
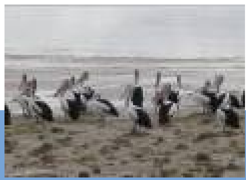



River Murray - Darling to Sea Ecological Community: Criteria/Condition Thresholds Workshop Report

Threatened Species Scientific Committee
19 April, 2010
Adelaide

Image Credits: Lake Albert (G. Newton) Pelicans (G. Newton) River Murray Gorge (K. Walker) Wetlands (SA MDB NRM Board) Murray Mouth (K. Walker)

Threatened Species Scientific Committee

The establishment of the Threatened Species Scientific Committee is provided for under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC Act also sets out the functions of the Committee. These include advising the Commonwealth Environment Minister on the amendment and updating of lists for threatened species, threatened ecological communities, and key threatening processes, together with the making or adoption of recovery plans and threat abatement plans.

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Disclaimer

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Executive Summary

An expert Technical Workshop was held by the Threatened Species Scientific Committee (TSSC) in July 2009 to deliberate on the *Lower Murray River and associated wetlands, floodplains and groundwater systems from the junction of the Darling River to the Sea* (here after River Murray – Darling to Sea). This nomination, placed on the 2008 Final Priority Assessment List, is being assessed under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) as a potentially threatened ecological community. Outcomes from the Technical Workshop provided information and guidance on the description, boundaries, key characteristics, and suitability of listing criteria for this complex aquatic ecosystem.

The Technical Workshop was unable to focus on the consideration of thresholds for both the listing criteria used to assess ecological communities under the EPBC Act and potential ecological community condition states (or classes). Criteria thresholds enable the assignment of conservation status (i.e. vulnerable, endangered, critically endangered). Condition thresholds enable determination of degraded components of the ecological community (previously, for some terrestrial ECs, severely degraded parts have been excluded from listing protection under the Act). The Criteria/Condition Thresholds Workshop addressed this important gap and examined the suitability and applicability of these two types of thresholds for aquatic ecosystems using the River Murray – Darling to Sea ecological community as a test case. Information gained from this workshop will be used to guide the assessment process for this priority aquatic ecological community.

A vital aspect of the assessment process of an ecological community is the assessment and interpretation of 'listing criteria' as set out in the EPBC Regulations, which each specify indicative thresholds against the various conservation categories (i.e. vulnerable, endangered, critically endangered). The TSSC have adapted the criteria and provided additional interpretive explanation for their application to ecological communities (see *Guidelines*). Outcomes of the Thresholds Workshop highlighted the challenges associated with assessing aquatic ecological communities when applying the regulated criteria and their thresholds. While there were no recommendations to amend the criteria thresholds, it was clear that the interpretation of the criteria thresholds should be undertaken on a 'case-by-case' basis for aquatic ecological communities. In some cases they apply, in others they do not, and in yet others additional considerations need taking into account, such as meaningful timeframes, connectivity factors, etc.

The importance of ecological function appears more relevant than physical area for aquatic ecological communities, and therefore Criteria 4 seems the most effective for assessment for the River Murray – Darling to Sea, with Criteria 3 and 5 also highly relevant. The possibility for unpredictable and sudden or 'step' change in aquatic systems, rather than gradual or linear change also needs consideration when interpreting the criteria thresholds. Regarding probability of extinction, for ecological communities the concept of 'functional extinction' is more relevant (i.e. as compared to species extinction).

The River Murray – Darling to Sea ecological community is a highly dynamic and highly connected system. The workshop agreed that a number of states (or conditions) and associated indicators could be identified for the system as a whole and for its various sub-units – with 'state' often forming a series of continua. However, the consensus view was that condition thresholds were in general not practical for this type of aquatic ecological community. The inherent resilience and capacity for 'functional' recovery added further weight to the approach of not excluding degraded components of the ecological community. However, it was acknowledged that there is the potential for the ecological community to irreversibly change state so that it becomes compositionally, and even functionally, different but would still constitute the 'ecological community'.

Workshop Objectives and Methods

Background and Purpose

An expert Technical Workshop was held by the Threatened Species Scientific Committee (TSSC) in July 2009 to deliberate on the *Lower Murray River and associated wetlands, floodplains and groundwater systems from the junction of the Darling River to the Sea* (here after River Murray – Darling to Sea)*.* This nomination, placed on the 2008 Final Priority Assessment List, is being assessed under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) as a potentially threatened ecological community (EC). Outcomes from the Technical Workshop provided information and guidance on the description, boundaries, key characteristics, and suitability of listing criteria for this complex aquatic ecosystem. The Technical Workshop report is available at http://www.environment.gov.au/biodiversity/threatened/publications/workshop-river-murray.html.

Six 'listing' criteria are used to assess potential threatened ecological communities under the EPBC Act. Due to time constraints, the Technical Workshop was unable to focus on the more detailed aspect of thresholds for both the listing criteria and potential ecological community condition states (or classes). Criteria thresholds enable the assignment of conservation status (i.e. vulnerable, endangered, critically endangered). Condition Class thresholds enable determination of degraded components of the EC (previously, for some terrestrial ECs, severely degraded parts have been excluded from listing protection under the Act). The listing criteria have been successfully applied to terrestrial, vegetation-based systems. As the River Murray – Darling to Sea is the first complex, dynamic aquatic ecosystem to be assessed as a threatened EC under the EPBC Act, this represents a significant gap in applying the listing criteria and associated thresholds. This Thresholds Workshop aims to address this important gap and examine the suitability and applicability of these two types of thresholds for aquatic ecosystems using the River Murray – Darling to Sea EC as a test case.

Objectives

1) Inform the assessment process for the priority Ecological Community, *Lower Murray River and associated wetlands, floodplains and groundwater systems from the junction of the Darling River to the Sea* (River Murray – Darling to Sea).

2) Provide guidance for the River Murray – Darling to Sea EC in particular, and aquatic ecological communities in general regarding:

    a. current legislated Listing Criteria thresholds as per the EPBC Act Regulations 2000 and the *Guidelines*
    b. Condition Class thresholds as per the *Guidelines* (i.e. what's in and what's out).

Methods

Scene Setting

The Thresholds Workshop was prefaced by a series of brief presentations to set the scene. This introductory material provided participants with an overview of the EPBC Act and the listing process for potentially threatened ecological communities. It also covered the strategic direction of the Threatened Species Scientific Committee toward a broader, landscape approach for defining ECs, and introduced the River Murray – Darling to Sea nomination and assessment. Presentations on the development and application of Limits of Acceptable Change (LAC) for two of the Ramsar listed sites that occur within the region of the ecological community provided useful comparative insights and concepts for later discussions on aquatic ecological community thresholds.

Thresholds - Listing Criteria

Workshop participants formed three breakout groups to discuss a series of questions related to 'Listing Criteria' thresholds. Each group was Chaired by a member of the TSSC and each group had a rapporteur who was charged with preparing a presentation on discussion outcomes for a plenary session.

The questions were specific to each of the three listing criteria deemed to be the most likely to be triggered for complex aquatic ecosystems, i.e. C3, C4 and C5, in addition to Criterion 6. This had been determined at the previous Technical Workshop (see next section).

The questions were as follows:

Table 1: Criteria 3 - Loss or decline of functionally important species.

Status	**Level of Decline**	**Decline Threshold**	**Restoration Threshold (not likely within)**
Critically Endangered	very severe	80% (over last 10 yrs or 3 generations if greater)	Immediate future (next 10 yrs or 3 generations to a maximum of 60 years)
Endangered	severe	50% (over last 10 yrs or 3 generations if greater)	Near future (next 20 yrs or 5 generations to a maximum of 100 years)
Vulnerable	substantial	20% over last 10 yrs (or 3 generations if greater)	Immediate future (next 50 yrs or 10 generations to a maximum of 100 years)

Qn. 1. Considering the description of **Criteria 3** (loss or decline of functionally important species) and the associated thresholds for a given conservation status (see Table 1), do the current decline and restoration threshold levels apply to the River Murray – Darling to Sea EC? If so please suggest why and if not please suggest appropriate alternatives.

Table 2: Criteria 4 - Reduction in community integrity.

Status	**Regeneration Threshold (change in integrity such that regeneration is unlikely in)**
Critically Endangered	Immediate future (next 10 yrs or 3 generations to a maximum of 60 years)
Endangered	Near future (next 20 yrs or 5 generations to a maximum of 100 years)
Vulnerable	Immediate future (next 50 yrs or 10 generations to a maximum of 100 years)

Qn. 2. Considering the description of **Criteria 4** (reduction in community integrity) and the associated regeneration thresholds for a given conservation status (see Table 2), do the current regeneration timeframes (criterion thresholds) apply to the River Murray – Darling to Sea EC? If so please suggest why and if not please suggest appropriate alternatives.

Table 3: Criteria 5 and 6.

Status	Criteria 5: Rate of Continuing Detrimental Change (immediate past or immediate future)	Criteria 6: Probability of Extinction (or extreme degradation over all geographic distribution)
Critically Endangered	Very severe ≥ 80%	At least 50% in the immediate future
Endangered	Severe ≥ 50%	At least 20% in the near future
Vulnerable	Substantial/ Serious ≥ 30%	At least 10% in the medium-future

Qn. 3. Considering the description of **Criteria 5** (rate of continuing detrimental change) and the associated thresholds of detrimental change for a given conservation status (see Table 3), do the current thresholds apply to the River Murray – Darling to Sea EC? If so please suggest why and if not please suggest appropriate alternatives.

Qn. 4. Do you have any suggestions for analysis under **Criteria 6** (quantitative analysis showing probability of extinction, or extreme degradation over all geographic distribution) for the River Murray - Darling to Sea EC (see Table 3)?

Thresholds - Condition

The Threshold Workshop participants also formed three breakout groups to discuss a series of questions related to 'condition' thresholds. Each group was Chaired by a member of the TSSC and each group had a rapporteur who was charged with preparing a presentation on discussion outcomes for a plenary session.

The questions were as follows:

Qn. 5. Are there a range of states applicable/relevant/practical for the River Murray – Darling to Sea EC and if so what are they?

[e.g. for a recognised woodland EC, possible states could be: all components of overstorey and understorey are present; understorey of significant value botanically; overstorey with recognised dominant and co-dominant species present, etc.].

[Possible examples for aquatic systems may be: high flow phase/mouth open, low-flow phase/mouth closed, transition flow phase, functional estuary present/absent, etc.]

Qn. 6. Consider these states for the entire River Murray - Darling to Sea EC system ***(i.e. broad scale)*** and then for other sub-units of the system ***(i.e. river channel and water; wetlands; floodplain vegetation; groundwater)***.

Qn. 7. Can the concept of condition be applied to all sub-units of the River Murray – Darling to Sea EC? If so, what would be the indicators of condition for these states?

[e.g. structure of EC state, species composition, presence/absence of agreed indicator species or ecological processes, etc.].

[Examples for terrestrial ECs may include: patch size; connectivity; native plant species presence; diversity and abundance; vegetation structure and cover attributes; understorey composition and cover; intensity of weed invasion; recognised faunal values; etc.]. This approach may be applied to the floodplain sub-unit, for example.

[Possible examples for a complex river may include: invasive species; flow features; salinity and acid sulfate levels; trophic levels; open exchange with ocean; functional estuary - mixing of fresh and salt water; stability of banks; etc.].

Qn. 8. What are the possible thresholds for these indicators to enable the 'condition classes' of each of the states previously identified? Answer for broad-scale and specific sub-units if applicable.

*[For example, w*e know that condition thresholds can be applied to floodplain vegetation. For *another floodplain vegetation threatened EC in the MDB, the coolibah/black box woodlands, the following condition thresholds are:*

- A minimum patch size of 5 ha. A patch may include naturally open, treeless areas.

- A tree canopy layer dominated by mature trees with a dbh (diameter at breast height) of ±30 cm OR
  hollow-bearing trees OR
  coppiced trees with a main stem that has a dbh of ±20 cm.

- The ground layer must have ≥10% native perennial vegetation cover of graminoids and/or sub-shrubs (i.e woody plants that are typically under 50 cm tall) AND not be dominated by perennial exotic species (i.e. cover ≤50% (or ≤70%?)).

Session One: Setting the Scene

Overview EPBC Act and Listing Process for Ecological Communities

About the EPBC Act

The *Environment Protection and Biodiversity Conservation Act* (EPBC Act) came into effect in July 2000. This premier Commonwealth legislation improves on the environmental legislative reforms of the 1970s and the *Endangered Species Protection Act 1992*. The EPBC Act focuses on nationally significant aspects of the environment and provides for the identification and protection of matters of National Environmental Significance (NES). Matters of NES as defined under the Act include:

- areas of World and National Heritage
- Ramsar wetlands
- threatened species and ecological communities
- migratory species
- Commonwealth marine areas
- the Great Barrier Reef Marine Park, and
- nuclear actions.

The Act promotes conservation of biodiversity and recognises indigenous interests. It enables the listing of threatened species, threatened ecological communities, and key threatening processes and development of associated recovery plans and threat abatement plans. It also provides for high level environmental planning, such as the marine based Bioregional Plans. Importantly, the EPBC Act regulates actions in relation to:

- matters of NES
- Commonwealth land, places and actions
- international wildlife trade
- EPBC Act listed species and ecological communities, and
- the Australian Whale Sanctuary.

