Heritage
TLM	The Living Murray

1 Introduction

The Commonwealth Environmental Water Office Monitoring Evaluation and Research Basin-scale Project (Flow-MER) builds on the evaluation process developed for the Long-Term Intervention Monitoring (LTIM) project. Foundation reports were produced under LTIM for six themes: (1) Hydrology; (2) Ecosystem Diversity; (3) Species Diversity; (4) Vegetation; (5) Fish; and (6) Stream Metabolism and Water Quality. The reports provide a summary of why these themes are used to evaluate the effectiveness of Commonwealth Environmental Water; the criteria used for evaluating short and long-term outcomes; the approach adopted in the evaluation; as well as any anticipated risks for the evaluation process.

The Foundation Report Updates 2020 have been produced under Flow-MER to report on any changes to the original Foundation Reports 2019 developed in LTIM. Updates are provided to reflect the focus on including unmonitored areas across the basin-scale evaluation, as well as advances in available methods and data. The Updates provide consistency with the Flow-MER Evaluation and Research Plan.

A summary of updates for the Vegetation theme is provided in Table 1.

Table 1 Summary of updates for the Vegetation theme Foundation Report Update 2020

Section	Updates
Learnings	New section detailing the lessons learnt from LTIM and EWKR and how these are being incorporated into the Flow-MER program
Why	Additional context in relation to: • Recognition of Australia's Indigenous population and their culturally significant relationship with plant species and vegetation communities • Basin-scale objectives for vegetation from the MDBA Basin Watering Strategy, including an explanation of the timing of the development of the Basin Watering Strategy objectives and the LTIM evaluation questions • Contextual framing with reference to relevant vegetation information in LTIM development documents such as the Logic and Rationale document (Gawne et al. 2013) and Cause and Effect diagrams (MDFRC 2013)
What	• Updated summary of sampling at each Selected Area • Inclusion of the Lower Murray Selected Area as part of the Vegetation Theme for the Flow-MER program
How	Updates to: • Data inputs • Analyses • Data products • Specific activities to be undertaken as part of the Flow-MER program • Integration
Risks	Updated risk section

2 Learnings from LTIM

The Flow-MER project builds on work undertaken as part of the Long-Term Intervention Monitoring (LTIM) project and the Murray-Darling Basin (MDB) Environmental Water Knowledge Research (EWKR) project. Key learnings from those projects have been incorporated into foundational and development tasks to be undertaken as part of the Flow-MER project and have informed our annual and cumulative evaluation approach.

A key learning from these past projects is that the Basin supports high plant and community diversity and non-woody vegetation responses are unique and heterogeneous. Variability in vegetation responses is due to differences in location; recent flow conditions (such as water depth, time-since-last inundation, proportion time wet); vegetation structure; and medium to long-term flow regimes. As responses are highly heterogeneous, trade-off decisions will be required between spatial and temporal scales. Watering large spatial areas is likely to increase Basin-scale diversity, while temporal (repeat) watering at a location is likely to increase site-specific resilience and condition. Other key learnings highlight the need to:

1. identify statistical approaches to tackle issues associated with different sampling methods;
2. identify species and functional groupings in order to
    a. simplify the response patterns from 600+ species
    b. identify species or groupings which may resonate with the broader public
    c. provide links to species-specific objectives in the Basin Watering Strategy (MDBA 2014);
3. define objectives and outcomes at different levels of ecological organisation (e.g. species, communities, mosaics of communities); and to
4. improve our understanding of good or improved condition through the development of benchmarks and links to function and value.

The Flow-MER project, through a combination of foundational and development tasks, annual evaluation, multi-year modelling and research, will address some of the needs highlighted above and will continue to build our knowledge base regarding vegetation responses to flow regimes to adaptively inform watering decisions.

3 Why

Australia's floodplains, wetlands and riverine ecosystems are characterised by unique, diverse and often iconic vegetation. From ancient red gum forests fringing wide lazy rivers to sedges and grasses emerging from open wetlands, vegetation shapes our landscapes and provides a range of ecological, cultural and economic services.

The vegetation that is found along rivers, floodplains and wetlands provides food and habitat for a wide variety of species, often within otherwise dry landscapes. It also provides organic matter to rivers, contributing important basal resources to biota and many ecosystem processes.

