

Technical note supporting the 2018 Murray Mouth (Days open) Trend and Condition Report Card

DEW Technical note 2018/17



Government of South Australia

Department for Environment
and Water

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Department for Environment and Water

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Summary

This report provides the background information, assessment methods and more detailed discussion for the Murray Mouth (Days open) Trend and Condition Report Card developed as part of the 2018? NRM report cards.

The Murray Mouth Report Card seeks to report on the trend and condition of the openness of the Murray Mouth. The report draws on previous work that has developed thresholds for both management intervention and definitions of "open". The Diurnal Tide Ratio (DTR) was used to assess the condition of the Murray Mouth, with a DTR of greater than 0.3 being considered "open" and a DTR of less than 0.2 being "critical".

In 2016, the Mouth was "open" for 76% of the calendar year. A major contributing factor to this score was the operation of two dredges over the majority of the 2016 year. Without the dredges, the mouth would likely been critical for the majority of the year. The current management objectives for the Murray Mouth state that the goal is to keep the mouth open with flows over the barrages and not with dredging. The operation of the dredges is expensive and does not provide the equivalent ecological benefits of having the Mouth open with flow. Therefore, the condition was assessed as **poor**.

The trend over the last 10 years has been considered **getting better**. This can be attributed to the unregulated flow events in 2010–11, 2011–12 and 2016–17. This trend is not surprising as the last 10 years includes the last few years of the Millennium Drought.

The condition of the Murray Mouth will always be considered poor while there is a need to dredge.

The assessment of the trend and condition of the Murray Mouth was based upon reliable data, rated as 5 out of a possible 5 due to its currency, applicability, representation and accuracy.

1 Introduction

The *Natural Resources Management Act 2004* has a requirement ‘to keep the state and condition of the natural resources of the State under review.’ In order to consolidate the data collected around the state in to a simple, easy to interpret information source, the Department for Environment and Water (DEW) produces report cards for the state’s natural resources. Previous rounds of report cards have reported against the targets in the South Australian Natural Resources Management Plan (Government of South Australia, 2012). However, for the next round of reporting, the report cards will not only seek to report on the state of the natural resources of South Australia, but will also form the main source of data for the State of the Environment Report.

The State of the Environment Report (SOER) is a legislated requirement under the *Environment Protection Act 1993*. The SOER has several key assessments that need to be undertaken including:

- Include an assessment of the condition of the major environmental resources of South Australia 112(3(a))
- Include a specific assessment of the state of the River Murray, especially taking into account the Objectives for a Healthy River Murray under the *River Murray Act 2003* 112(3(ab))
- Identify significant trends in environmental quality based on an analysis of indicators of environmental quality 112(3(b))

The River Murray has previously been part of the reporting process as it is a focal point of the state’s natural resources. See the 2014 River Murray report cards [here](#). However, the way that the river health has been assessed has continuously been adapted to reflect the needs of the reporting within the constraints of the available data and information. For the 2017 report cards, the River Murray report cards will be adapted to reflect the requirements of the SOER.

The *Environment Protection Act 1993* specifically refers to the *River Murray Act 2003* for the assessment of the health of the River Murray. Under the River Murray Act there is a series of objectives known as the Objectives for a Healthy River Murray (*River Murray Act 2003* 7(1-5)). These objectives cover a range of issues including:

- River health
- Environmental flows
- Water quality
- Human dimensions.

The suite of River Murray report cards for 2017 was developed with specific line of sight to the objectives for a healthy River Murray to facilitate both adequate reporting on the condition of the state’s natural resources as well as the requirements of the SOER.

The seven report cards for the River Murray are:

- River Murray: floodplain trees (Tree condition index) Trend and Condition Report Card
- River Murray: Coorong and Lower Lakes vegetation (Vegetation target success) Trend and Condition Report Card
- River Murray: high value wetlands (Achievement of ecological targets) Trend and Condition Report Card
- River Murray: Murray Mouth (Days open) Trend and Condition Report Card
- River Murray: fish passage (Permanently wet area accessible) Trend and Condition Report Card

- River Murray: flow regime (Achievement of environmental water requirements) Trend and Condition Report Card
- River Murray: water (quantity and quality) Trend and Condition Report Card

This report provides the background information, methodology and results that will underpin the 2017 Murray Mouth (Days open) Trend and Condition. The report card will report on the current condition and trend of the Murray Mouth in relation to the objectives of the *River Murray Act 2003* with comment on the objectives in the Basin Plan and delivery of environmental water.