The Approval Process

The EPBC Act is unique in that direct powers of approval lie with the Australian Government's Environment Minister. An 'action' that is likely to have a significant impact on a matter of NES cannot be undertaken without approval of the Minister. The Act provides administrative guidelines to assist with the determination of 'significance'. An action constitutes a physical interaction or material change to the environment, including a development activity or capital works (e.g. road building, bulldozing, landuse change), or a downstream impact on wetlands etc. Also, decisions and failure to do something are not considered 'actions'.

It is important to note that ongoing land use or activities that were legal and routine before the EPBC Act came into force (16 July 2000), are exempt under the 'continuous use' and 'prior authorisation' clauses of the Act (Section 43A and 43B). Man-made infrastructure, such as that related to dwellings, roads, agriculture, water operations, etc, does not form part of the 'natural' environment and is therefore <u>not</u> part of the ecological community. The Commonwealth does not become involved in developments where those risks have been eliminated by design or by State/local regulation or planning. Strong penalties may apply for breaches of the EPBC Act, for example up to $5.5 million for civil matters and up to seven years gaol for criminal matters.

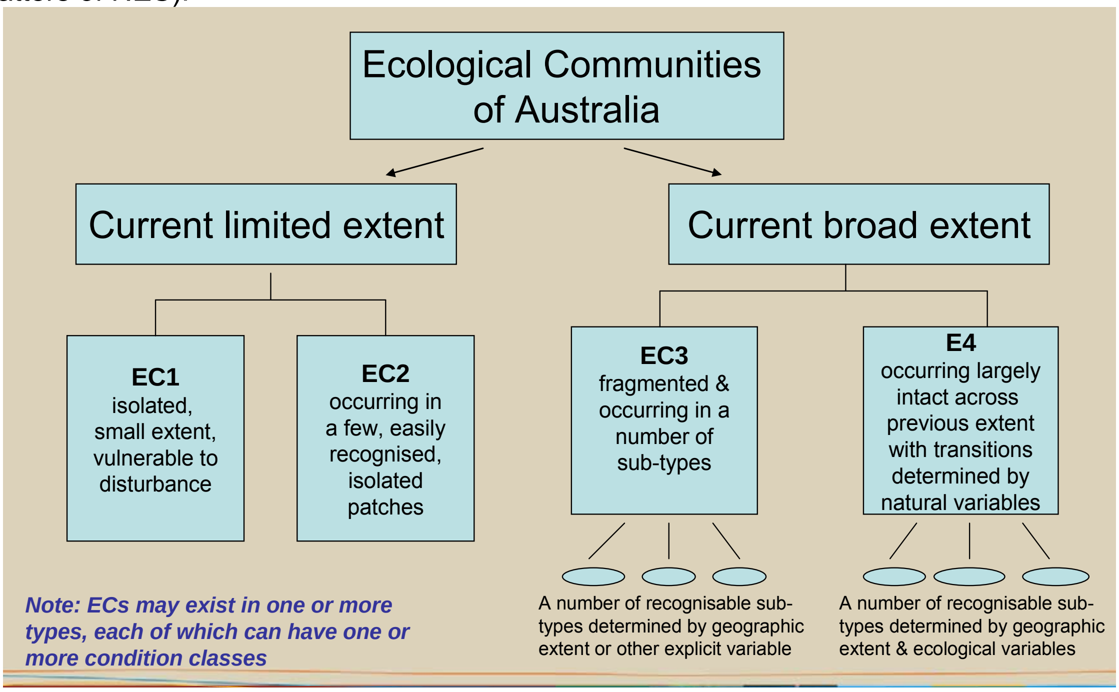
Specifically, the EPBC Act allows for the listing of nationally threatened species, nationally threatened ecological communities, and key threatening processes, and adoption of their associated recovery plans and threat abatement plans. For new listings since 2007, the preparation of 'a conservation advice' is required at the time of listing. Further information and guidance is produced to assist with determining if an action should be 'referred'. Note, the Minister determines, based on advice from the TSSC , whether to have a recovery plan, taking into account existing management plans.

The Listing Process

The listing process for potentially threatened ecological communities (EC) begins with the receipt of nominations from the public. These are strategically assessed by the Threatened Species Scientific Committee (TSSC) for suitability and a Proposed Priority Assessment List (PPAL) is forwarded to the Environment Minister for approval. Based on the Minister's determination, this list then becomes the Finalised Priority Assessment List (FPAL). For assessment of the ecological communities on the FPAL, the Department relies heavily on input and data from experts, including those from State/Territory agencies. Expert consultation also generally includes the holding of a technical workshop. In particular, the definition of an ecological community under the EPBC Act has a considerable amount of flexibility and the expert advice sought assists with refining the scope, context and boundary for a particular EC. The listing criteria, as set out in the Regulations of the EPBC Act, provide the enabling foundation for nomination and listing assessments. Assessment of listing criteria also involves the analysis of thresholds for assigning conservation status (i.e. critically endangered, endangered, vulnerable) and expert advice is sought to assist with this aspect.

A period of public consultation is also part of the listing assessment process. Taken cumulatively, this approach ensures that listings are both scientifically robust and legally defensible. It is also important that the definition of an ecological community listed under the EPBC Act should be described in such a way as to allow the listed threatened ecological community to be recognised in the field. Lastly in the process, a Listing Advice is forwarded to the Environment Minister, via the TSSC, for a final determination. If accepted for listing, the Department then publishes a 'Listing Advice' and a 'Conservation Advice', and a 'Policy Statement' to assist the community with how to identify the EC, as well as advice on how to manage it, conservation actions, etc.

If the ecological community is assessed and approved by the Minister to be 'endangered' or 'critically endangered', it will have full legislative protection under the EPBC Act. Other benefits include leverage for funding opportunities which may support conservation actions to maintain and enhance good quality remnants, or to restore degraded sites to better condition. Another important benefit is the generally increased awareness of the EC, and a bringing together and analysis of disparate information, thereby building on knowledge and increasing access to knowledge. This could also potentially complement any future 'Strategic Assessment' initiatives and regional recovery approaches. (Section 146 of the EPBC Act provides for the conduct of strategic environmental assessments on the impacts of implementing a policy, plan or program on matters of NES).



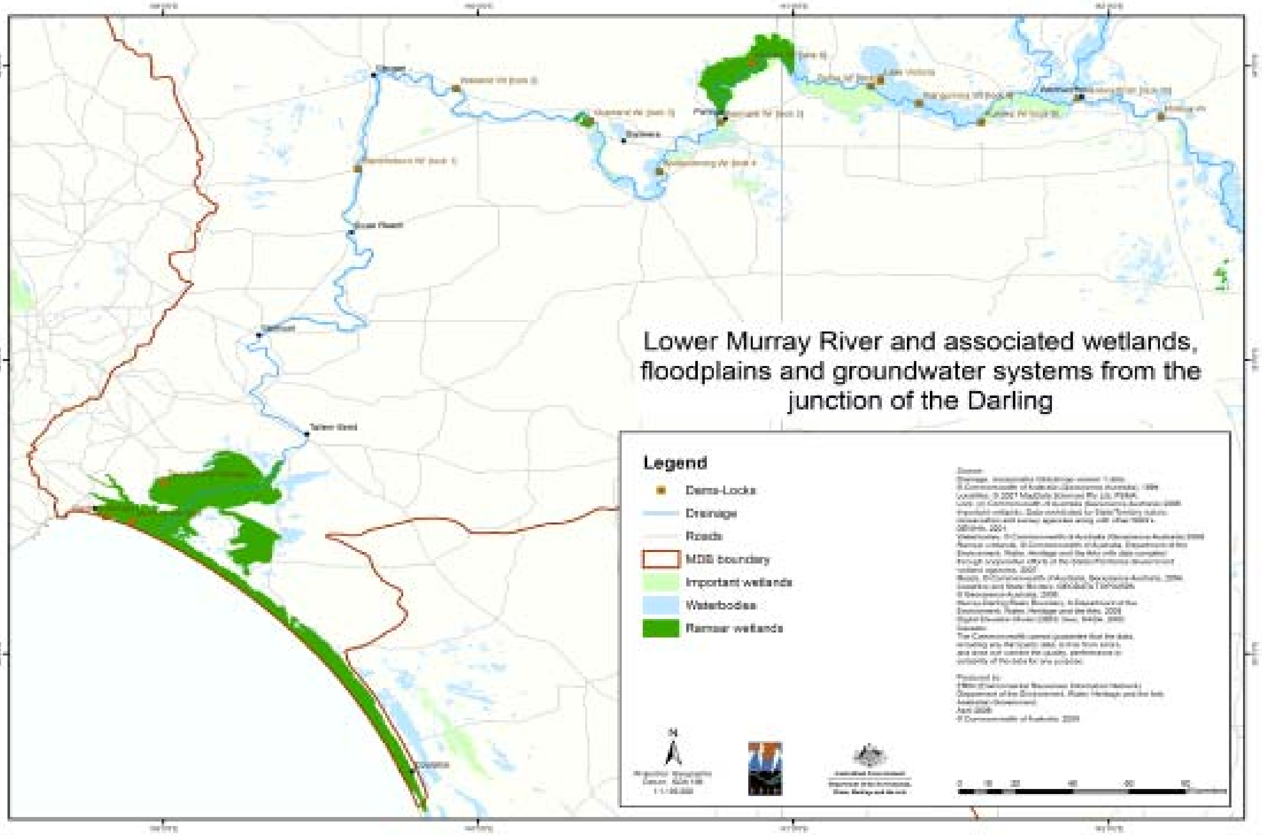
TSSC Framework for understanding ecological communities.

Adaptable Approach to Defining Threatened Ecological Communities

The EPBC Act (s. 528) defines an ecological community extremely broadly – "*the extent in nature within the Australian jurisdiction of an assemblage of native species that inhabits a particular area in nature, and meets additional criteria as specified by the Regulations*". The TSSC in recent years has been endeavouring to increase conservation outcomes by moving away from listing individual species (i.e. a species centric approach) and moving towards managing the threats and condition of ecological communities (i.e. a landscape approach). However, defining ecological communities has been challenging. For example: what constitutes the EC?, what is the extent to which different levels of condition (degradation) affect the defined identity of the EC?, and what is the national extent of the EC? The TSSC has moved away from the more traditional, hierarchical definition of an ecological community, and adopted a more practical approach that fits within the statute definition of an EC. In effect the TSSC has worked with the EPBC Act to maximise conservation outcomes, and sometimes this is leading to an ecosystem level approach.

River Murray - Darling to Sea EC

An expanded version of the original nomination (i.e. the Coorong and Lower Lakes, Alexander and Albert) was included on the August 2008 FPAL – as '*the Lower Murray River and associated wetlands, floodplains and groundwater systems from the junction of the Darling to the sea*'. It related to the conservation theme at the time of, 'rivers, wetlands and groundwater dependent species and ecosystems of inland Australia'. The TSSC agreed that there was greater conservation benefit in extending the Coorong and Lower Lakes (already Ramsar listed and therefore a matter of NES) nomination to include the region of upstream influence and impacts, as well as the interdependent groundwater, floodplain and wetland components of the system. The River Murray – Darling to Sea is unique in that it represents the first riverine system to be assessed under the EPBC Act as a threatened EC. It therefore also poses a challenge with respect to the listing assessment criteria used, as these were initially developed for terrestrial vegetation-based systems. The three year assessment period for this EC ends in September 2011.



Map of the region of the River Murray-Darling to Sea EC.

Limits of Acceptable Change

Limits of Acceptable Change – Outcomes, lessons & issues from the Murray Riverland and other Ramsar sites

Limits of acceptable change (LAC) are used as part of the national framework and guidance for describing the ecological character of Australian Ramsar wetlands (i.e. in line with implementing the Ramsar Convention in Australia). Setting LAC for the critical components, processes, benefits and services of a wetland facilitates easier determination of human-induced change or 'likely change' in the ecological character of a system. This is particularly important for Australian wetlands given that they often have a large range in natural variability. According to the Ramsar Convention 1996 Annex to Resolution VI.1, change in ecological character occurs when the critical parameters of the wetland ecosystem fall outside their normal range. Limits of acceptable change are also defined by DEWHA [1] as:
"…the variation in a component/process that is considered acceptable without causing a change in the ecological character of the site."

Limits of acceptable change help to indicate the variation that is considered acceptable in a particular measure or feature of the ecological character of a wetland. This may include population measures, hectares covered by a particular wetland type, the range of a certain water quality parameter, etc. The inference is that if the particular measure or parameter moves outside the LAC this may indicate a change in ecological character that could lead to a reduction or loss of the values for which the site was Ramsar listed[1]. This type of information can help site managers determine limitations to activities, monitor the site, and take action to maintain a particular wetland type, the range of a certain water quality parameter, etc [2]. In most cases, change is considered in a negative context, leading to a reduction in the values for which a site was listed.

In practice, setting LAC is not straight forward, as assessing the natural variability of a particular parameter can be complex. It is important to understand natural variability of the parameters or populations under consideration, as well as the system drivers (natural) and levers (anthropogenic) of change, components and processes. It is also preferable to have long-term data on which to base LAC. In some cases there may be insufficient data to support LAC, although as a precautionary approach, an interim LAC can be used until further data becomes available.[1] In addition, extreme measures of a given parameter, alone, do not set LAC – although a LAC may equal the natural variability or be set at some other value. There also needs to be consideration of:

- frequency and magnitude of extreme events
- changes in the temporal or seasonal patterns
- changes in spatial variability
- changes in the mean or median conditions, etc.

