

Ecosystems and Landscapes

1 Catchment Health

Indicator Overview

A catchment disturbance index (CDI) reports the likely impacts of different land-uses on water quality entering Darwin Harbour. This indicator was used in the 2021 Darwin Harbour Integrated Report Card (DHIRC) and is calculated by the Department of Environment, Parks and Water Security within the Northern Territory Government.

Methodology

The CDI is developed using satellite imagery to classify six different land uses, which are each assigned an “impact to water quality” weighting. Land-use is defined using the Australian Land Use and Management (ALUM) classification guidelines shown in Table 1-1 with weightings developed using expert opinion and reference to historical studies in the region including TraCK FARWH trials in the Daly and Darwin regions¹, and the Australian Water Resources Assessment of River and Wetland Health (2005)².

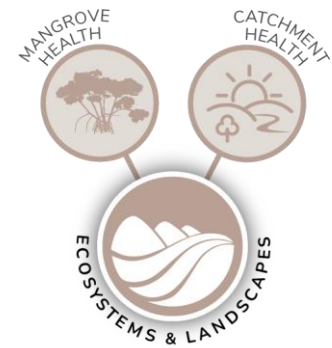


Table 1-1. Land use classes used in CDI calculations.

| Land use class | ALUM Classification | Weighting |
|----------------|---|-----------|
| 1 | Conservation and natural environments | 0 |
| 2 | Production from relatively natural environments: grazing natural vegetation | 0.35 |
| 3 | Production from dryland agriculture and plantations | 0.53 |
| 4 | Production from irrigated agriculture and plantations | 0.70 |
| 5 | Intensive uses | 0.68 |
| 6 | Water | 0 |

The CDI reports on a scale between 0.3 (most disturbed) and 1.0 (least disturbed). The CDI is converted to a report card score using a linear relationship (Figure 1-1). This relationship is represented by Equation 1 which is used for converting CDI to a report card score.

¹ Dixon I, Dobbs R, Townsend S, Close P, Ligtermoet E, Dostine P, Duncan R, Kennard M and Tunbridge D 2011, 'Trial of the Framework for the Assessment of River and Wetland Health (FARWH) in the wet-dry tropics for the Daly and Fitzroy Rivers', Tropical Rivers and Coastal Knowledge (TRaCK) research consortium, Charles Darwin University, Darwin.

² Norris, R. & Dyer, Fiona & Hairsine, P. & Kennard, Mark & Linke, Simon & Merrin, Linda & Read, A. & Robinson, Wayne & Wilkinson, Scott & Williams, David. (2007). Australian Water Resources 2005, Assessment of river and wetland health: A framework for comp

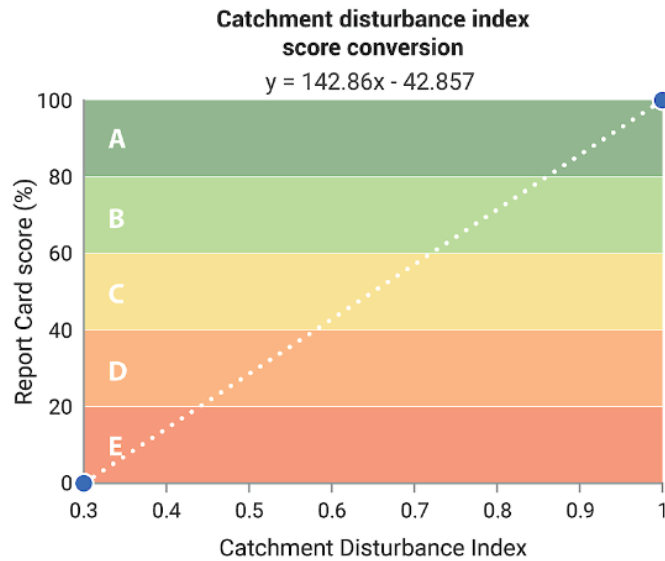


Figure 1-1. Linear relationship between the catchment disturbance index (CDI) scale and the standardised 0-100% report card scale. Report card indicator results are standardised to a common scale of 0-100% and categorised into five categories ranging from 'Very Poor' to 'Very Good'. If a score is within 5% of a grade boundary, a '+' or '-' is added to the grade (e.g. a score of 58% = C+, whereas a score of 62% = B-).