The Mouth of the River Murray is located in South Australia, approximately 10 km east-south-east from Goolwa, and is the point where the River Murray meets the Southern Ocean. The maintenance of an open Mouth is considered to be important as this connection allows for the passage of recreational and commercial vessels as well as the many fish species that move between the marine and freshwater environment of the River Murray (DWLBC, 2008; MDBA, 2014; O'Connor et al., 2015). It is also important as it allows for the exchange of both freshwater and oxygenated seawater water between the Coorong and the Southern Ocean, maintaining suitable water parameters (in combination with suitable barrage flow) (O'Connor et al., 2015).

The importance of an open Murray Mouth has been recognised in both State and Federal legislation. The *South Australian River Murray Act 2003* has a specific objective that relates to the Murray Mouth. Section 7(3)b states that "the Murray Mouth should be kept open in order to maintain navigation and the passage of fish in the area, and to enhance the health of the River Murray system and estuarine conditions in the Coorong." The Basin Plan has multiple references to an open Mouth all relating to "enhanced economic, social and environmental outcomes" (Section 7.09(d)). Specifically, the Basin Plan has an outcome of "ensuring the mouth of the River Murray is open without the need for dredging in at least 95% of years, with flows every year through the Murray Mouth Barrages" (Schedule 5(2) c).

The Mouth is subjected to multiple forces that result in a dynamic environment (DWLBC, 2008). The Mouth is in a depositional environment with sand being deposited into the mouth from the ocean. Without sufficient flow through the mouth, this sand deposition results in the mouth silting up and eventually closing (DWLBC, 2008). This has been seen in recent years with the Mouth completely closing for a short duration in 1981 and nearly closing again in 2002.

In 2002, in response to the risk of closure of the Mouth, the South Australian Government began a dredging program to remove the buildup of sand in the mouth (Murray Mouth Sand Pumping Program, DWLBC, 2008). Dredging the Mouth is the most cost effective and culturally acceptable method of maintaining an open Mouth when river flows are insufficient. Two channels were dredged, one connecting to the Goolwa Channel and one to the Tauwichee Channel. These were first completed in 2006 and maintained by dredge through to the 2010 when higher flows returned to the Mouth. In January 2015, dredging was recommenced in response to increase siltation levels (Pers. Comm. Eaton J. 5th October, 2017). Dredging was paused during the 2016/17 high River Murray flow event but has recommenced from January 2017 (Pers. Comm. Eaton J. 5th October, 2017).

The Mouth is monitored to ensure that accurate and timely information is provided to decision makers. Current monitoring consists of the following:

- A combination of weekly (coarse) and 6 weekly (detailed) bathymetric surveys to assess the configuration of the dredging program and the volume of sand inside the Mouth
- Monthly Diurnal Tide Ratio (DTR) updates
- Depth and continuity of channels within the Coorong and Mouth
- Weekly review of aerial photography

The key measure that is used to assess if the Mouth is open is the DTR (O'Connor et al., 2015). This is a measure of the energy of water level fluctuations in the Coorong relative to the Southern Ocean (DWLBC, 2008). The DTR is used as an indicator by the Murray Mouth Sand Pumping Steering Committee (comprising membership from the Murray-Darling Basin Authority, SA Water and the Department for Environment and Water) to assess the effectiveness of and to broadly manage the dredging operations.