For some wetlands, there may be a trend of change in the natural variation of the system over time, so it is important to review LAC over time to ensure they still reflect the natural variability of the system.

Importantly, limits of acceptable change are not synonymous with management values or 'trigger levels'. Management triggers should be set at a level that allows appropriate management responses *well in advance* of the LAC being reached. Where possible, it would be useful to describe the impact that exceeding the limits of acceptable change may have on the components, processes, benefits and services.

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1. Phillips W and Muller K (2006). Ecological Character of the Coorong, lakes Alexandrina and Albert Wetland of International importance, South Australian Department for Environment and Heritage.
2. DEWHA (2008). National Framework and Guidance for Describing the Ecological Character of Australian Ramsar Wetlands. Module 2 of the National Guidelines for Ramsar Wetlands – Implementing the Ramsar Convention in Australia, Australian Government Dept. of the Environment, Water, Heritage & the Arts, Canberra.
3. Newall P, Lloyd L, Gell P and Walker K. (2009). River Ramsar Site: Ecological Character Description, Lloyd Environmental Pty Ltd Report (Project No.LEO739) To DEH, South Australia.

When determining LAC, critical components and/or processes are those:

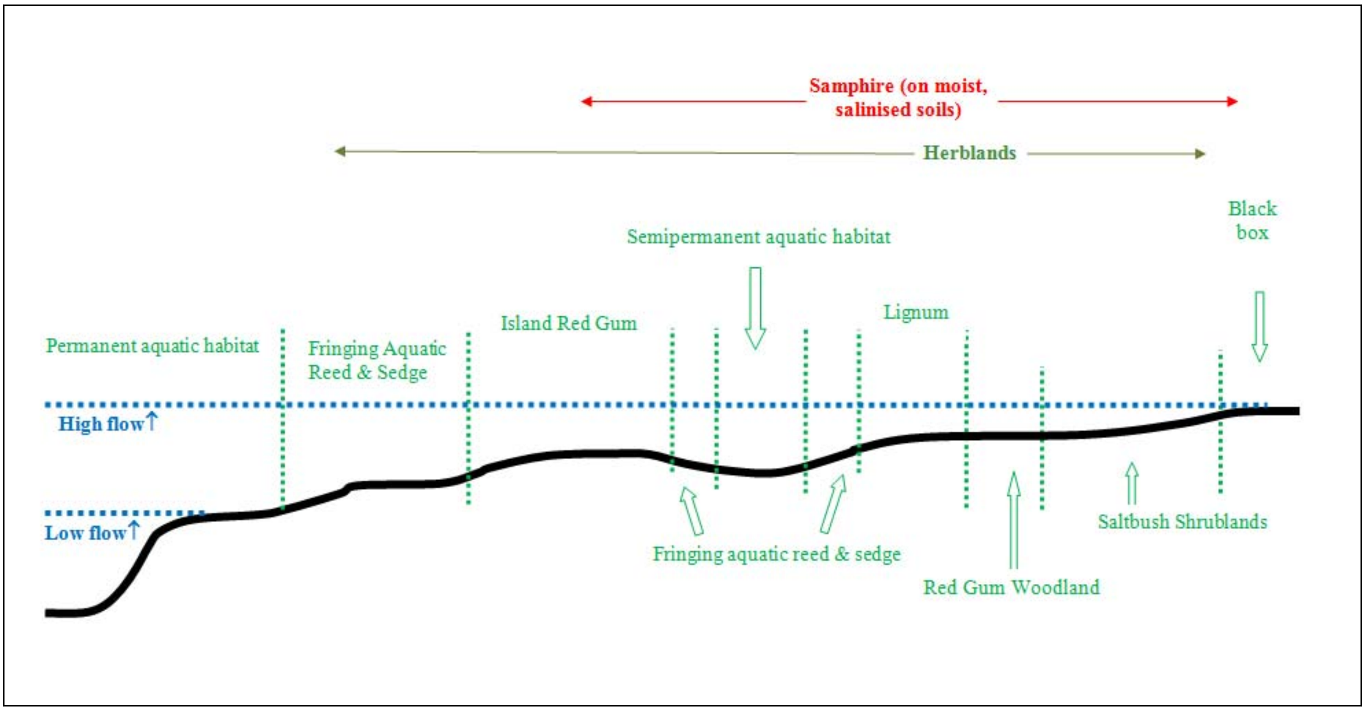
- that are important determinants of the sites unique character
- that are important for supporting the Ramsar criteria under which the site was listed
- for which change is reasonably likely to occur over short to medium time scales (<100 years)
- that will cause significant negative consequences if change occurs.

Riverland Ramsar Site

The 30 615 ha Riverland Ramsar site occurs along an 80 km stretch of the River Murray, downstream of the Victorian/South Australian border. It follows the 1956 floodline and incorporates a variety of habitats including: creeks, channels, lagoons, billabongs, swamps, lakes and floodplains. An Ecological Character Description (ECD) was developed for the Riverland Ramsar Site in 2009. Critical components and processes for the Riverland Ramsar site are considered to be:

- hydrological regime
- remnant habitat (e.g. floodplain & aquatic vegetation, wetland mosaics)
- rare, endangered, threatened species
- diverse and abundant waterbirds
- diverse fish and invertebrate fauna, and
- high diversity and mosaic of both terrestrial and aquatic habitats.

The simple conceptual model below demonstrates that different vegetation communities respond to different water levels, timing, duration, frequency, etc. Key aspects of the ***hydrological regime*** that would be expected to protect, enhance and maintain each of the different vegetation community types are further described in Table 4.



Indicative conceptual model of habitat types and hydrological regime for the Riverland Ramsar site (Lance Lloyd).

Table 4. Key aspects of hydrological regime for various vegetation types (Lance Lloyd).

Vegetation Community	Recurrence Interval	Duration	Timing	Magnitude	Time Between Events
Aquatic – Permanent	annual (watercourses) 1 in 2 years (billabongs & swamps)	permanent	permanent	50 GL/day (watercourses) 40 GL/day (for billabongs & swamps)	0 years (watercourses) 1 year (for billabongs & swamps)
Aquatic – semipermanent	9 in 10 years	long duration, frequently not drying out at all	Aug/Sep to Jan/Feb	40 GL/day	1 year
Fringing aquatic reed & sedge	1 in 1 – 2 years (nearly every year)	3 months (summer) or 6 months (winter), to enable seedlings to establish	shallow inundation for germination, deeper water (10 – 15 cm) for seedling establishment	25 – 30 GL/day (adjacent to channel) 45 – 60 GL/day (on low relict meander plain)	6 – 9 months
River redgum Forest (flood dependent understory)	7 – 9 years in 10	120 days	spring	50 GL/day for approx. ⅓ of this veg comm.); 80 GL/day for approx 80% of this veg. comm.	serial inundation 2 to 3 years in succession to optimise recruitment probability
Lignum shrubland	1 in 2 – 8 years more frequently In saline soils (>1.5mS cm-^{1})	120 days	unknown (possibly summer)	50 GL/day will reach ⅓ of this veg. comm; 70 GL/day for approx. ⅔	complete drying required between floods to enable cracking & aeration of soils
River redgum Woodland (flood tolerant Understorey)	7 – 9 years in 10	120 days	spring	50 GL/day for approx. ⅓ of this veg comm.; 70 GL/day (for approx 80% of this veg. comm.	serial inundation 2 to 3 years in succession to optimise recruitment probability
River saltbush chenopod shrubland	1 year in 10	long enough to saturate surface soil, with slow recession	unknown	60 GL/day for approx. ¼ of this veg. comm.; 300 GL/day for majority of this veg. comm.	unknown (> 2 years)
Low chenopod shrubland	1 year in 10 (2-3 years in succession every 30 years)	long enough to saturate surface soil, with slow recession	unknown	70 GL/day for approx. ½ of this veg. comm.; 300 GL/day for majority of this veg. comm.	unknown (> 2 years)
Samphire low shrubland	1 in 2-8 years; more frequently in saline soils (>1.5mS cm-^{1})	120 days	unknown (possibly summer)	50 – 60 GL/day will reach 60% of comm.; 80 GL/day will reach 80%	unknown
Black box woodland	1 year in 10 (2 -3 years in succession every 30 years)	long enough to saturate surface soil, with slow recession	unknown	70 GL/day for approx. 20% of this veg. comm.; 100 GL/day (or approx. 40% of this veg. comm.; 300 GL/day for majority of this veg. community	unknown (< 30 years)

With respect to ***remnant habitat*** (e.g. floodplain & aquatic vegetation, wetland mosaics) and LAC, it is suggested that surveys and a baseline condition (if known) should be used to determine the level of variation. Importantly, it was determined that:

- tree health should not decline further than previously surveyed conditions (e.g. 2003 survey found an estimated 24% of tree cover was healthy *Eucalyptus camaldulensis* (river red gum), *Eucalyptus largiflorens* (black box) and *Acacia stenopylla* (coobah)
- there should be no loss of greater than 20% of any vegetation type
- there should be no loss of greater than 20% of any wetland type within any 10 year period.

With respect to ***rare, endangered, threatened species***, the LAC should be:

- no loss of any recorded, rare or threatened species (over any time period, excluding natural seasonal/annual variations).

Again, it is suggested that surveys and a baseline condition (if known) should be used to determine the level of variation.

With respect to LAC for ***diverse and abundant waterbirds***, there should be:

- no net reduction in waterbird breeding numbers over any rolling 10 year period
- no net reduction in waterbird populations (particularly migratory) in any rolling 10 years.

[Note: ‘rolling’ refers to consecutive years].

With respect to ***diverse fish and invertebrate fauna*** (and it is recognised that floodplain wetlands support a more diverse macroinvertebrate fauna than the main channel), the LAC should be:

- no loss of any rare or threatened fish and invertebrate species
- no net reduction in fish and invertebrate populations over any rolling 10 year period.

With respect to ***high diversity and mosaic of both terrestrial and aquatic habitats***, the LAC should be:

- no further death of trees and no increase in area of unhealthy trees in any 2 year period (i.e. a short time frame)
- no loss of greater than 20% of any habitat type (i.e. diversity and mosaic must be maintained).

Baseline condition for habitat diversity can be defined using past and future vegetation surveys.

It is recognised that there is a broader issue of river regulation which has implications for the LAC, including that of causing much change to the system prior to the Ramsar listing. Although, it is also acknowledged that river regulation has a common impact across all River Murray Ramsar sites – both longitudinally and temporally. It is also possible that information and data collected previously may not align with the specifications of the proposed LAC. Also, for some LAC there is no data available. Many LACs may be affected by underlying processes in train before listing and that are continuing. ***Importantly, many of the LACs are dependent on future monitoring.***

It is also important to recognise that LAC may be confused with management triggers. If management triggers are not developed (for example in Management Plans), then this may limit the usefulness of LAC (i.e. may only be useful in hindsight). However, ***LAC are useful for assessing whether management actions have protected the site***, and ***LAC are useful in assessing proposed developments that might affect the site*** (Article 3.2 Ramsar and EPBC Act) - i.e. in assisting to determine 'significant impact'.

Limits of Acceptable Change – Outcomes, Lessons and Issues from the Coorong, Lakes Alexandrina & Albert Wetland of International Importance

Site background

The site, made up of Lake Alexandrina, Lake Albert and the Coorong, was declared a Wetland of International Importance in 1985 (i.e. Ramsar) and a Living Murray Icon Site in 2003. It consists of a series of freshwater, estuarine, marine and hyper-marine habitats that have been identified to incorporate at least:

- 23 wetland types
- 77 bird species
- 7 endangered or vulnerable plant species
- 49 native fish species
- 10 frog species including the endangered Southern Bell Frog
- many types of reptiles.

It is estimated that the area receives in excess of 200,000 visitors per year. The traditional owners of the region are the Ngarrindjeri people.