For tens of thousands of years, Australia's Indigenous people used the incredible diversity of floodplain and wetland plants to provide themselves with food, shelter, fibre and medicines. We see echoes of their presence in the scar trees that dot the banks of our inland rivers. European settlers were similarly drawn to rivers, floodplains and wetlands for the resources they provided.

The combination of land-clearing, grazing and water use have fundamentally changed the nature and condition of vegetation across rivers, floodplains and wetlands of the Basin. There has been widespread loss of vegetation and what remains is often in poor condition. For the period 2008 - 2010, the Sustainable Rivers Audit assessed the condition of the riverine vegetation as very poor to moderate across the majority of regulated rivers in the Murray-Darling Basin (MDBA 2012). In contrast, many unregulated rivers were assessed as being in better condition. One of the main causes of decline has been changes to the frequency, duration and timing of water received by a wide variety of vegetation communities.

Environmental water is used throughout the Murray-Darling Basin to support diversity and condition of vegetation – both woody (trees) and non-woody (groundcover) vegetation, including a wide range of shrubs from tangled lignum to floating ferns such as azolla. The Basin Watering Strategy (MDBA 2014) expects that environmental water will be used to 'maintain the extent and to improve the condition of water dependent vegetation on the parts of the floodplain that can be actively managed'. Outcomes for vegetation defined within the Basin Watering Strategy (MDBA 2014) are framed within the context of specific vegetation structural groups (forests and woodlands, shrublands and non-woody vegetation, Box 1).

At the time the initial LTIM program was established, the Basin Watering Strategy was still under development. The LTIM program thus used the objectives of the Murray-Darling Basin Plan to develop a suite of expected outcomes for vegetation (Gawne et al. 2013) based on the scientific understanding of flow and ecological responses at the time (MDFRC 2013). Gawne et al. (2013) and MDFRC (2013) established the priorities for monitoring for the LTIM program, which are continued as part of Flow-MER. The expected outcomes for vegetation were nested within objectives for Biodiversity within the Basin Plan (Basin Plan Section 8.05) and were focussed on the use of environmental water to support vegetation diversity within the Basin. Further, at the time of LTIM program establishment, it was assumed that outcomes for forests, woodlands, and shrublands would be evaluated through other MDBA and state programs. Thus, the Basin Scale Vegetation Theme focus is to evaluate the outcomes from using environmental water to support the diversity of non-woody vegetation. This remains the focus of the Basin Scale Vegetation Theme evaluation for the Flow-MER program.

Box 1. Expected Basin Watering Strategy outcomes for Basin vegetation groups (MDBA 2014)

FORESTS AND WOODLANDS. The expected outcomes for forests and woodlands in the Basin are:

- to maintain the current extent of forest and woodland vegetation including approximately [1]:
  - – 360,000 ha of river red gum
  - – 409,000 ha of black box
  - – 310,000 ha of coolibah
- no decline in the condition of river red gum, black box and coolibah across the Basin [2]
- by 2024, improved condition of river red gum in the Lachlan, Murrumbidgee, Lower Darling, Murray, Goulburn–Broken and Wimmera–Avoca
- by 2024, improved recruitment of trees within river red gum, black box and coolibah communities—in the long term achieving a greater range of tree ages. (River red gum, black box and coolibah communities are presently primarily older trees; which places them at risk.)

SHRUBLANDS. The outcomes expected for shrubland vegetation are:

- to maintain the current extent of extensive lignum shrubland areas within the Basin
- by 2024, improvement in the condition of lignum shrublands.

These outcomes apply to lignum communities across the following regions (at a minimum): Lower Lachlan, Lower Murrumbidgee, Lower Darling, Lower Condamine–Balonne (including Narran Lakes), Lower Gwydir, Macquarie Marshes, Lower Border Rivers and the River Murray from the junction of Wakool River to downstream of Lock 3 (including Chowilla and Hattah Lakes).

There are not enough data to measure areas of lignum at a Basin scale. However, information is available at a regional scale and Basin states are encouraged to quantify this vegetation type within their catchments.