A DTR of 0 represents a complete physical closure of the Mouth, however, in order to function as an exchange point for water between the Coorong and the Southern Ocean, the mouth does not just need to be physically open, it needs to be sufficiently open to allow for exchange. A lower DTR suggests that there is greater disconnection between the bodies of water created by the siltation of the Mouth i.e. between the Coorong and Southern Ocean. The key performance indicator for the sand dredging program is to maintain a DTR of greater than 0.2 with the point of intervention, i.e. the point at which values are impacted, is a DTR of 0.3 (DWLBC, 2008). For this report, the DTR level of 0.3 will be used to represent an "open" Mouth. A DTR below 0.2 will be referred to as "critical".

2 Methods

2.1 Condition assessment

The Department for Environment and Water (DEW) collects monitoring data on the Murray Mouth. In order to assess whether the Mouth has been maintained in an open state the Diurnal Tide Ratio (DTR) was assessed against its 0.3 threshold.

DTR information was sourced from the River Murray Operations Group along with information on dredging operations (J. Eaton (DEW), 2017, pers. comm., 5th October). The DTR information started from October 2002 and was last updated at the end of 2016. Operational information on dredging covered the period from October 2002 to present. DTR values are updated on a monthly basis.

The percentage of time spent in both 'open' and 'critical' states was calculated for each year between 2002 and 2016. Condition scores were developed as part of this report card development and were assigned based on the percentage of days that the Murray Mouth was considered open (DTR > 0.3) (see Table 1).

Table 1: Condition assessment criteria for the Murray Mouth for the River Murray: Murray Mouth (Days open) Trend and Condition Report Card

| Condition assessment | Report card definition | Percentage of days |
|----------------------|--|--|
| Very good | The natural resource is in a state that meets all environmental, economic and social expectations, based on this indicator. Thus, desirable function can be expected for all processes/services expected of this resource, now and into the future, even during times of stress (e.g. prolonged drought) | 95-100 – (Basin Plan Target, River Murray Act Objective) |
| Good | The natural resource is in a state that meets most environmental, economic and social expectations, based on this indicator. Thus, desirable function can be expected for only some processes/services expected of this resource, now and into the future, even during times of stress (e.g. prolonged drought) | 90-94 |
| Fair | The natural resource is in a state that does not meet some environmental, economic and social expectations, based on this indicator. Thus, desirable function cannot be expected from many processes/services expected of this resource, now and into the future, particularly during times of stress (e.g. prolonged drought) | 80-89 |
| Poor | The natural resource is in a state that does not meet most environmental, economic and social expectations, based on this indicator. Thus, desirable function cannot be expected from most processes/services expected of this resource, now and into the future, particularly during times of stress (e.g. prolonged drought) | <80 |

2.2 Trend assessment

The trend assessment was undertaken on the annual percentage of days where the Mouth was open for the last 10 years (2007–16). Days with missing data were removed from the analysis and the total days adjusted accordingly. A linear regression was performed to identify the slope of the line. A positive slope illustrates that the percentage of days per year that the Mouth was open is increasing over the 10 year window, i.e. getting better. A negative slope illustrates the opposite, i.e. getting worse.

2.3 Reliability

The reliability of the data was scored using the scoring system developed for the 2018? Report Cards. This scoring system uses four scores (1–5) to assess different aspects of the data used to underpin the report card. Scores for all four are then averaged to determine the final score. The four scores are:

- Information currency
- Information applicability
- Spatial representation
- Information accuracy

Scoring was undertaken according to Table 2.

Table 2: Scoring system for the reliability of the information used to underpin the analysis for the River Murray Fish Passage Report Card.

| Score given | Information currency | Information applicability | Spatial representation | Information accuracy |
|-------------|--------------------------------|---|--|--|
| 5 | Information >10 years old | Data are based on expert opinion of the measure | From an area that represents less than 5% the spatial distribution of the asset within the region/state or spatial representation unknown | Better than could be expected by chance |
| 4 | Information up to 10 years old | All data based on indirect indicators of the measure | From an area that represents less than 25% the spatial distribution of the asset within the region/state | > 60% better than could be expected by chance |
| 3 | Information up to 7 years old | Most data based on indirect indicators of the measure | From an area that represents less than half the spatial distribution of the asset within the region/state | > 70 % better than could be expected by chance |
| 2 | Information up to 5 years old | Most data based on direct indicators of the measure | From across the whole region/state (or whole distribution of asset within the region/state) using a sampling design that is not stratified | > 80 % better than could be expected by chance |
| 1 | Information up to 3 years old | All data based on direct indicators of the measure | From across the whole region/state (or whole distribution of asset within the region/state) using a stratified sampling design | > 90 % better than could be expected by chance |