Map of Coorong, Lower Lakes and Murray Mouth (Source: J. Highman, DEH, SA)

Of significance, the Coorong, Lower Lakes and Murray Mouth complex incorporates the only:

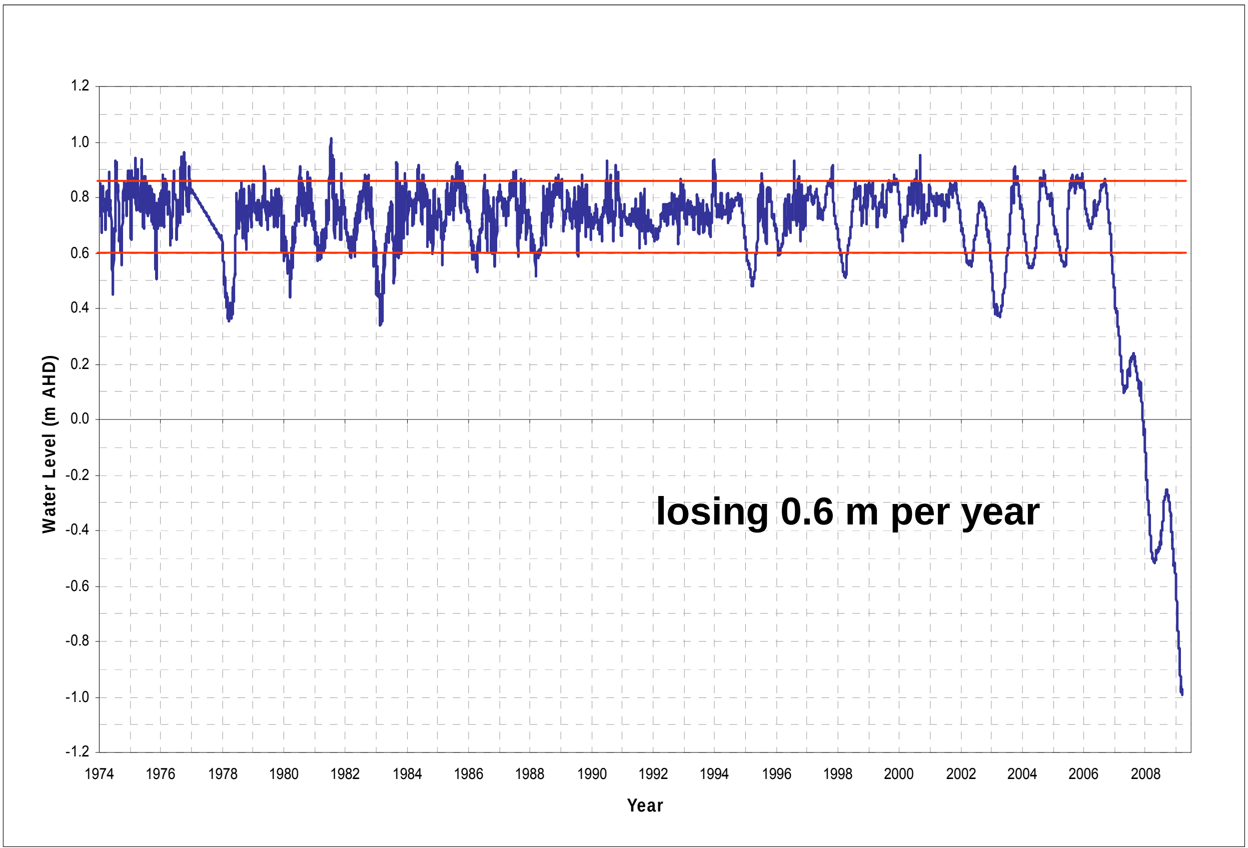
- estuary in the Murray-Darling Basin (MDB) system
- migratory pathway for diadromous fish species of the MDB (e.g. congolii)
- MDB site with *Nannoperca obscura* (Yarra pygmy perch)
- site with 3 hardyhead species (i.e. the EPBC Act listed *Craterocephalus fluviatilis* (Murray hardyhead), *Antherinosoma microstoma* (smallmouthed hardyhead) and *Cratenocephalus stercusmuscarum fulvus* (flyspecked hardyhead).

The site provides habitat for a host of nationally threatened species and communities, for example:

- components of the Critically Endangered ecological community, 'Swamps of the Fleurieu Peninsula'
    - the State recognised threatened *Gahnia* sedgeland ecosystem
    - a number of threatened plant species, such as *Thelymitra epipactoides* (metallic sun-orchid).

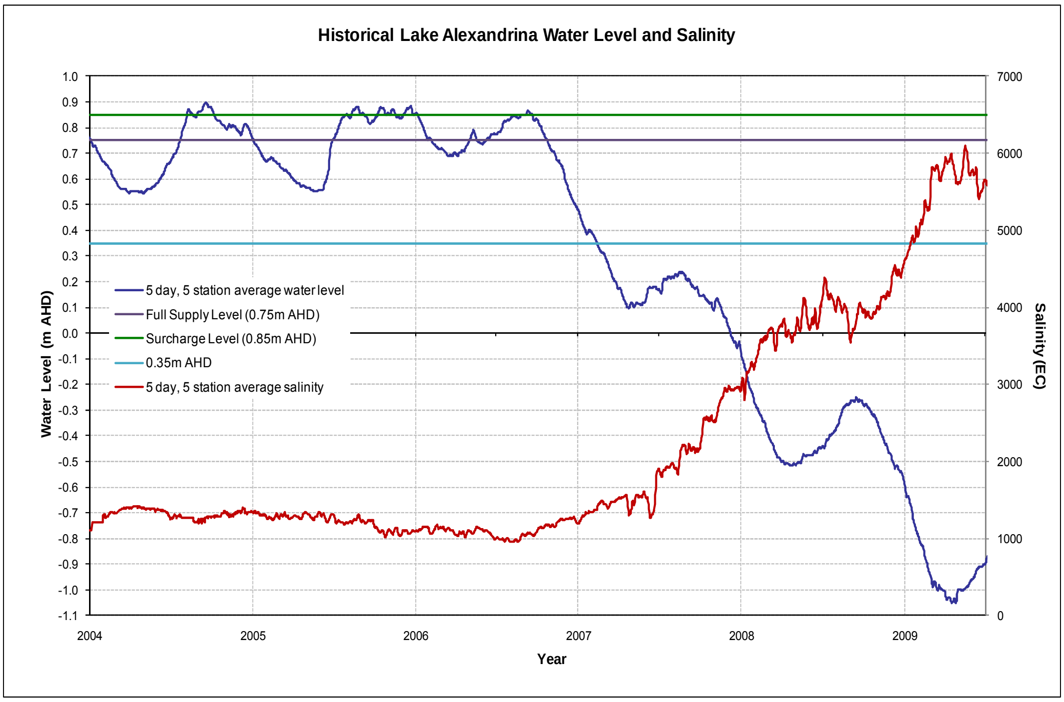
The site is also important for several state listed species and is particularly important for waterbirds, for example:

- a total of 85 species of waterbirds have been recorded in the region
- the site ranks within the top six waterbird sites in Australia In terms of species richness and overall numbers of waterbirds of all kinds
- the Coorong and estuary and wetlands rank among the top three sites in Australia for seven species of wader
    - many of the waders are seasonal migrants to Australia and breed in Alaska, northern China and Siberia
- the area is particularly important for *Calidris ruficollis* (red-necked stints), *Calidris acuminata* (sharp-tailed sandpipers) and *Calidris ferruginea* (curlew sandpipers) - all protected, along with other species, under JAMBA, CAMBA and RoKAMBA agreements
- on a state basis, the area contains more than half of the waterbirds that occur in South Australia, and one quarter of all the waterbirds in Australia.



Water level below Lock 1 (Source: Jason Highman, DEH, SA).

Water levels at the site are generally between 0.6 to 0.8 AHD, however this has dropped significantly over recent years and has been below sea level since 2008 to at least the present (April 2010, see above figure). This has resulted in a severe case of hypersalinity in both the Coorong (south lagoon) and parts of the Lower Lakes (see figure below of Lake Alexandrina). *[Note: the upper limit for drinking water quality is at 800 EC (electrical conductivity). 1000 EC units are equivalent to a salinity of 640 ppm and seawater is 35 ppt].*



Water levels and salinity in Lake Alexandrina (Source: Jason Highman, DEH, SA).

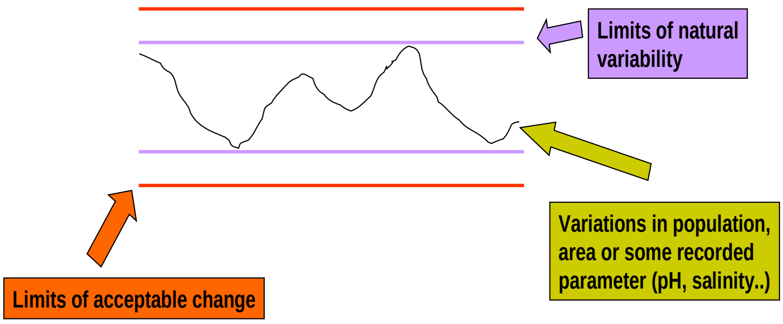
Critical components and processes of this system were identified by Phillips and Muller (2006) as:

- salinity
- turbidity and sedimentation patterns
- keystone aquatic plant species and assemblages
- water levels
- habitat availability, particularly temporal and spatial connectivity
- water regime, particularly flow patterns
- wetland type.

Ramsar significant components were also identified by Phillips and Muller (2006) as:

- endangered and vulnerable plant species
- swamps of the Fleurieu Peninsula (EPBC listed ecological community)
- *Stipiturus malachurus* Mount Lofty Ranges southern emu-wren
- *Neophema chrysogaster* (orange-bellied parrot)
- *Litoria raniformis* (southern bell frog)
- *Gahnia* vegetation association
- breeding wetland-dependent birds
- wading birds, including migratory species
- *Ceropsis navaehollandiae* (Cape Barren goose)
- obligate freshwater fish species
- diadromous fish species
- euryhaline or estuarine fish species
- marine straggler fish species.

Indicative Limits of Acceptable Change were prepared by Phillips and Muller for the Coorong and Lower Lakes in 2006, prior to the development of a national framework. They developed LAC for six primary determinants, 23 wetland types and 13 Ramsar significant biological components. Four of the components (or wetland types) were not assigned a LAC as they were considered 'not natural' wetlands. A large proportion of the LAC, particularly for the biota, were unable to be specified. Many of these early LAC are written as management triggers or goals and many are considered as qualitative or difficult to measure. It was agreed that greater specificity is required and work is underway at present to better define ecological measures and develop a revised set of LAC, including guidance for monitoring and linking to baselines. Complementary conceptual modelling work is also underway at Flinders University to assist in this process. An important consideration is that the ratio of wetland types or loss of a wetland type may prove more critical to the health of the system as a whole.



A new long-term plan (LTP) has been produced for the Coorong and Lower Lakes by the SA government, with a mission statement to maintain the Coorong, Lower Lakes and Murray Mouth (CLLMM) site as:

"*a healthy & resilient Wetland of International Importance.*"

Ecological Objectives

Objectives and outcomes of the LTP are shown in Table 5. In addition, indicator species have been identified and a draft example for Murray cod is shown below.

Indicator species: Maccullochella peelii (Murray cod)

Outcome	Rationale	Metric	Knowledge gaps
i	Use size or age structure of population (spawning is not recruitment)	Abundance, size and age structure of population	
ii	Juveniles will grow in the Lakes and need suitable habitats to do so.	Abundance, size and age structure of population, movements (tags)	Distribution and abundance in Lower lakes
iii	Apex predator that likely depends on food resources being available for a range of species (via direct and indirect consumption). Therefore abundance potentially related to abundance of food resources for other species too.	Abundance, size and age structure of population, movements (tags), gut contents	
iv	Sensitive to low dissolved oxygen and elevated salinity, and other water quality variables thus demographics likely to indicate if water quality is declining to a level that is likely to be unfavourable for a range of other species as well.	Abundance, movements (tags), fish kills	Impacts of multiple water quality stressors
v	Migratory species.	movement study (tags)	Timing of movement of young fish into lakes from upstream

Where to from here:

- Complete LAC review, develop specific and measurable limits and management triggers
  - species: abundances, population structure etc
  - communities: ratios
  - requirements of species and communities: water quality, 'connectivity ' in all its guises
  - habitats – wetland types
  - include missing components: macroinvertebrates, mammals, reptiles etc
- Complete trophic ecological models
- Develop monitoring linked to the LAC metrics and triggers
- Implement 'adaptive management' within site.

Table 5: Objectives and Outcomes of the Coorong & Lower Lakes Long Term Plan of 2010[1].