NON-WOODY VEGETATION. The outcomes for non-woody vegetation are:

- to maintain the current extent of non-woody vegetation
- by 2024, increased periods of growth for communities that:
  - – closely fringe or occur within the main river corridors
  - – form extensive stands within wetlands and low-lying floodplains including Moira grasslands in Barmah–Millewa Forest; common reed and cumbungi in the Great Cumbung Swamp and Macquarie Marshes; water couch on the floodplains of the Macquarie Marshes and Gwydir Rivers; and marsh club-rush sedgelands in the Gwydir
- a sustained and adequate population of Ruppia tuberosa in the south lagoon of the Coorong, including:
  - – by 2019, *R. tuberosa* to occur in at least 80% of sites across at least a 50 km extent
  - – by 2029, the seed bank to be sufficient for the population to be resilient to major disturbances [3].

[1] The areas specified for river red gum, black box and coolibah are within a range of plus or minus 10%.

[2] Limitations in the data available in many areas of the Basin, particularly in the north, mean that it is not yet possible to specify the current condition of river red gum, black box and coolibah. As additional data become available

it will be possible to accurately calculate the condition at 2014 and to describe the expected outcomes for these species across the Basin.

[3] Advice suggests that this would require at least 10,000 seeds/m^2 within the bed of the core population of R. tuberosa.

4 What

The evaluation questions and approach will remain broadly similar to that outlined in Capon et al. (2018). Data collected by monitoring and evaluation teams at the Selected Areas will be collated and analysed by the Basin Vegetation team to evaluate the effects of Commonwealth environmental water on the diversity of plants and vegetation communities with respect to:

1. *species level responses:* responses to environmental water of individual plant species across Selected Areas including changes to species presence, distribution and abundance;
2. *community level responses:* responses to environmental water of particular vegetation communities within specific habitat types (e.g. ANAE vegetation types) across Selected Areas including changes in species richness, composition and structure; and
3. *landscape level responses:* responses to environmental water of vegetation communities across the Selected Areas including changes in the presence, distribution and diversity of particular vegetation communities.

Both annual evaluation and longer-term evaluation (using LTIM data from 2014) will be conducted. Evaluation data will continue to be collected from the same Selected Areas with the addition of data collected from the Lower Murray Selected Area. A summary of vegetation diversity sampling at Selected Areas is presented in Table 2. Outcomes from analysing these data sets will be used to infer responses at unmonitored locations.

Table 2 Summary of vegetation diversity and vegetation community structure data to be collected at each Selected Area as part of the Flow-MER project

Selected Area		SAMPLING DESIGN						VEGETATION DIVERSITY METRICS		COMMUNITY STRUCTURE METRICS					
	Veg type[1]	Timing of sampling	# Zones [2]	# Sites per zone	# Quadrats /Transects per site	Quadrat / Transect description	Sampling unit description	% Cover by species	# Tree seedlings/saplings 3 classes (20-50cm; 50-130cm; 1.3-3m)	% Canopy cover (>5 m tall)	% Understorey cover (1-5 m tall)	% Groundcover (<1 m tall)	% Litter cover	% Wood cover	% Bare ground
Riverbank Selected Areas															
Edward/ Kolety-Wakool	Rb	bi-monthly between Sept & Mar (monthly for non-id metrics)	4	5	1	transects perpendicular to channel, sampling from 5 permanent markers along 25m transects parallel to water, points every 50 cm along	% cover values calculated for each elevation on each transect (point-intercept method)	✓		✓	✓	✓	✓	✓	✓
Goulburn	Rb	before & after Oct Spring Fresh	1	4	16	transects perpendicular to channel, sampling every 1m along 2m lengths, points every 10cm. (point-intercept method)	% cover values calculated for each elevation on each transect (point-intercept method)	✓	✓ (in 3 1m x 1m quadrats at top, middle and bottom of bank)	✓	✓	✓	✓	✓	✓
Lower Murray	Rb														
Wetland and floodplain Selected Areas															
Gwydir	Fr	before & after CEW (Aug/Oct & Mar/Apr)	1	1	2	transects with observations recorded every 1m	% cover values for each 1m x 1m quadrat	✓	✓			✓			✓
Gwydir	Fl	before & after CEW (Aug/Oct and Mar/Apr)	2	13	3	0.04ha plots nested within 0.1ha plots	% cover values for 0.04ha plot (N.B. Canopy cover recorded for 0.1ha plot)	✓	✓	✓	✓	✓	✓	Length of fallen timber >10 cm	✓