3 Results

3.1 Trend

The Diurnal Tide Ratio (DTR) shows an increasing trend over the entire record of data from 2002 to 2016. Associated with this is an increase in the number of days that the Murray Mouth is considered to be open. Figure 1 illustrates the DTR over the 2002-16 periods. Highlighted on this figure are the periods when a single dredge (light grey) or two dredges (dark grey) were operating.

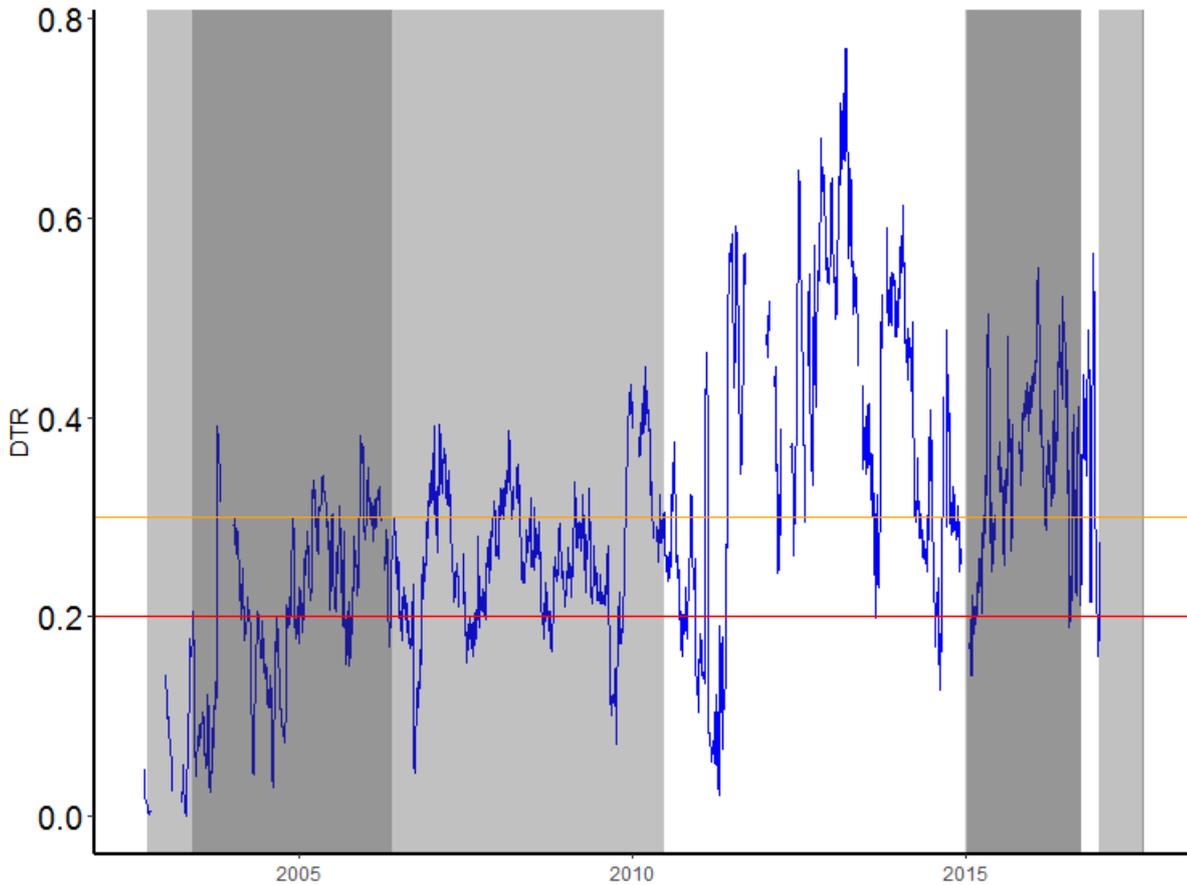


Figure 1: Diurnal Tide Ratio for the Murray Mouth (2002-2016)

Dredge operations are highlighted in grey (light grey for a single dredge, dark grey for two dredges). The orange line represents the 0.3 threshold that denotes an open Murray Mouth. The red line represents the 0.2 level below which the siltation in the Murray Mouth is considered critical. This figure was modified for the report card.