Objective	Outcome		
Self-sustaining populations	1) Successful recruitment of local breeding species occurs through time (i.e. individuals recruit often enough to sustain the population)	2) Suitable habitat exists for breeding, feeding, shelter and development of individuals to accommodate all life history stages[2]	3) Suitable food resources exist for a variety of species[2] 4) Water quality within tolerances for all life history stages for a variety of species for the majority of time [3]
Population connectivity	5) Exchange of species occurs between Lakes, Coorong, from upstream habitats, regional wetlands and tributaries (including South-East), the ocean (and possibly other nearby estuaries) and terrestrial environments to enable spatial connectivity[2]	6) Viable propagule banks exist to enable temporal connectivity[3]	7) No barriers to connectivity (either physical, temporal or seasonal) exist that prevent eventual intraspecific connectivity amongst life history stages/sexes for the purpose of breeding or recruitment[2]
Hydraulic connectivity	8) Floodplains (& mudflats, island habitats etc.) are hydraulically connected to permanent water bodies (e.g. via a variable flow regime) [3,4] 9) Residence times for water in each of the management units are not indefinite	10) The River, Lakes, tributaries, Coorong, ocean and South East are hydraulically connected. Ideally this would mimic natural levels of connectivity but at a minimum it needs to occur often enough during periods that are critical for ecological functionality (e.g. seasonally and inter-annually)	11) Exchange of energy, nutrients and carbon between management units, and from upstream or to downstream of the site [3,4] 12) Pollutants delivered to the site are passed through and do not accumulate at abnormally high rate (e.g. sediment, salinity, acid, metals, agrochemicals) 13) Water quality within tolerances for all life history stages for a variety of species for the majority of time[2,3]
Habitat complexity and diversity	14) A diverse range of habitat units exist across the site both above and below the water line (e.g. submerged plants to reed beds to paperbark or samphire to ephemeral mudflats to clean shorelines)	15) There is temporal and spatial variability in available habitats	
Persistent salinity gradient across site	16) A range of salinities are represented across the site (with no areas outside maximum salinity tolerances for all life histories of a variety of species for extended periods or across extended areas) [4]	17) Salinities vary through time (with no areas outside maximum salinity tolerances for all life histories of a variety of species for extended periods or across extended areas) [4]	18) Communities requiring a variety of salinity regimes are supported across the site (e.g. ranging through fresh, estuarine, marine and hypersaline) [4]
Flow and water level variability	19) A range of flow volumes are delivered to the site through time[3] 20) Seasonality of flows exists (mimicking the pattern of the natural hydrograph) [3]	21) Seasonality of water levels exists (mimicking natural patterns) [3] 22) Communities requiring a variety of hydrological conditions are supported across the site (e.g. patches of dry, ephemeral and permanently-inundated habitats)	23) Communities and processes requiring occasional flooding (e.g. to cue spawning or stimulate germination) are supported by the site 24) A tidal signal is apparent in the Murray Mouth region
Redundancy and appropriateness of ecological function	25) Complex, diverse food webs across the site 26) Multiple species are present that are capable of performing similar functions (e.g. shredding of organic matter, microbial processing, food sources) within the site	27) Working, efficient and appropriate cycling of nutrients and carbon occurs throughout the site with appropriate biogeochemical pathways present at each location (also with connections to upstream/downstream etc.)	28) Invasive species do not dominate and are not spreading uncontrollably through the region[5] 29) Proportions of acid-tolerant, saline-tolerant and terrestrial species remain approximately constant in the medium to long term (although these should vary spatially and on short temporal scales)
Aquatic-terrestrial connectivity	30) Variable water levels allow wide riparian and littoral zones to develop and persist through time (both as plants and as propagules) [3] 31) Interconnected mosaic of diverse vegetation from terrestrial, through riparian and submerged down to the extent of the euphotic zone [3]	32) Ecosystem supports a balanced mix of terrestrial and aquatic taxa through space and time 33) Exchange of energy, nutrients and carbon occurs between aquatic and terrestrial ecosystems[3]	34) Variable water levels regularly oxidise sulfidic material and limit the formation of new acid sulfate soils around the shallow water margin

1. Lester R, Muller K, Heneker T and Fairweather P (2009). Methodology for developing a robust end-of-system flow regime that will support the ecological character of the Coorong, Lower Lakes and Murray Mouth Ramsar Site. A report prepared for the South Australian Department for Environment and Heritage.
2. Closs G, Downes B and Boulton A (2004). Freshwater Ecology: a scientific introduction. Blackwell Publishing, Carlton Vic.
3. Boulton AJ & Brock MA (1999). Australian Freshwater Ecology: Processes and Management. Gleneagles publishing, Glen Osmond SA.
4. Edgar GJ (2001). Australian marine habitats in temperate waters. New Holland Publishers, Frenchs Forest.
5. Walker B and Salt D (2006). Resilience thinking: sustaining ecosystems and people in a changing world. Island Press, Washington.

Table 6: Summary of EPBC Act Listing Criteria for assessing threatened ECs.

	Criterion	Category		
		Critically Endangered	Endangered	Vulnerable
1	Its decline in geographic distribution is:	very severe (≥95%)	severe (≥90%)	substantial (≥70%)
2	Its geographic distribution is:	very restricted	restricted	limited
	and the nature of its distribution makes it likely that the action of a threatening process could cause it to be lost in:	the immediate future	the near future	the medium-term future
3	For a population of a native species that is likely to play a major role in the community, there is a:	very severe decline	severe decline	substantial decline
	to the extent that restoration of the community is not likely to be possible in:	the immediate future	the near future	the medium-term future
4	The reduction in its integrity across most of its geographic distribution is:	very severe	severe	substantial
	as indicated by degradation of the community or its habitat, or disruption of important community processes, that is:	very severe	severe	substantial
5	Its rate of continuing detrimental change is:	very severe	severe	substantial
	as indicated by: (a) rate of continuing decline in its geographic distribution, or a population of a native species that is believed to play a major role in the community, that is:	very severe	severe	serious
	or (b) intensification, across most of its geographic distribution, in degradation, or disruption of important community processes, that is:	very severe	severe	serious
6	A quantitative analysis shows that its probability of extinction, or extreme degradation over all of its geographic distribution, is:	at least 50% in the immediate future	at least 20% in the near future	at least 10% in the medium-term future

Session Two: Listing Criteria Thresholds

Background

Criteria for Listing Threatened Ecological Communities under the EPBC Act

A vital aspect of the assessment process of an EC is the assessment and interpretation of 'listing criteria' as set out in the EPBC Regulations (Reg. 7.02). The listing criteria provide the enabling foundation for both nomination and listing assessments. They were adapted from international guidelines for threatened species. The Threatened Species Scientific Committee (TSSC) has adapted the criteria and provided additional interpretive explanation for their application to ecological communities in its '*Guidelines*' document (available at: http://www.environment.gov.au/biodiversity/threatened/pubs/guidelines-ecological-communities.pdf).

While the *Guidelines* 'allow for' aquatic ECs, to date the *Guidelines* have mostly been applied to terrestrial vegetation-based ECs. There are six criteria (see Table 6 for summary) and in the past, these have had varying rates of application in terms of being met for an Australian threatened ecological community. For example, as of mid 2009, for the 45 or so ECs listed, Criterion 1, 2 and 4 were triggered the most (68%, 70% and 20%, respectively), while Criterion 3 and 5 had hardly ever triggered (9% and 2%, respectively), and Criterion 6 had not been triggered at all.

Another important consideration for an EC assessment is the fact that it relies almost exclusively on existing available data. In addition to published academic studies, much data is State/Territory based rather than Commonwealth based. To address this requirement, experts from all relevant jurisdictions are involved/consulted from the start of the assessment process. Importantly, all criteria are assessed, but a criterion cannot be met without requisite 'evidence' to merit listing at a certain level of conservation status (i.e. vulnerable, endangered, and critically endangered).

To assist with the assessment process, each criterion also specifies indicative thresholds against each conservation category (see Table 7). The criterion with the highest conservation category is used to assign conservation status for the final listing of the EC. As an example: C1 may be 'critically endangered', C2 'endangered', C3 not met, C4 'vulnerable', and C5 and C6 not met - the EC if listed, would then have the category of 'critically endangered'.

The *Guidelines* also provide indicative thresholds for each of the conservation categories for each of the six criteria. Threshold variables are used for establishing 'condition classes', for example: patch size, connectivity, species presence, etc. A number of assessment criteria also use timeframe thresholds to consider the possibility of restoration of the EC. For example:

- *immediate future (or past)*
  - next (past) 10 yrs, or 3 generations of any key long-lived species, to a maximum of 60 yrs
- *near future (or recent past)*
  - next (past) 20 yrs, or 5 generations of key long-lived species, to a maximum of 100 yrs
- *medium-term future (or past)*
  - next (previous) 50 yrs, or 10 generations of key long-lived species, to a maximum of 100 yrs.

Thresholds applied to date have been mainly for terrestrial, vegetation based systems – it remains to be determined how, and/or if, the indicative thresholds and timeframes apply to aquatic ecological communities.

Table 7: Indicative Thresholds for the Listing Criteria used to assess potentially threatened ecological communities.

	Criteria 1	**Criteria 2 (small distribution plus demonstrable threat)**			**Criteria 3**		**Criteria 4**	**Criteria 5**	**Criteria 6**
Indicative Threshold/ Conservation Threat Status	Decline in geographic distribution	Area of Occupancy (actual area covered)	Extent of Occurrence (measure of geographic range)	Average Patch Size	Decline of a functionally important native species	Restoration Timeframe (not likely within)	Regeneration Timeframe (change in integrity such that regeneration is unlikely in)	Detrimental Change (immediate past or Immediate future)	Probability of extinction or extreme degradation over all geographic distribution
Critically Endangered	Very severe ≥95%	< 10 km^2 (1000 ha)	<100 km^2 (10,000 ha)	generally <10 ha	Very severe ≥80% (over last 10 yrs or 3 gens. if >)	Immediate future next 10 yrs (or 3 gens.→ max 60 yrs)	Immediate future next 10 yrs (or 3 gens.→ max 60 yrs)	Very severe ≥80%	At least 50% in immediate future
Endangered	Severe ≥90%	< 100 km^2 (10,000 ha)	<1000 km^2 (100,000 ha)	generally < 100 ha	Severe ≥50% (over last 10 yrs or 3 gens. if >)	Near future next 20 yrs (or 5 gens.→ max 100 yrs)	Near future next 20 yrs (or 5 gens.→ max 100 yrs)	Severe ≥50%	At least 20% in the near future
Vulnerable	Substantial ≥70%	< 1000 km^2 (100,000 ha)	<10,000 km^2 (1,000,000 ha)	N/A	Substantial ≥20% (over last 10 yrs or 3 gens. if >)	Medium-term future next 50 yrs (or 10 gens. → max 100 yrs)	Medium-term future next 50 yrs (or 10 gens. → max 100 yrs)	Substantial /Serious ≥30%	At least 10% in the medium-term future

Previous Technical Workshop Outcomes

With respect to listing criteria, a previous Technical Workshop on the River Murray – Darling to Sea EC found that for complex aquatic ECs there needs to be:

- a greater emphasis on ecological functionality rather than 'change in area'
- greater inclusion of temporal aspects
- recognition of the cumulative impacts of threats
- recognition of natural versus anthropogenic variability
- acknowledgement of the high degree of temporal, spatial and qualitative variability of surface water
- acknowledgement that groundwater hydrodynamics and quality are key drivers affecting status and vulnerability.

Importantly, the Technical Workshop determined that of the six listing criteria, Criteria 3 and Criteria 4 are more fundamentally relevant to the assessment of aquatic ecosystems, as these pick up on the critical aspect of ecological functionality. Criterion 1 and 2 are based on geographic distribution or extent which is of less relevance to complex and dynamic aquatic ecosystems. The workshop also found that Criteria 5 is likely to become increasingly relevant as more data becomes available on aquatic ecosystem health.

The previous Technical Workshop also considered that the River Murray – Darling to Sea EC is a hybrid between the terrestrial systems listed to date, and an aquatic system. Participants concluded that the FPAL listed EC should proceed to assessment guided by the outcomes of the workshop in terms of its definition or description, boundaries and major characteristics. It was accepted that the EC is a ‘constructed’ system with values that are distributed across a range of ‘connected’ sub-units and the need to identify what ‘holds it together’ was recognised as essential (e.g. suggestions were flow regime, connectivity, saltwater-freshwater flooding interaction). Importantly, the Technical Workshop determined that the triggering of different components of the system (i.e. wetlands versus channel versus groundwater, etc.) by different criteria would not align with the intent of the nominated EC as a ‘holistic, functioning ecological entity', in addition to the imprimatur of the TSSC to aim for the greatest possible extent – particularly where there is a clearly demonstrated relationship between components of the broad-scale community. A benchmark state (or reference condition) was considered to be the post-regulation period of good flows in the early 1970s.

Outcomes of Thresholds Workshop

Results of breakout group discussions on listing criteria thresholds are shown in Tables 8 and 9. Preliminary discussions highlighted the need to focus on the concept of ‘functionally extinct’ for threatened ecological communities - particularly those such as the River Murray – Darling to Sea EC that constitute an ecosystem-scale. That is, the suite or assemblage of species considered for assessing criteria or thresholds should be selected to adequately show the ecological community of concern - they must be representative of the function of the ecological community. It was also considered important that if thresholds were to be used, then they should be applicable at a range of time scales and sub-components of the ecological community.

Other significant points raised were:

- thresholds are important, however at present they may not be relevant or practical for the River Murray – Darling to Sea EC

- the reality of thresholds is arguable at the level of species

- the issue of community integrity is important - how different can the community become?

- the aquatic/terrestrial interface was seen as an ecotone where criteria thresholds may need to deal more with landscape issues

- Aquatic ecological communities can change as a series of jumps - i.e. stepwise change, or a particular 'tipping point' is reached. So a linear approach, as in 80%, 50%, 30% may not always be appropriate

- there may be a need to assess criteria from a sub-component level

- for C4 it is logical to look at suites of species that have similar function

- the High Ecological Value Aquatic Ecosystem (HEVAE, formerly HCVAE) was seen as a relevant process, but it was acknowledged that this is approaching the issue from a higher or more generic level.

Answers to Questions on Criteria Thresholds

***Qn. 1. Criteria 3** - Considering the description of Criteria 3 (loss or decline of functionally important species) and the associated thresholds for a given conservation status (see Table 1), do the current decline and restoration threshold levels apply to the River Murray - Darling to Sea EC? If so please suggest why and if not please suggest appropriate alternatives.*

The decline and restoration thresholds associated with Criteria 3 were considered as generally applicable with respect to aquatic communities, although in some cases they may not be practical – for example for some short-lived species. Application should apply only to species or suites of species that have an important functional role in the community and where there has been a demonstrable decline. However, the dynamic nature of aquatic ecological communities means that landscape-scale change can occur extremely rapidly and unpredictably, as can progress towards restoration. In addition, the interdependent nature of temporal and spatial factors may complicate a linear approach to assigning thresholds. Criteria thresholds are easier to apply where good data exist, and this is more often the case for longer-lived species or those of higher anthropogenic interest, such as trees (e.g. river red gum, black box) or fish (e.g. Murray cod). It is more difficult for lesser studied components of the system, such as zooplankton or macroinvertebrates. The use of 'surrogate' or 'indicator' species to represent suits of species that relate to a particular ecological function would work well for this criterion (and also for criterion 4). Interpretation of thresholds for Criteria 3 will need to be undertaken on a 'case-by-case' basis for aquatic ecological communities and their constituent species, and functional elements and processes.