Selected Area		SAMPLING DESIGN						VEGETATION DIVERSITY METRICS		COMMUNITY STRUCTURE METRICS					
	Veg type[1]	Timing of sampling	# Zones [2]	# Sites per zone	# Quadrats /Transects per site	Quadrat / Transect description	Sampling unit description	% Cover by species	# Tree seedlings/saplings 3 classes (20-50cm; 50-130cm; 1.3-3m)	% Canopy cover (>5 m tall)	% Understorey cover (1-5 m tall)	% Groundcover (<1 m tall)	% Litter cover	% Wood cover	% Bare ground
Lachlan	Fr	before & after CEW (Mar/April and 3 months after 1st fill)	5	1-4	2-3	100m transects with observations recorded every 1m	% cover values for each 1m x 1m quadrat	✓					✓	Length of fallen timber >10 cm	✓
Lachlan	Fl		5	2-5	2-4	0.04ha plots nested within 0.1ha plots	% cover values for 0.04ha plot (N.B. Canopy cover recorded for 0.1ha plot)	✓	✓	✓	✓	✓	✓	✓	✓
Murrum-bidgee	Fl		3	4	2-3	1 x 10m quadrats	% cover values for each 10m quadrat	✓	✓	✓	✓	✓	✓	✓	✓
Warrego-Darling	Fl	before & after CEW (Aug/Oct & Mar/Jun)	1	8	3	0.04ha (20m x 20m) quadrats	% cover values for 0.04ha quadrat	✓	✓	✓	✓	✓	✓	✓	✓

5 How

5.1 Vegetation data

Monitoring of vegetation diversity occurs across all Selected Areas using area specific methods (Category II methods, (Hale et al. 2013). Data are collected from a range of fixed wetland, floodplain and riverine sites, at multiple times throughout the year (at a minimum twice per year). There is variation in the methods used to collect the data across the Selected Areas because each area has tailored their approach to address Selected Area evaluation questions.

The data collected includes records of species (presence, cover and height) and measures of vegetation structure (canopy cover, litter cover, bare ground) (see also Table 2).

Unlike Capon et al. (2018), we do not expect to complement the vegetation data collected by the Selected Area teams with data sets such as those collected under previous monitoring programs. During the LTIM Basin Evaluation, it was found that the data from other monitoring programs were not easily comparable, nor was time available to manage the additional data sets and transform them into a useable format.

5.2 Hydrological metrics

Site scale hydrological metrics are collected across all Selected Areas using a range of methods that vary in spatial and temporal resolution. These include antecedent inundation conditions as well as metrics relevant at the time of sampling (water depth and soil moisture). Where possible, data will be leveraged from the Flow-MER Basin scale hydrology work as it progresses.

5.3 Other variables

Weather conditions and land management activities that are likely to affect vegetation diversity responses to the provision of water, will be used to supplement the hydrology data and contribute to understanding vegetation responses to environmental water.

5.4 Analyses

Evaluation at a Basin scale will adopt a combination of aggregated area scale evaluation and Basin-wide evaluation considering annual and multi-year evaluation and is based on the approaches of Capon et al. (2018). It is expected that as the length of the temporal data set increases, so will our capacity to evaluate outcomes. The original framing for the LTIM project (Gawne et al. 2013) expected that outcomes for vegetation diversity would become apparent at a time scale of greater than 10 years (Figure 1).