Equation 1. Method for converting catchment disturbance index (CDI) results into a standardised 0-100% report card scale.

$$\text{Report card score} = 142.86 * (\text{CDI}) - 42.857$$

Report card score and grade

The CDI scores for the current and previous report periods are shown in Table 1-2. The 2023 CDI scores demonstrate higher levels of disturbance in the Howard River and Western Harbour regions, and decreased levels of disturbance in the Darwin City, Pioneer Creek and Elizabeth River regions when compared to 2021.

Table 1-2. Summary of catchment disturbance index (CDI) scores in 2021 and 2023.

| Region | 2021 CDI score | 2021 Report Card score | 2021 Grade | 2023 CDI score | DHIRC 2024 score | DHIRC 2024 grade |
|-----------------|----------------|------------------------|------------|----------------|------------------|------------------|
| Darwin City | 0.42 | 17 | E | 0.45 | 21.4 | D |
| Elizabeth River | 0.62 | 45 | C | 0.70 | 56.8 | C+ |
| Blackmore River | 0.83 | 76 | B+ | 0.83 | 75.2 | B+ |
| Palmerston City | 0.64 | 48 | C | 0.62 | 45.9 | C |
| Pioneer Creek | 0.96 | 94 | A | 0.99 | 98.5 | A+ |
| Rapid Creek | 0.44 | 20 | D | 0.45 | 21.3 | D |
| Howard River | 0.87 | 81 | A | 0.81 | 72.8 | B |

| | | | | | | |
|----------------------------|------|-----------|-----------|------|-------------|----------|
| Western Harbour | 0.99 | 99 | A+ | 0.97 | 96.4 | A+ |
| Area Weighted Score | | 75 | B+ | | 73.8 | B |

Note: Recent revision of LUMP datasets have resulted in some changes to the previous categorisation of uses which may explain any discrepancies since the 2020 dataset was generated. Table 2 is based on revised 2021 CDI scores which vary from those presented in the 2021 DHIRC. It also may reflect changes in land use such as a change in production or conversion to low intensity land use. The recent use of sentinel imagery may also result in enhanced resolution for areas. The Rangeland group of DEPWS now undertake annual revisions of land use to enable detection and response to change. A summary of these scores has been provided below in Appendix A.

The Darwin Harbour Catchment has attained an overall ‘B’ grade for CDI in the 2024 Report Card (Table 1-3). This represents a minor reduction from the ‘B+’ obtained in 2021, driven predominantly by a reduction in CDI scores for Howard River.

Table 1-3. Overall results for CDI for the 2024 DHIRC.

| | DHIRC 2021 | DHIRC 2024 |
|-------------------|------------|------------|
| Report Card Score | 75 | 73.8 |
| Report Card Grade | B+ | B |

2 Mangrove Health

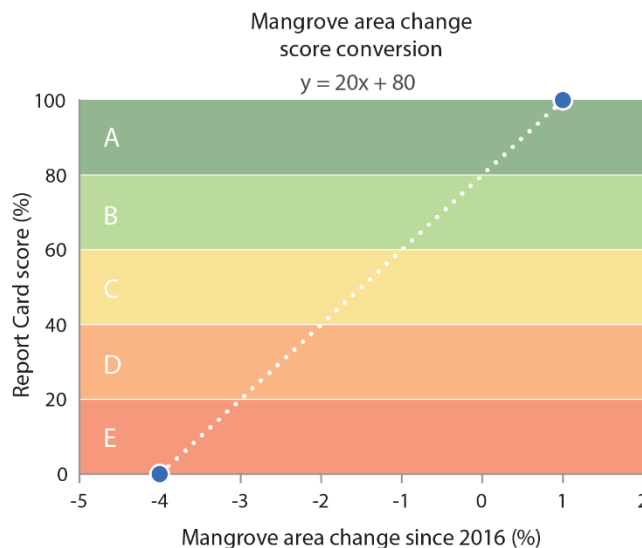
Indicator Overview

Mangrove extent is an ideal ecosystem health indicator due to its sensitivity to environmental and human induced pressures. The presence and abundance of mangroves reflect the overall well-being of coastal ecosystems, as these unique habitats play vital roles in supporting biodiversity, protecting coastlines, and serving as indicators of water quality and climate resilience in Darwin Harbour. Mangrove extent was identified in the inaugural 2021 Darwin Harbour Integrated Report Card (DHIRC) as an indicator within the Ecosystems and Landscapes value and remains an indicator in the 2024 DHIRC.