***Qn. 2. Criteria 4** - Considering the description of Criteria 4 (reduction in community integrity) and the associated regeneration thresholds for a given conservation status (see Table 2), do the current regeneration timeframes (criterion thresholds) apply to the River Murray - Darling to Sea EC? If so please suggest why and if not please suggest appropriate alternatives.*

Criteria 4 was considered the most effective/relevant of the six for aquatic ecological communities, as reduction in community integrity relates best with 'ecological function' and process rather than dependence on a single 'species' focus. However it was determined that, in general, the regeneration threshold associated with this criterion is challenging to determine for aquatic ecological communities. Timeframes relevant to ecological function and 'restoration' capacity (i.e. compare with 'regeneration') range from hours to days to hundreds of years for various taxonomic components of aquatic systems. There are a multitude of generation times, from short to long, and dormant egg and seed banks can feature prominently in regeneration/ re-colonisation processes in aquatic ecosystems over varying time scales (e.g. days to decades). Aquatic ecosystems have far greater 'potential' to regenerate compared with many terrestrial systems, and restoration may be driven by the addition of water to the system (although it is acknowledged that the situation is invariably more complex than this). Interpretation of thresholds for this criterion will require consideration of how much potential change the system can absorb for the 'ecological community' to endure, compared to some form of reference or 'benchmark' state. Interpretation of thresholds for Criteria 4 will need to be undertaken on a 'case-by-case' basis for aquatic ecological communities and their constituent species, and functional elements and processes.

***Qn. 3.* Criteria 5** *- Considering the description of Criteria 5 (rate of continuing detrimental change) and the associated thresholds of detrimental change for a given conservation status (see Table 3), do the current thresholds apply to the River Murray - Darling to Sea EC? If so please suggest why and if not please suggest appropriate alternatives.*

This criterion, which relates to rate of continuing detrimental change was considered to be suitable for aquatic ecological communities. It can apply to an ecological process or to the population of a species or group with a key functional role. There were similar concerns with this criterion as with Criteria 4. Of note however, was the point raised that aquatic ecological communities can often change in a series of jumps, for example a 'tipping point' or 'stepwise' change rather than linear or gradual change (i.e as per the 30%, 50%, 80% change stated by Criteria 5). This then means that the proportions associated with the thresholds for this criterion may be less meaningful and are likely to be influenced by an unpredictable temporal element. It is also beneficial to consider the different sub-units of an aquatic system that may vary between aquatic and terrestrial (i.e. according to wetting and drying cycles). For example, terrestrial components may change in a more projected and predictable fashion. Interpretation of thresholds for Criteria 5 will need to be undertaken on a 'case-by-case' basis for aquatic ecological communities and their constituent species, and functional elements and processes.

***Qn. 4.* Criteria 6** *- Do you have any suggestions for analysis under* Criteria 6 *(quantitative analysis showing probability of extinction, or extreme degradation over all geographic distribution) for the River Murray - Darling to Sea EC (see Table 3)?*

Criteria 6 is based on the probability of extinction/extreme degradation with the thresholds of 50%, 20%, and 10%. The concept of 'extinction' of biological components is less practical for an ecological community as compared to a species; 'functional extinction', to the point that original function is irrecoverable, is perhaps more applicable. Probability of extreme degradation would also be applicable for an aquatic ecological community (as may happen, for example, with extreme cases of salinised wetlands or the situation of acute acid sulphate soils). As this criterion is based on quantitative analysis, it would be ideal to have adequate data available on key species, functions or processes. Long-term data series would also significantly enhance potential outcomes for this type of analysis and add rigour. Identification of trigger or 'tipping points' for the ecological community or its processes would also be useful to input to this type of analysis. It was considered by the workshop that conceptual modelling has the potential to be a useful tool for this criterion, for example, the current conceptual modelling of the Coorong being undertaken by Flinders University. It was acknowledged, however, that this criterion has yet to be used in the listing assessment of a threatened ecological community.

Table 8: Results from Breakout Group discussions for Listing Criteria Thresholds.

Question	Group A	Group C

Qn.1. For **Criteria 3** (loss or decline of functionally important species), do the current decline and restoration threshold levels apply to the River Murray – Darling to Sea EC? If so please suggest why and if not please suggest appropriate alternatives.	• function – red gum habitat
	• scale dependent
	• set by most sensitive species
	• thresholds not sensible
		• processes (and function) more relevant than individual species (Hydrology – species changes are symptoms of change in hydro)
		• e.g. Murray cod – apex predator. EC would not fall over if cod disappeared, however the system would become a different EC (change in character). Individual species may apply to sub-components
		• no one species apply to whole of EC area
		• *Ruppia* in Coorong lagoon completely gone – probably more appropriate under Criteria 4
		• use of groups e.g. colonial nesting water birds (8-10 spp)
		• data for potential species/sp groups:
		  o river red gum
		  o black box
		  o Murray cod
		  o 27 years of eastern aerial water bird survey (EAWS)
		• some good quantitative data & thresholds may be relevant

Qn 2. For **Criteria 4** (reduction in community integrity), do the current regeneration timeframes (criterion thresholds) apply to the River Murray – Darling to Sea EC? If so please suggest why and if not please suggest appropriate alternatives.	• most potent of the six criteria for aquatics • Goulbourn billabongs 350 yrs of resting eggs – endemics • loss of trophic flow-on effect – assemblage • suggest restoration not regeneration • needs to be reconstructed before it's effective • amalgamated things with a range of response time • thresholds do not apply • listing ecosystem based on component species – a problem? • ecosystem – 1956 floodline – water threshold	• can potentially meet but need good support base • functional approach (groupings) may work well • link to process/restoration of process e.g. overbank flows • timeframes important – work for long lived species not for short-lived (fish and invertebrates). Can go extinct within short timeframes • some threats well established e.g. invasive species carp, and willows (reached max impact)

Qn. 3. For **Criteria 5** (rate of continuing detrimental change), do the current thresholds apply to the River Murray – Darling to Sea EC? If so please suggest why and if not please suggest appropriate alternatives.	• same concerns as for Criterion 4
	• biological response
	• landscape metrics for vegetation e.g. 80%, 50%, 30%
	• ELOHA
		• Coorong - last decade massive decrease in connectivity – regulators, barrage closed, low flows
		• changes to frequency of flow over time
		• floodplain
		  o Salinity and increase in salt tolerant vegetation
		  o Tree decline / health
		  o Acid soils – rapid assessment

Qn. 4. Do you have any suggestions for analysis under **Criteria 6** (quantitative analysis showing probability of extinction) for the River Murray – Darling to Sea EC?	• extinction not practical for EC; based on PVA based on species • Coorong conceptual model good – hard to translate whole river • salinity, acid extrapolating • destruction or state change? Consider what state change means, would it be changed to an unrecoverable state – trigger points • limits of intervention – natural or human intervention? • focus on what makes the transition from seedling to functioning tree – community doesn't take shape until we identify species	• acid sulphate soils work – may show something • situation below Lock 1 – extreme example of sub-unit decline of Coorong. Flow to barrages declining, salinity increasing etc. Quantitative data on fish catch, cockle catch, physical and chemical data, etc • challenge in using data to inform process and tell the story in a quantitative sense

Table 9: Listing Criteria 3 – Loss or decline of functionally important species. Results from Group B discussions. [Note: this group ran out of time for full deliberations].

Flora/Fauna	**Decline Thresholds**	**Restore Thresholds**
River red gum	A	
Black box	A	B
River coobah – important role in flood runner creeks	A	
Lignum		
Zooplankton (mixed spp. – ratio of different types)	sliding average more appropriate	
Submerged aquatic plants such as: *Myriophyllum* spp. (water milfoil) *Vallisneria* spp. (eelgrass) *Ruppia* spp. (tassel, widgeon grass)		
Diadromus fish (eels, congolli, lamprey)		
Potadromus fish (Murray cod, callop)		
Small bodied floodplain wetland spp (pigmy perch)		
Emergent vegetation (sedges, reeds, etc)		
Phytoplankton		

Key: A - Has a measurable decline over the last 10 years
- Appropriate timeframe for 3x generations

B - Have not considered as is too difficult

Notes: for Criteria 3 use age structure (number of year classes)

Option Status:

Critically Endangered	Highest	1 Age Class within 3 generations
Endangered	Moderate	2 Age Classes within 3 generations
Vulnerable	Lowest	3 Age Classes within 3 generations

Session Three: Condition Thresholds

Background

For largely terrestrial, vegetation-based systems, national listing has focussed legal protection on remaining patches of the ecological community that are most functional, relatively natural, and in relatively good condition. Condition thresholds assist in identifying a patch of the threatened ecological community and when the EPBC Act is likely to apply to the ecological community. They provide guidance for when a patch of threatened ecological community retains sufficient conservation values to be considered as a matter of National Environmental Significance (NES) as defined under the EPBC Act. This means that the referral, assessment and compliance provisions of the EPBC Act are focussed on the most valuable elements of Australia's natural environment, while heavily degraded patches which do not trigger the 'significance test' of the EPBC Act, will be largely excluded.

However, although severely degraded or modified patches may not be protected as the ecological community listed under the EPBC Act, it is recognised that patches that do not meet the condition thresholds may still retain natural values. Therefore, these patches should not be excluded from recovery and other management actions. It is also recognised that some patches may never recover.

Condition thresholds are determined in consultation with experts on a particular ecological community. For the vegetation-based systems listed to date, they have included a range of aspects or features of the ecological community, such as: richness and diversity of native plants and animals present; vegetation structure and cover attributes; intensity of weed (exotics) invasion; patch size, connectivity and proximity to native vegetation remnants, etc. Therefore, a listed threatened ecological community may be limited to patches that meet a specified suite of key characteristics and condition thresholds. To date, the suitability and applicability of such condition thresholds to complex aquatic systems is unknown and untested.

Previous Technical Workshop Outcomes

The following outcomes from the previous Technical Workshop provide useful background for considering the issue of states and conditions of aquatic ecological communities and related thresholds, particularly that of the River Murray – Darling to Sea EC:

- the River Murray – Darling to Sea EC is highly variable in time and space, and it is accepted as a 'constructed' (regulated) system

- the most useful benchmark state (reference condition) is the good-flow, pre-drought condition of the early 1970s

- states and condition thresholds have been identified and applied to other terrestrial, vegetation-based threatened ECs – we need to determine if they are applicable and can be applied to aquatic systems

- the main aim of condition thresholds should be to determine what is IN and what is OUT of the listed threatened EC for triggering the full referral, assessment and compliance provisions of the EPBC Act. Condition thresholds provide guidance for when the area of a threatened EC retains sufficient conservation values to be considered a matter of National Environmental Significance (NES) as defined under the EPBC Act

- consideration should be given to what condition(s) of the threatened EC we are aiming for to guide management and recovery actions (acknowledging that what the EC looks like and what it functions like will vary under different flow scenarios or states).

Outcomes of Thresholds Workshop

Results of breakout group discussions on condition thresholds are shown in Table 10. In order to consider ‘condition’ it was deemed important for this highly dynamic system (i.e. the River Murray – Darling to Sea) that an appropriate ‘time window’ be determined to better understand and detect rates of change. For such an aquatic system, detection of change was considered by the experts to be realistically about 10 years, with a rolling 10 year average. Therefore a ‘decadal window’ may be appropriate and make sense ecologically. This may also be consistent with ecological thinking of El Niño - which is also roughly on a decadal scale. However, it was acknowledged that there is an element of arbitrariness to this, for example in terms of natural variability, as well as in terms of considering the impact of the weirs on the system which have introduced an ‘un-natural’ element of stability.

Other points of interest raised were:

- need states to help define condition and to assist with detecting detrimental change
- condition metrics (need to be robust) - not a management thing but rather how to define the community
- river ecology - flow is the primary driver and influences everything in the system
- appropriate to use the 1970s as a good condition state
- the impact of regulation may take up to 100 years to show
- differentiate between responses and drivers
- do we recognise comparable states? e.g. hydrological - drought dominated/flood dominated.
- perhaps a ‘buffer’ should be considered for the extreme drought impact
- do we need the concept of states at all? - it was considered yes due to hydrology
- there is a need to understand the system, the sub-systems and how these will be managed in an adaptive management capacity
- what are the metrics of state/transition? – e.g. vegetation, or a range of something ecological (process). What causes change from pristine to irreversibly degraded? For example: Murray hardyhead breed above salinity 10,000 EC (electrical conductivity), and Murray cod below.
- need to conceptualise states - provide elements to describe anthropogenic influences
- is extreme drought a new benchmark?
- likely that no part of the system should be excluded – it is all connected
- need to consider if current state is acceptable?
- floodplain considered in two parts - wetlands and terrestrial areas which are wettable habitat with a temporal component
- small scale backwash condition - drawing river water back into floodplain.