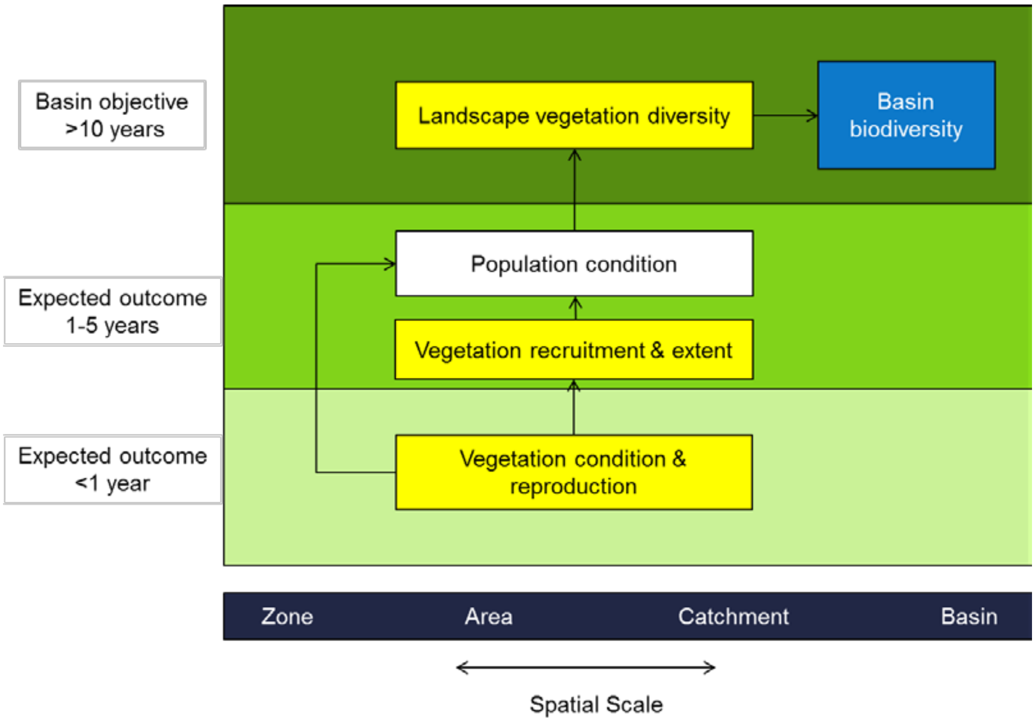

Figure 1 An illustration of the spatial and temporal relationships between elements of the vegetation objectives hierarchy. The yellow boxes represent aspects of the Level 3 vegetation objective for which cause-effect diagrams have been developed. From Gawne et al. (2013)

Evaluation will be based on the following analyses, which largely follows that described in Capon et al. (2018):

Aggregated Area scale, annual evaluation.

Species presence/absence data from Selected Areas will be analysed to identify vegetation outcomes (changes in species distribution, presence and abundance) to watering actions by comparing observed outcomes to outcomes predicted to occur in the absence of environmental flow. The predicted counterfactual (absence of environmental flow), will draw on information provided by the hydrology theme (annual extent of CEW inundation) and Selected Area knowledge (likelihood of inundation in the absence of CEW). In contrast to Capon et al. (2018), the aggregated area scale annual evaluation will focus less on responses within and between individual Selected Areas (given the LTIM findings of high heterogeneity) and more on aggregate learning through the comparison of similar watering objectives in broad habitat types (e.g. river bank, wetland and floodplain) and ANAE vegetation types. Expanding on the methods in Capon et al. (2018), the presence/absence of regionally relevant target species, species from particular functional/classification groups and culturally significant species, will be analysed in relation to Commonwealth environmental water.

Basin-scale, annual evaluation.

For unmonitored sites, likely outcomes of annual water actions will be based on species and communities that have received water across the Basin (e.g. proportion of particular ANAE vegetation types across the Basin that received environmental water). If generalised responses (such as increases or decreases in the number of species in an area or cover of particular species of interest) are apparent from the aggregated area scale evaluation, these will be used to infer specific responses at unmonitored sites. This aspect of the evaluation will have close collaboration with the Ecosystem Diversity theme. Unlike Capon et al. (2018), for Basin-scale evaluation we do not expect to complement the vegetation data collected by the Selected Area teams with other data sets. Additional to Capon et al. (2018), the coincidence of Basin-wide annual watering actions with the occurrence of example species of Basin-wide cultural significance, will be determined to establish the likely benefit of Basin-wide environmental watering.

Aggregated Area scale, Cumulative evaluation.

For Selected Areas, this will assess the cumulative outcomes from water actions over the relevant time-frame. Models are being developed that may be able to identify the influence of antecedent conditions, in which case counterfactual scenario(s) will include consideration of the annual outcome without antecedent water actions. It is likely that this will be able to be implemented later in the MER program.

Basin scale, Cumulative evaluation.

This assessment will build on the annual Basin-scale evaluation and area scale cumulative evaluations, to describe the likely cumulative outcomes of water actions compared with counterfactual scenario(s).