The number of days per year that the Mouth was considered open (DTR >0.3) also shows an increasing trend, although the trend is stronger than the base DTR data (Figure 2). Conversely, the percentage of days where the siltation was considered critical shows a strong decreasing trend.

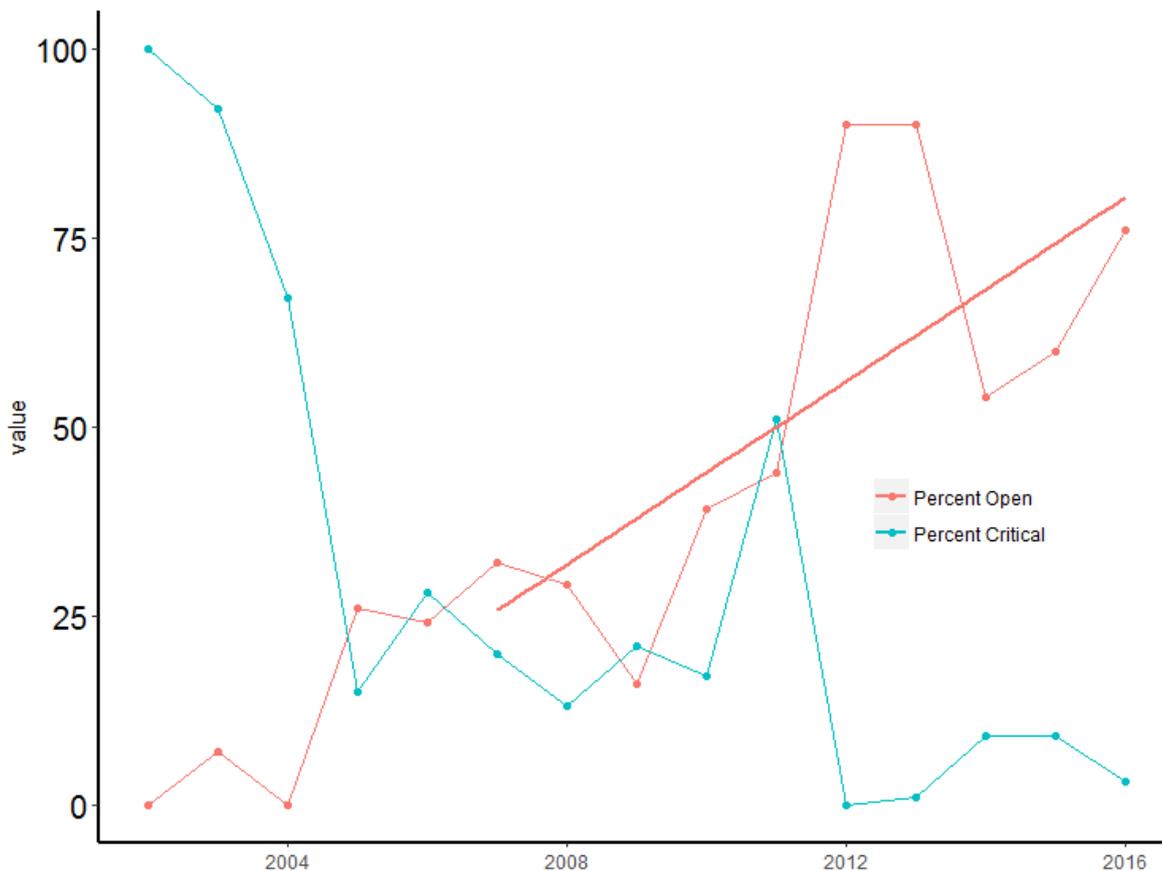


Figure 2: Annual percentages of time the Murray Mouth was considered open (DTR > 0.3) or critical (DTR < 0.2)
Trend line illustrates the trend in the percentage of time the Murray Mouth was considered open during the period 2007–16. This figure was modified for the report card.