Hydro-geological processes were considered some of the best potential indicators, e.g. near river wetlands (e.g. river red gum), combination of surface and subsurface flow, channel - gaining river, channel - losing river. Salt was also considered a potentially useful geomorphic indicator - with a story of transport, salt accession to the river, rate of storage in floodplain soil, and assessed over 10+ years. The time factor is also important, for example as with low salinity when cod are breeding and juveniles are on the floodplain (note: Murray cod are salt intolerant when breeding).

Answers to Questions on Condition Thresholds

***Qn. 5.** Are there a range of states applicable/relevant/practical for the River Murray - Darling to Sea EC and if so what are they?*

The workshop determined that a range of states were applicable to the River Murray – Darling to Sea ecological community, with hydrology as a primary driver. These are overlain with varying levels of temporal and spatial variability. Therefore states could be categorised from the perspective of flow and the related variables/factors that are influenced by flow (e.g. very low flow, ≤1000-1500 ML/day; low flow,3000 – 7000 ML/day; medium flow, 10 000 – 30 000 ML/day; high flow, 50 000 – 80/90 000 ML/day). Importantly, however, it was recognised that these 'states' may actually represent a series of continua, i.e. a state will occur along a spectrum or continuum. Pertinent examples of this are: wet to dry; flowing to still; fresh to hypersaline; clear to turbid; groundwater recharging to discharging; physical connection to disconnection; etc.

With respect to the state or condition at the key functional species level, it was also considered that a continuum of states applies – for example:

- adults surviving but no recruitment; maintenance of adults - building condition but with limited recruitment; adults in good condition with boom recruitment
- migratory species – presence to absence.

The workshop considered system resilience and capacity for recovery for the ecological community and the concept of 'acceptability' of a certain state. In general it was felt that the system has a high degree of resilience and capacity to recover, but it is possible that the recovered state may be somewhat different compositionally and functionally. For example, exceptions to the 'states-as-continua' approach may occur when 'tipping points' are reached and the system 'flips' to a different ecological state that may or may not be reversible – as for example in the case of a macrophyte dominant system changing to phytoplankton dominant system or sub-system.

***Qn. 6.** Consider these states for the entire River Murray - Darling to Sea EC system **(i.e. broad scale)** and then for other sub-units of the system **(i.e. river channel and water; wetlands; floodplain vegetation; groundwater)**.*

With respect to determination of the condition of the ecological community, the workshop agreed that a useful 'benchmark' state was the early 1970s – with some considering this as the time when the biological impact of regulation began (i.e. biological lags were apparent in the 1970s). This period also represents a time before the major impacts of the European carp invasion were manifest.

Wetlands serve as an example of a sub-unit of the system. There are many types of wetlands, such as lacustrine (relating to lake) and palustrine (relating to wetlands, marshes) depressional wetlands, or vegetated and non-vegetated wetlands. In general, it was considered that the wetland component of the ecological community is represented by a continuum and therefore should not be categorised. On a rudimentary basis it was agreed that wetlands are wet and the floodplain is dry (although sometimes wet). It was, however, acknowledged that different states (e.g. flow) may manifest differently in different components of the system; for example, the existence of a functional estuary state was considered essential. The six sub-units of the ecological community identified in the first, Technical Workshop (i.e. Coorong and Murray Mouth; Lower Lakes; Eastern Mount Lofty Ranges; Swampland Section; Gorge Section; Top Valley Section) were also considered as important in terms of determining state and condition.

One group identified four main flow regime scenarios that may lead to different states in various sub-units of the system, but emphasised that the integral factor of connectivity precludes exclusions of any one component or sub-unit. The ability to recover was considered an important aspect of condition assessment, and it was agreed that most areas within the 1956 floodline are recoverable. For example, the 300 or so floodplain plant species are very resilient and adapted to disturbance. An exception to this general principle of no exclusion may apply to small patches of wetland or floodplain considered to be irreversibly affected by salinity, or pre-existing modified areas such as reclaimed dairy swamps. Pre-existing infrastructure related to river regulation is not considered part of the 'natural' ecological community.

Qn. 7. *Can the concept of condition be applied to all sub-units of the River Murray - Darling to Sea EC? If so, what would be the indicators of condition for these states?*

The workshop agreed that the concept of condition can be applied to all sub-units of the ecological community (by habitat or location) linked to their state at a point in time. However, the workshop also agreed that the notion of defining states to then exclude them from this highly connected system was impractical. It was considered that the concept of 'condition' as used to date under the EPBC Act does not readily apply to aquatic ecosystems .

It was acknowledged that there is a multitude of useful indicators for assigning condition or state to the ecological community and/or its sub-units – notwithstanding the need to allow for natural variability. These range from hydro-geomorphic type indicators such as flow or salinity, through to ecological indicators such as recruitment of a key species, or presence of a suite of plant species (e.g. weeds).

Qn. 8. *What are the possible thresholds for these indicators to enable the 'condition classes' of each of the states previously identified? Answer for broad-scale and specific sub-units if applicable.*

In general, it was not deemed practical to apply thresholds to indicators of state in the highly dynamic and connected system of the River Murray – Darling to Sea EC. An exception may apply for small patches of salt scalded floodplain or swamp under certain circumstances. Importantly, a case-by-case approach should be adopted for interpretation of states of condition were they to be applied in an assessment process under the EPBC Act. Thresholds, indicators and states may have more meaningful application in the post-listing management of aquatic ecological communities or in determining conservation outcomes, such as limits of acceptable change.

Table 10: Results of breakout group discussions on Condition Thresholds.

Questions	Group A	Group B	Group C
Qn 5. Are there a range of states applicable/relevant for the RM-DS EC and if so what are they?	• hydrology is the driver - so states within the system from that viewpoint (i.e. flood, drought, intermediate) • biological impact of regulation began about the 1970s • alien species here to stay so not trying to get back to prior • biological lags apparent in 1970s • does the system maintain capacity for recovery? - there is resilience. • plankton - signature flow - change of state from macrophyte to plankton domination • flip from state A to B - caused by significant change in X? • what makes it go from pristine to stuffed?	• Series of continua: o wet to dry (floodplain wetting) o flowing (+ extent, timing, etc) to lacustrine (still) o water level variable to stable (regulated) o fresh to saline to hypersaline o clear to turbid o connected to disconnected (lat. & longitudinal) o groundwater: recharging to discharging o species: death to survival (adults survive but no recruitment) to maintenance(low recruits, adults build condition) to boom recruitment o migratory species: presence to absence • need to determine what are the PRIMARY drivers • threats should be considered separately • fisheries - in channel flows (below pool) connected floodplain wetlands, broad floodplain flooding	• high temporal / spatial variability throughout entire system and within components • some components more variable than others and more impacted. Different flow states manifest differently in different parts of system e.g. floodplain c.f. to channel or lower lakes (but don't lose sight that everything connected) • possible to identify 4 – 6 States ? • visualise through use of conceptual models & diagrams to illustrate states • threatening processes – consider as deviations from optimal conditions e.g. flow regimes and other threats/stresses to identify condition / targets / triggers
Qn. 6. Consider these states for the entire RM-DS system and then for other sub-units (i.e. channel, wetlands, floodplain vegetation, groundwater).	• notion of wet and dry states • Technical Workshop - 6 sub-regions • sub-units are: river channel & water; floodplain wetlands (a continuum & resisted putting into categories); floodplain woodlands; estuarine & marine; groundwater • may need state for biota	• applies to all sub-units - channel; wetland; floodplain; groundwater o wet/dry o flowing/still o fresh/saline/hypersaline o clear/turbid o connected or not o recharging or discharging o species survival o migratory species	See Table 11.
Qn. 7. What would be the indicators of condition for these states (i.e. as identified in Qn. 2)? Can the concept of condition be applied to all sub-units of the RM-DS EC?	• yes. But little point in defining states to exclude them in this highly connected system. • salt a hydro-geomorph indicator • ELOHA (flow - ecology relationships) • ecological indicators -e.g. recruitment • vegetation condition class indicators associated with land clearing NSW	• Biota o connectivity critical o most areas within 1956 floodplain recoverable o ability to recover is an important aspect of condition assessment o but to what level of recovery? o is halting decline enough? • the concept of "condition" as used to date under EPBC Act does NOT apply to Aquatic Ecosystems	• salinity and flooding (frequency) are key indicators • acid levels? • generally no or very difficult due to natural variability • all resilient floodplain protected but need to define to provide clarity
Qn. 8. What are the possible thresholds for these indicators to enable the 'condition classes' of each of the states identified? Answer for broad-scale and specific sub-units if applicable.	• deal with in terms of big picture – decadal • no point in defining states to exclude them. It's a continuous dynamic system – can't pick off certain areas – even if degraded would still include it – want to include everything	• which modified Habitats are included? o Drainage Basins? o Flowing Anabranches o ASS affected wetlands o Salt Scalded Floodplains o Dairy Swamps • need to establish Criteria to decide o values; amount of water for recovery; o level of funding for recovery	• floodplains: functional groups based on processes • system so dynamic - where trigger starts? • ~300 floodplain species (veg) - very resilient (adapted to disturbance) • no development/cropping below 1956 flood level • targets should be flooding frequency • river channel; wetlands; lakes; Coorong; GW

Table 11: 'State' Scenarios from Breakout Group C

Very Low Flow Water Regime Scenario	Low Flow Water Regime Scenario	Medium Flow Water Regime Scenario	High Flow Water Regime Scenario – two levels
1,500 ML/day (flow across border) – can be as low as 1,000 ML/day	3,000 ML/day up to 7,000 (flow across border) – will be some losses down the system and need to offset evaporation	Approx 10 – 30, 0000 ML/day (flow across border) – will be some losses down the system and need to offset evaporation	Approx 50 – 80/90,0000 ML/day (flow across border) – will be some losses down the system and need to offset evaporation
Response different if low flows follow a period of high flow years	Response different if low flows follow a period of high flow years	Measurable fluctuations in level within the channel (biggest just below a lock)	> 80/90,0000 ML/day
Levels within the channel starting to drop. If over longer period of time can be significant – especially below Lock 1	Limited fluctuations in level within the channel	Important increases in flow / mixing different velocities	Measurable fluctuations in level within the channel and overbank flow. Overbank flow (trigger) commences around 50 ML/day
Floodplains / temp woodlands not inundated (dry – loss of connectivity)	Floodplains / temp. woodlands not inundated (connectivity issue)	Floodplains / temp woodlands inundated	(Lock /weirs impact not relevant)
Risk of permanent wetlands drying out or becoming disconnected	Barrage state – impact based on whether open or closed	Transition phase	Further increases in flow / mixing different velocities
Potential for impact on riparian vegetation	Open => Coorong mixing estuary (limited extent)	Lower elevations wet (floodplains)	Floodplains / temp woodlands inundated =>True connectivity of floodplain, temp. wetlands and river (riparian vegetation and terrestrial)
Potential for acid / sulphate soils	Closed => Coorong marine	Temp. wetlands some wet / some not	Inundation of riparian vegetation
Barrage state – impact based on whether open or closed	Lakes Albert and Alex. - traditionally connected with Albert drying out first (e.g. after several years of low flows)	Inundation of riparian vegetation	Effects on biota – micro / macro (e.g. frog breeding, water birds, fish)
Closed => Coorong marine	Lakes are quite different to channel, floodplain, wetlands	Effects on biota (e.g. frog breeding)	Barrage state – impact based on whether open or closed
Lakes Albert and Alexandrina - lakes drawing down. Salinity increasing. Acid sulphate soils	Coorong => decrease in estuarine extent. North and South Lagoons highly saline (marine to hyper-marine)	Barrage state – impact based on whether open or closed	Generally open in high flow to maintain lake level
Coorong => no estuarine extent. North and South Lagoons marine to hyper-marine	Groundwater – need clarification ? Has impact on floodplain.	Generally open in high flow to maintain lake level	Lakes - Albert and Alexandrina
Mouth maintained in open state (artificial)		Lakes - Albert and Alexandrina	Limited change in water level – but significant connectivity with fringing wetlands
Groundwater – need clarification. Has impact on floodplain		Limited change in water level	Significant flush / improvement in salinity

APPENDIX 1:

AGENDA 'River Murray from Darling to Sea' Threatened Ecological Community Assessment - Criteria and Condition Thresholds Workshop

Monday 19th April; 9.15 for 9.30 am to 5.00 pm
SARDI, South Australian Aquatic Sciences Centre, 21 Hamra Ave, West Beach

Workshop Session One: Setting the Scene and Workshop Objectives

Chair: Matt White

9.30 Welcome and housekeeping
Matt White (Director Ecological Communities, DEWHA)

9.35 Overview of EPBC Act, listing criteria and condition classes for assessing threatened ecological communities and Today's Objectives.
Gina Newton (Ecological Communities, DEWHA)

9.55 Limits of Acceptable Change – Outcomes, lessons & issues from the Murray Riverland and other Ramsar sites.
Lance Lloyd (Lloyd Environmental Consulting)

10.10 Limits of Acceptable Change – Outcomes, lessons & issues from the Coorong and Lower Lakes.
Jason Higham (Department of the Environment and Heritage, SA)