Vegetation theme evaluation will be supported by outcomes from Ecosystem Diversity, Hydrology, Modelling and Visualisation themes.

5.5 Data products

Data products will include:

1. Combined data set of groundcover wetland vegetation
2. Map of the vegetation community types that received Commonwealth environmental water
3. List/map of groundcover vegetation species from Selected Area data sets that have responded to Commonwealth environmental water
4. List/map of example culturally significant species from Selected Area data sets that have responded to Commonwealth environmental water. This aspect is an addition to Capon et al. (2018)

5.6 Activities

The activities described below have been added (Foundational and development activities) or updated (Annual Evaluation, Communication and collaboration) for the Flow-MER project. Evaluation of vegetation diversity as part of Flow-MER involves three activity streams. The first includes a series of foundational and development tasks that will enable the Basin-scale evaluation of groundcover vegetation diversity responses to environmental water. Second, is the annual evaluation which occurs in 2020/21 and 2021/22 using the combined LTIM and Flow-MER data. Third is a series of communication and collaboration tasks.

Foundational and development activities

There are four tasks that provide the foundation for the on-going evaluation. These will commence during year 1, and will be refined during evaluation in years 2 and 3. The tasks are:

D1. Development of appropriate statistical techniques for combining data sets that are collected at different degrees of sampling intensity.

Groundcover data collected by each of the Selected Areas has been collected with differing sampling intensity and thus, current evaluation approaches are confined to an analysis of presence/absence data. Techniques will be investigated to enable the evaluation of species cover responses to environmental water.

D2. Development of predictive tool(s) to support Basin-scale evaluation.

The LTIM Basin Matter team are expecting to invest in the development of Bayesian models to support Basin-scale evaluation of vegetation diversity outcomes in year 5 (see Capon et al. 2018). There is an opportunity for strategic collaboration between modellers from the two evaluation teams as the models are developed to ensure that the Flow-MER modelling team has a strong understanding of modelling approaches being developed and to maximise the capacity to use them in on-going evaluation.

D3. Review of functional group classification approaches

Numerous approaches exist to classify groundcover vegetation into functional groups and debate exists as to the relative usefulness in environmental water planning and evaluation. A review is needed to underpin the selection of the appropriate classification approach to be used in evaluating the use of environmental water for groundcover vegetation outcomes.

D4. Selection and mapping of Basin-wide culturally significant species

The selection of species of Basin-wide cultural significance will involve liaison with Selected Area teams to define a candidate species list and advice from Brad Moggridge as to the example species used in analysis. Current spatial data (such as the ALA, TLM, EWKR, LTIM data sets and State-based monitoring programs – e.g. NSW OEH) will be used to develop occurrence maps of key species used for evaluation.

Annual evaluation

Evaluation will be undertaken in years 2 and 3 of the Flow-MER project using data from both the LTIM program and data collected in years 1 and 2 of the Flow-MER project. Evaluation involves two main tasks:

E1. Compilation and review of data and Selected Area reports

During the LTIM program, considerable effort has been invested in ensuring the combined vegetation data set is clean and free of errors. This is expected to be an on-going task, which requires less time as the data set is continually improved. Once the combined (both the annual data and the long-term data set) data set is finalised, the data will be summarised, visualised and mapped.

Selected Area reports will be interrogated to determine key messages that occur across the Basin to help support both annual and long-term evaluation.

E2. Analysis and evaluation

Analysis to support the evaluation at the Basin-scale involves a combination of aggregated area scale evaluation and Basin-wide evaluation as described in the analysis section above.

Communication and collaboration

C1. Reporting

The main mechanism by which the evaluation will be communicated to the CEWO, the Selected teams and other scientists and water managers is the annual evaluation report for the Vegetation Theme. This will involve a technical report as well as a plain English summary report produced in years 2 and 3.

C2. Stories

In addition to the technical report, the Vegetation Theme will provide the Basin-scale Communication and Engagement theme with a story highlighting the key findings of the Basin Scale vegetation evaluation in years 2 and 3.