3.2 Condition

Based on the condition criteria set out in Table 1, the condition of the Mouth in 2016 was poor. It is likely that without the operation of the dredges, the Mouth would have been in a critical state (DTR less than 0.2) for the majority of the year. This means the natural resource is in a state that does not meet most environmental, economic and social expectations, based on this indicator. Thus, desirable function cannot be currently expected from most processes/services of this resource. This is expected given the operation of two dredges in the Mouth over the majority of the year. It should be noted that the continued accumulation of consolidated sediments behind the Mouth provide for a much narrower depositional environment in the Goolwa and Tauwitschere channels. The High River Murray Flow event in 2016 was not of a significant duration to enable scouring of the Mouth, similar to what was observed in 2011 when dredging ceased until resuming in January 2015.

3.3 Reliability

The scores for each of the four guides along with justification is provided in Table 3.

Table 3: Results of the reliability assessment of the DTR data

| Guide | Score | Justification |
|------------------------|-------|--|
| Currency | 5 | Data available up to the end of 2016 |
| Applicability | 5 | Data is a direct measure of the indicator |
| Spatial representation | 5 | Data is specific for the Murray Mouth |
| Accuracy | 5 | Data is collected using calibrated instruments. Missing data has been accounted for in methods |

The overall reliability of the data is considered to be five out of a possible five. The DTR is derived from data collected in and around the Murray Mouth. While there is a predicted DTR that could be used to infill missing data, this has not been used for this report. Overall there is a 12.1% missing data rate for the DTR on which the analysis is based. Missing data was removed from the analysis and the total days adjusted accordingly.

4 Discussion

4.1 Trend

The overarching trend in the DTR results is increasing as is the annual percentage of days where the Mouth was considered open. This result is not surprising as the data begins collection during the Millennium Drought, with the first eight years of data representing the majority of the worst drought since European settlement (van Dijk et al., 2013).

There is a notable increase in the DTR from the start of records through to mid-2006 and again from the start of 2015 through to late 2016. These increases illustrate the effect of dredging on the DTR and on the Mouth as a whole. This report makes no attempt to separate out the effects of dredging versus the effects of barrage releases on the DTR and on the openness of the Mouth.

The current trend is being sustained through the use of dredges. Therefore, it is important to note that while the trend in the DTR is getting better, the condition score will not improve until the Mouth can be maintained at a DTR of greater than 0.3 through flow alone.

4.2 Condition

Given dredging remains in place, despite the delivery of environmental water over the past three years (averaging around 1000 GL/year), the Mouth is regarded as being in poor condition. While the Mouth was physically open for 100% of the year, the condition of the Mouth for 2016 was classed as 'poor' as the mouth had a DTR of 0.3 or greater for 76% of the year. This reflects that while the Mouth was physically open, it was not considered to be functionally open and, therefore, not able to provide the functions that would be expected of a fully open and functional Murray Mouth.

The rating of poor suggests that many of functions of the Mouth were impaired, in this case passage of vessels and fish as well as impairment of the hydrological connection to the Coorong and the associated maintenance of water quality. As there were two dredges operating for the majority of 2016, it suggests that in order to achieve the outcomes outlined in the *River Murray Act 2003* additional flow is required. In order to flush the mouth of sediments, a longer duration flow event is required, particularly in the range of 60–70 GL/day, similar to that which occurred in 2011, for a longer duration. Post the 2011 flow event the dredges were not required for four years.

In order to achieve the Basin Plan objective for the Murray Mouth, it is apparent that additional flows are required to ensure the Mouth of the River Murray is open without the need for dredging in at least 95% of years, with flows every year through the Murray Mouth Barrages. The Basin Plan seeks to return an average of up to 3200 GL of water to the River for environmental use, with a portion of this water set aside to increase flows through the Murray Mouth.

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