10.25 Questions and Plenary Discussion Session

10.45 MORNING TEA

Workshop Session Two: Listing Criteria Thresholds - Breakout Groups (3x10-13p)

[Chairs: Keith Walker, Rosemary Purdie, Matt White; Rapporteurs: Gina Newton, Lance Lloyd, Chris Auricht]

11.15 Breakout Group - Instructions
Gina Newton

11.20 Breakout Group - Discussions: Thresholds for Listing Criteria (3,4,5 & 6)
3 Groups each led by Chair and Rapporteur to take notes

1.00 LUNCH
[Rapporteurs prepare 10 minute report-back via Power Point over lunch]

Workshop Session Three: Group Report Back 1 – Criteria Thresholds

1.40 Rapporteurs each give 5-10 minute Power Point presentation on results (questions at end)

2.10 Questions and Plenary Discussion on Criteria Thresholds

Workshop Session Four: Condition Thresholds - Breakout Groups (3x10-13p)

[Chairs: Keith Walker, Rosemary Purdie, Matt White; Rapporteurs: Gina Newton, Lance Lloyd, Chris Auricht]

2.30 Condition Class Overview and Instructions
Matt White

2.40 Breakout Group - Discussions: Thresholds for Condition Class
3 Groups each led by Chair and Rapporteur to take notes

3.30 WORKING AFTERNOON TEA *(quick pit-stop and/or grab a quick cuppa and biscuit and be seated)*

Workshop Session Five: Group Report Back 2 – Criteria Thresholds
3.45 Rapporteurs each give 5-10 minute Power Point presentation on results (questions at end)

4.15 Questions and Plenary Discussion on Condition Thresholds

4.55-5.00 pm Workshop Wrap-Up and Close
Matt White (Director, Ecological Communities, DEWHA)

Breakout Groups – Discussion on Criteria and Conditions Thresholds

Group A	Group B	Group C
Chair: Keith Walker **Rapporteur:** Gina Newton	**Chair:** Rosemary Purdie **Rapporteur:** Lance Lloyd	**Chair:** Matt White **Rapporteur:** Chris Auricht
Cherie Campbell	Paul Barraclough	Fiona Bartlett
John Cooke	Tumi Bjornsson	Erin Lenon
Di Conrick	Andrew Chalken	Kerri Muller
Angela Duffy	Jennie Fluin	Jason Nicol
Peter Fairweather	Mike Geddes	Glen Scholz
Ross Peacock	Phil Gibbs	Rebecca Turner
Russ Shiel	Jason Higham	Paul Wainwright
Jeff Richardson	Kate Holland	Tim Wyndham
Wei Yan	Ann Jensen	Brenton Zampati
	Jeanette Muirhead	
	Colin O’Keefe	

Appendix 2a: *Reworked* Limits of Acceptable Change*: Riverland Ramsar Site (Lloyd 2010+)

Component/Process	Limits of Acceptable Change
Hydrological Regime	• **As specified in Table 3**
Remnant habitat *(e.g. floodplain & aquatic vegetation, wetland mosaics)*	• tree health should not decline further than surveyed conditions (e.g. 2003 survey - an estimated 24% tree cover healthy, River Red Gum, Black Box, Coobah) • no loss of > 20% of any vegetation type *Use surveys and a baseline condition (if known) to determine the level of variation*
	• No greater than 20% loss of any wetland type within any 10 year period
Rare, endangered, threatened species	• LAC should be no loss of any recorded, rare or threatened species (over any time period, excluding natural seasonal/annual variations) *Use surveys and a baseline condition (if known) to determine the level of variation*
Diverse and abundant waterbirds	• no net reduction in waterbird breeding numbers over any rolling 10 yr period • no net reduction in waterbird populations (particularly migratory) in any rolling 10 yr • no reduction in number years with >20,000 waterbirds
Diverse fish and invertebrate fauna *(Note: floodplain wetlands support a more diverse macroinvertebrate fauna than the main channel)*	• no loss of any rare or threatened fish and invertebrate species • no net reduction in fish and invertebrate populations over any rolling 10 yr period
High diversity and mosaic of both terrestrial and aquatic habitats	• no further death of trees & no increase in area of unhealthy trees in any 2 yr period • no loss of > 20% of any habitat type (i.e. diversity and mosaic must be maintained) *Baseline condition for habitat diversity can be defined using past and future vegetation surveys*

* Limits of acceptable change (LAC) are defined as '*the range of variation in the components, processes and benefits/services that can occur without causing a change in the ecological character of the site*' (DEWHA 2008).
+Limits of acceptable change (LAC) as reworked to more closely match the current method of setting LAC as an example for the River Murray from Darling to Sea' Threatened Ecological Community Assessment - Criteria and Condition Thresholds Workshop (April 2010).

Lloyd, L.N. 2010. Oral Presentation at River Murray from Darling to Sea' Threatened Ecological Community Assessment - Criteria and Condition Thresholds Workshop, DEWHA.

Appendix 2b: Limits of Acceptable Change*: Riverland Ramsar Site (Lloyd Environmental 2009)

Ecosystem Service	**Limits of Acceptable Change**
Wetland of international, national, or bioregional significance • representative, rare or unique example • supports threatened species or ECs • supports key species for biodiversity maintenance • supports species at a critical life cycle stage or provides refuge • regularly supports > 20,000 waterbirds • regularly supports 1% of individuals in a population of a waterbird species • supports native fish • important food source/migration path for fish	No loss of meeting the first 8 Ramsar listing criteria, with • short-term - ≤ 10% loss of any wetland type within any 2 years • long-term - ≤ 20% loss of any wetland type within any 10 year period
Supports rare, endangered, threatened species	Use surveys and a baseline condition (if known) to determine the level of variation • short and long-term LAC should be no loss of any listed species of flora or fauna
Provision of remnant habitat *(e.g. floodplain, wetland mosaics)*	Use surveys and a baseline condition (if known) to determine the level of variation • short and long-term LAC should be no loss of any recorded, rare or threatened species (over any time period, excluding natural seasonal/annual variations) • tree health cannot decline further than surveyed conditions (e.g. 2003 survey - an estimated 24% tree cover healthy, River Red Gum, Black Box, Coobah) • no net reduction in populations of native fauna (vertebrate and invertebrate) over any 10 year period • no loss of > 20% of any vegetation type
Diverse and abundant waterbirds	Use surveys to determine baseline condition if unknown and levels of variation • short and long-term LAC should be derived from quantitative surveys Long-term LAC: • no net reduction in waterbird breeding numbers over any rolling 10 yr period • no net reduction in waterbird populations (particularly migratory) in any rolling 10 yr • no reduction in number years with >20,000 waterbirds • the site continues to support agreed numbers of rarer birds at same frequency as present
Diverse fish and invertebrate fauna *(Note: floodplain wetlands support a more diverse macroinvertebrate fauna than the main channel)*	Use quantitative surveys to set baseline/variation levels • short-term LAC should be derived from comparing baseline data (e.g. 2006 survey) - levels of variation should not be exceeded in any 2 yr period • long-term LAC - no loss of any rare or threatened fish and invertebrate species • no net reduction in fish and invertebrate populations over any rolling 10 yr period

High diversity and mosaic of both terrestrial and aquatic habitats	Baseline condition for habitat diversity can be defined using past and future vegetation surveys • short-term LAC - no loss of any habitat type (excluding natural seasonal/annual variation); no further death of trees & no increase in area of unhealthy trees in any 2 yr period • long-term LAC - no loss of > 20% of any habitat type (i.e. diversity and mosaic must be maintained)

Appendix 3: LAC for Vegetation Communities based on Hydrological Processes: Riverland Ramsar Site (Lloyd Environmental 2009)

Vegetation Community	Required Hydrologic Regime# for Short-term LAC (survival)	Required Hydrologic Regime# for Long-term LAC (recruitment)
Aquatic - permanent	• recurrence interval - annual (watercourse); 1 in 2 yrs (swamps & billabongs) • duration - permanent • timing - permanent • 3 GL/day - channel; > 26 GL/day swamps & billabongs • Max time between events = 0 for channel, 1 yr for swamps & billabongs • 62% community maintained (combined with semi-permanent) • surface water salinity tolerance 1,500 EC	• annual (watercourse); 1 in 2 yrs (swamps, billabongs) • duration - permanent • timing - permanent • 5 GL/day - channel; up to 40 GL/day some swamps & billabongs • Max time between events = 0 for channel, 1 yr for S&B • 62% community maintained (combined with semi-permanent)
Aquatic - semi-permanent	• 1 in 2 yrs • duration - 3 to 6 months • timing - spring/summer • 40 GL/day • Max time between events = 1 yr • 62% community maintained (combined with permanent) • surface water salinity tolerance 1,500 EC	• 9 yrs in 10 • duration - long, not drying out • timing - Aug/Sept to Jan/Feb • 40 GL/day • Max time between events = 1 yr
Fringing aquatic reed & sedge	• 1 in 2 yrs • duration - 6 months • timing - winter - spring/early summer • 25 - 30 GL/day (adjacent to channel); 45-60 GL/day (on low relict meander plain) • Max time between events = 1- 2 yrs • 89% community maintained • surface water salinity tolerance 1,500 EC	• 7-9 yrs in 10 • duration - 120 days • timing - spring • 25 - 30 GL/day (adjacent to channel); 45-60 (on low relict meander plain) • Max time between events = 1- 2 yrs • 89% community maintained
River Red Gum *forest (flood dependent understorey) and River Red Gum woodland (flood tolerant understorey)*	• 1 in 3 yrs, ≤ 24 months no flooding • duration - 4-7 months (≤24 mths flooding) • timing - winter - spring • 50 GL/day (for ~ ⅓ veg. community); 70 - 80 GL/day (for ⅔ - 80% veg. community) • Max time between events = 2 yrs • 34-38% 50GL/day);70-78% (70-80 GL/day) • root zone salinity tolerance 1,830 EC	• 1 in 3 yrs, ≤ 24 months no flooding • duration - 4-7 months (≤24 mths flooding) • timing - winter - spring • 50 GL/day (for ~ ⅓ veg. community); 80 GL/day (for 80% veg. community) • Max time between events = serial inundation 2-3 yrs in succession to optimise recruitment probability

Appendix 3 continued

Vegetation Community	Required Hydrologic Regime# for Short-term LAC (survival)	Required Hydrologic Regime# for Long-term LAC (recruitment)
Lignum shrubland	• 1 in 3-10 yrs, more frequent in saline soils • duration - minimum 3 - 6 months • timing - unknown • 50 GL/day (for ~ ⅓ veg. community); 70 GL/day (for ⅔ veg. community) • Max time between events = unknown but drying required between floods to crack soil • 37% 50GL/day); 73% (80 GL/day) • root zone salinity tolerance 1,830 EC	• 1 in 2-8 yrs, more frequent in saline soils • duration - 120 days • timing - unknown, long summer floods? • 50 GL/day (for ~ ⅓ veg. community); 70 GL/day (for ⅔ veg. community) • Max time between events = unknown but complete drying required between floods to crack and aerate soil
River saltbush chenopod shrubland and Low chenopod shrubland	• 1 year in 30 • duration - 2 - 4 months • timing - possibly not critical • 60-70 GL/day (for ~ ¼-½ veg. community); 300 GL/day (for most veg. community) • Max time between events = unknown • 27-49% 70GL/day);~ 100% (300 GL/day) • soil ECe = 30 dS/m	• 1 year in 10 (2-3 yrs in succession every 30 yrs) • duration - long enough to saturate soil with slow recession • timing - unknown • 60-70 GL/day (for ~ ¼-½ veg. community); 300 GL/day (for most) • Max time between events = unknown • soil ECe = 20 dS/m
Samphire low shrubland	• 1 year in 3-10, more frequent in saline soils • duration - minimum 3 - 6 months • timing - unknown • 50-60 GL/day (for ~ 60% veg. community); 80 GL/day (for 80% veg. community) • Max time between events = unknown • 60% (60GL/day); 82% (80 GL/day) soil ECe = 30 dS/m	• 1 yr in 2-8, more frequent in saline soils • duration - 120 days • timing - unknown/summer floods wet soil • 50-60 GL/day (for ~ 60% veg. community); 80 GL/day (for 80%) • Max time between events = unknown • 60% (60GL/day); 82% (80 GL/day) soil ECe = 20 dS/m
Black Box woodland	• 1 year in 30 • duration - 2 - 4 months • timing - possibly not critical • 70 GL/day (for ~ 20% veg. community); 100 GL/day (for 40% veg. community); 300 GL/day (for almost all veg. community) • Max time between events = 30 years	• 1 year in 10 (2-3yrs in succession every 30 yrs) • duration - long enough to saturate surface soil, with slow recession • timing - unknown • 70 GL/day (for ~ 20% veg. community); 100 GL/day (for 40% veg. community); 300 GL/day (for almost all veg. community)

	• 22% (70GL/day); 41% (100 GL/day); ~100% (300 GL/day) • soil ECe = <40 dS/m	• Max time between events = unknown • soil ECe = <40 dS/m

[#] *If the hydrological limits provided for maintenance of the vegetation communities are met, then it is likely that the limits for ecosystem services will also be met. LAC for water quality are not set, apart from salinity, as they do not strongly affect the ecological character of the site independent of other factors.*