C3. Collaborative activities

It is expected that the Basin-scale evaluation team will attend the annual Flow-MER forum, a theme-based workshop (see integration with Selected Areas below) and an annual Basin-scale meeting. In addition, it is expected that the team will work with Brad Moggridge to develop culturally relevant reporting for vegetation outcomes based on our evaluation of response of culturally significant species to watering. It is expected that at least one member of the team will be required to attend a further collaboration meeting during each year.

5.7 Integration

Links to other Basin Matters were identified in Capon et al. (2018) and are expanded more explicitly here.

With Selected Areas

Basin-scale evaluation is reliant on data collected from Selected Areas. There is considerable expertise within Selected Areas in relation to vegetation responses to water. We propose to work collaboratively with Selected Areas to share ideas and approaches. At a minimum, an annual workshop will be held to progress areas of mutual interest to the Basin and Selected Area evaluation. This will initially include progression of the development of conceptual models of wetland vegetation responses to inundation, within a framework of hydrological predictability. Subsequent workshops may address functional traits for use in predictive modelling.

We will also work collaboratively with Selected Area vegetation leads to ensure key messages raised in Selected Area reports are synthesised and highlighted in Basin-scale reporting. Particular emphasis will be given to messages that are consistent between Selected Areas and/or habitat types (e.g. impacts of grazing, invasive species, seasonal timing of freshes etc.).

To inform Whole of Basin Scale Evaluation

Basin-scale evaluation will require broad scale inundation data from the Basin Hydrology Theme as well as mapping of ANAE classes across the Basin. It is expected that the coincidence of inundation and ANAE classes will be a joint output from the Hydrology Theme, the Ecosystem Diversity Theme and the Vegetation Theme.

The diversity of floodplain and wetland plants are critical to numerous supporting and regulating functions for a range of biota which are also targeted by Commonwealth environmental water. Thus, the vegetation diversity analysis will involve collaboration with:

1. the Ecosystem Diversity Theme – providing information that may inform the interpretation of Basin wide responses by other biota
2. the Food Web Theme – providing information about potentially relevant drivers of carbon inputs to streams and wetlands.

6 Risks

The main risks associated with the Basin-scale evaluation of vegetation diversity concern dependencies on organisational and staff capability and the timing and availability of data. A detailed breakdown of risks, including control measures, is available in the Flow-MER Basin Scale Vegetation Theme Operational Plan (Doody et al. 2020) and in Table 3 below.

Table 3 Risk assessment for the Evaluation component of the Flow-MER Vegetation theme

ASSESS the risks of the activities					
CONSEQUENCE (credible risk)		**LIKELIHOOD**		**RISK SCORE**	
Significant	Fatality, permanent/severe impairment Whole site/significant multiple equipment damage Long term damage from toxic pollutants Significant legal breach, loss of licences	Almost Certain	> 90% chance of the risk occurring or Has occurred in the last year or is expected to occur in the next year	Severe	Authorisation by **Senior Manager** to proceed
Major	Permanent/major impairment Whole building/major multiple equipment damage Prolonged damage from toxic pollutants Major legal breach, loss of one licence	Likely	60-90% chance of the risk occurring or Has occurred in the last 2 years or is expected to occur in the next 2 years	Very High	Authorisation by **Senior Manager** to proceed
Moderate	Reversible medium term impairment Partial building/moderate multiple equipment damage	Possible	40-60% chance of the risk occurring or Has occurred in the last 3 years or is expected to occur in the next 3 years	High	Authorisation by Line Manager to proceed

IMPACT

LIKELIHOOD	CONSEQUENCE				
	Sig	Maj	Mod	Min	Negl
Almost Certain	S	VH	VH	H	H
Likely	VH	VH	H	H	M
Possible	VH	H	H	M	L
Unlikely	H	H	M	L	L
Rare	H	M	L	L	L

	Short term damage from toxic pollutants Moderate legal breach, non-compliance
Minor	Reversible short term impairment Moderate single/minor multiple equipment damage Transient damage from toxic pollutants Minor legal breach, no sanctions
Negligible	No impairment, injury or illness Temporary restriction to single piece equipment Transient damage, no external report Minor legal failing with no breach

Unlikely	10-40% chance of the risk occurring or Has occurred in the last 4 years or is expected to occur in the next 4 years
Rare	<10% chance of the risk occurring or Has occurred in the last 5 years or is expected to occur in the next 5 years