Methodology

Mangrove extent along the creeks, rivers and coastline of Darwin Harbour is assessed annually by the Department of Environment, Parks and Water Security within the Northern Territory Government (NT Government) using satellite imagery to detect the expansion or contraction of mangrove forests. Sentinel fractional cover imagery is the basis for comparing years, with 2016 as the baseline. Mangrove extent classification was undertaken for the 2024 DHIRC on imagery collected in 2022 using machine learning Random Forest Classification³ combined with manual editing to avoid false positive classification of mangroves via UAV imagery of monitoring sites and aerial photographs.

During stakeholder consultation in 2020/21, it was decided that no change (or an increase) in mangrove area compared to a 2016 baseline of mangrove area equates to a very good report card grade (A); and a net loss of 3% or more of mangrove area compared to the 2016 baseline, equates to a very poor report card grade (E). Change in mangrove extent is standardised to the 0-100% report card scoring scale as shown in Figure 2-1 and outlined in Equation 2.



³ Staben, G., Lucieer, A., and Scarth, P. 2018. Modelling LiDAR derived tree canopy height from Landsat TM, ETM+ and OLI satellite imagery—A machine learning approach. *International Journal of Applied Earth Observation and Geoinformation*, 73, 666-681.

Figure 2-1. Linear relationship between % mangrove area change and the standardised 0-100% report card scale. Report card indicator results are standardised to a common scale of 0-100% and categorised into five categories ranging from 'Very Poor' to 'Very Good'. A score of 80% or more (A grade) indicates that mangrove area has remained the same or improved; whilst a score of 20% or less indicates that mangrove area has decreased by 3% or more (E grade). If a score is within 5% of a grade boundary, a '+' or '-' is added to the grade (e.g. a score of 58% = C+, whereas a score of 62% = B-).

Equation 2. Formula for converting Mangrove Area Change (%) to the standardised 0-100% report card scale.

$$\text{Report card score} = 20 * (\% \text{ mangrove area change}) + 80$$

Report card score and grade

The Darwin Harbour attained an overall 'A+' grade for the indicator mangrove extent in the 2024 DHIRC (Table 2-1 and Table 2-2). Results show an increase in mangrove area in all regions, except in Central Harbour, which showed a slight decrease in mangrove area. The regions with the greatest increase (> 3%), were Shoal Bay and Buffalo Creek.

Table 2-1. Darwin Harbour mangrove area change standardised scores.

| Region (Harbour) | 2016 Mangrove area (ha) | 2022 Mangrove area (ha) | Net change in mangrove extent between 2016 - 2022 ha (%) | DHIRC 2024 Score (0-100%) (Equation 2) | DHIRC 2024 Grade |
|-----------------------------|-------------------------|-------------------------|--|--|------------------|
| Elizabeth River | 2,052.79 | 2,073.07 | +20.28 (0.99) | 99.8 | A+ |
| East Arm | 2,741.88 | 2,768.66 | +26.78 (0.98) | 99.5 | A+ |
| Middle Arm | 6,585.89 | 6,635.28 | +49.39 (0.75) | 95.0 | A+ |
| West Arm | 5,250.36 | 5,298.10 | +47.74 (0.91) | 98.2 | A+ |
| Central Harbour | 1,303.47 | 1,303.15 | -0.32 (-0.02) | 79.5 | B+ |
| Outer Harbour | 530.77 | 533.78 | +3.01 (0.57) | 91.3 | A+ |
| Shoal Bay | 6,220.84 | 6,448.38 | +227.54 (3.66) | 100.0 | A+ |
| Buffalo Creek | 339.92 | 354.51 | +14.59 (4.29) | 100.0 | A+ |
| Myrmidon Creek | 370.35 | 375.97 | +5.62 (1.52) | 100.0 | A+ |
| Darwin Harbour Total | 25,396.27 | 25,790.90 | +394.63 (1.55) | 100.0 | A+ |

Table 2-2. Overall results for Mangrove Extent for the 2024 DHIRC.

| | DHIRC 2024 |
|-------------------|------------|
| Report Card Score | 100.0 |
| Report Card Grade | A+ |

The additional manual editing applied to mangrove detection in the 2024 DHIRC represents a significant improvement in accuracy over the method originally applied for the 2021 DHIRC. As a consequence, the results between report cards are not comparable. Works are underway to recalculate results from the

2021 DHIRC using this refined method to allow true comparison, however the results of this analysis are not available at this time.