Medium	Authorisation by Line Manage to proceed
Low	Proceed and monitor

CHOOSE the most appropriate and most effective risk controls for the activities											
HAZARD	CREDIBLE RISK Interaction with people/property/ environment/other hazards	C	INHERENT RISK		CONTROLS: Effective, tangible, measurable Level 1: Eliminate Level 2: Engineer, Substitute Level 3: Admin, PPE	C	RESIDUAL RISK		ADDITIONAL CONTROLS TO BE IMPLEMENTED	BY WHOM	BY WHEN
			L	IR			L	RR			
Evaluation **1. Capability**	**Project: Personnel illness, departure** Delays in project outcomes related to unavoidable personnel dependencies such as illness, change of role, change jobs etc	Significant	Possible	Very High	**Existing:** • Evaluation Team to check-in with each other regularly • Notify of significant changes as soon as possible	Major	Possible	High	• Monitor existing controls.	Fiona Dyer	Continuous

CHOOSE the most appropriate and most effective risk controls for the activities											
HAZARD	**CREDIBLE RISK** **Interaction with people/property/ environment/other hazards**	C	**INHERENT RISK**		**CONTROLS: Effective, tangible, measurable** **Level 1**: Eliminate	C	**RESIDUAL RISK**		**ADDITIONAL CONTROLS TO BE IMPLEMENTED**	**BY WHOM**	**BY WHEN**
			L	IR	**Level 2:** Engineer, Substitute **Level 3:** Admin, PPE		L	RR			
2. Capability	**Project: Dependent on Selected Area for data** The evaluation is contingent on the timely provision of data from the Selected Areas via the CEWO.	Significant	Possible	Very High	**Existing:** • Evaluation team to liaise regularly with data management team • Notify significant delays as soon as possible	Moderate	Unlikely	Medium	• Monitor existing controls.	Fiona Dyer	Continuous
3. Capability	**Project: COVID-19 impacts** COVID-19 has implications for evaluation in terms of: • Ability of Selected Area teams to collect field data (see risk #2) • Ability to meet face-to-face with evaluation team members and Selected Area vegetation leads	Major	Possible	High	**Existing:** • Evaluation team to liaise regularly with Selected Area vegetation leads • Notify significant delays or inability to collect data as soon as possible • Move face-to-face meetings to online platforms				• Monitor existing controls	Fiona Dyer	Continuous
4. Capability	**Project: Psychosocial Hazards** Physiological and physical well-being when working across and within teams including bullying and harassment.	Significant	Possible	Very High	**Existing:** • Be proactive in speaking up when there is a problem. There are 3 Project Leaders which can be contacted for advice • Refer to relevant organisations intervention counselling • Check-in with each other regularly • Ensure not sole individual in the team that can access data	Moderate	Possible	Medium	• Monitor existing controls	Fiona Dyer	Continuous

CHOOSE the most appropriate and most effective risk controls for the activities											
HAZARD	**CREDIBLE RISK** **Interaction with people/property/ environment/other hazards**	C	**INHERENT RISK**		**CONTROLS: Effective, tangible, measurable** **Level 1**: Eliminate	C	**RESIDUAL RISK**		**ADDITIONAL CONTROLS TO BE IMPLEMENTED**	**BY WHOM**	**BY WHEN**
			L	IR	**Level 2:** Engineer, Substitute **Level 3:** Admin, PPE		L	RR			
5. Operational risk	**Project: Red Tape in accessing external data** Difficulty accessing data in a timely fashion due to red tape	Major	Possible	High	**Existing:** • List and begin access process as soon as possible • Engage data team to assist or facilitate • Seek alternatives to reduce project impacts	Moderate	Unlikely	Medium	• Monitor existing controls	Fiona Dyer	Continuous
6. Communications risk	**Project: Results or public communication is taken out of context** There could be a risk of 'bad media' related to the project if results or data are taken out of context	Major	Possible	High	**Existing:** • Ensure media is approved by relevant parties before release (i.e. CSIRO Comms, Flow MER Comms and management team) • Do not comment on policy • Consider implications of use of Twitter/FaceBook in relation to the project • Manuscripts and reports must follow appropriate approval process	Moderate	Unlikely	Medium	• Monitor existing controls	Fiona Dyer	Continuous

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