Gorgon Gas Development and Jansz Feed Gas Pipeline

Environmental Performance Report 2023

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Contents

Tables

Figures

1 Introduction

1.1 Proponent

Chevron Australia Pty Ltd (CAPL) is the Proponent and the person taking the action for the Gorgon Gas Development and Jansz Feed Gas Pipeline (collectively referred to hereafter as the Gorgon Gas Development [the 'Project']) on behalf of these companies (collectively known as the Gorgon Joint Venture Participants):

- Chevron Australia Pty Ltd
- Shell Australia Pty Ltd
- Mobil Australia Resources Company Pty Ltd
- Osaka Gas Gorgon Pty Ltd
- Tokyo Gas Gorgon Pty Ltd
- JERA Gorgon Pty Ltd.

1.2 Purpose of this Environmental Performance Report

CAPL, as the Proponent, is required to prepare an Environmental Performance Report (EPR) in accordance with:

- Condition 5 and Schedule 3 of Ministerial Statement (MS) 800 (and Condition 2 of MS 965), as amended by MS 1198
- Condition 5 and Schedule 3 of MS 769
- Condition 4 and Schedule 3 of EPBC 2003/1294
- Condition 4 and Schedule 3 of EPBC 2008/4178
- relevant systems, programs, and plans as amended or replaced from time to time approved under MS 800, MS 769, MS 965, and EPBC 2003/1294 and 2008/4178.

1.3 Contents of this EPR

This EPR covers the period from 10 August 2022 to 9 August 2023 (the 'Reporting Period') unless otherwise stated. Table 1-1 lists the State and Commonwealth Condition requirements of this EPR and the sections in this EPR that fulfil them. This includes the EPR requirements under Schedule 3 of MS 800, MS 769, EPBC 2003/1294, and EPBC 2008/4178 and any additional EPR commitments contained in relevant systems, programs, and plans.

Table 1-1: Environmental performance reporting requirements addressed in this EPR

Environmental Aspect	MS 800	MS 769	EPBC 2003/1294	EPBC 2008/4178	EMP Commitment	Section in this EPR
Terrestrial and Subterranean Environment State	✓	✓	✓	✓	✓	2
Terrestrial and Marine Quarantine (including weed management)	✓		✓	✓		3
Marine Turtles (including light and noise management)	✓		✓	✓		4
Short-range Endemics and Subterranean Fauna	✓		✓	✓		5
Fire Management	✓	✓	✓	✓		6
Carbon Dioxide Injection System[1]			✓	✓		7
Air Quality	✓					8
Coastal Stability	✓		✓	✓		9
Terrestrial Rehabilitation	✓				✓	10
Spill Management		✓				11

1 *Reporting of this aspect was no longer required under MS 800 as amended by MS 1198, published 20 October 2022.*

1.4 Project

CAPL is developing the gas reserves of the Greater Gorgon Area. The gas is processed in a Gas Treatment Plant (GTP) on Barrow Island, which is located off the Pilbara coast 85 km north-north-east (NNE) of Onslow in Western Australia (WA) (Figure 1-1).

Subsea gathering systems and pipelines deliver feed gas from the Gorgon and Jansz–Io gas fields to the west coast of Barrow Island. The underground feed gas pipeline system then traverses Barrow Island to the GTP on the east coast. The GTP includes natural gas trains that produce liquefied natural gas (LNG), condensate and domestic gas (DomGas). Carbon dioxide (CO_2), which occurs naturally in the feed gas, is separated during the production process and injected into deep rock formations below Barrow Island. The LNG and condensate are loaded onto tankers from a jetty, and then transported to international markets. Gas for domestic use is exported by pipeline from Barrow Island to the DomGas collection and distribution network on the WA mainland.

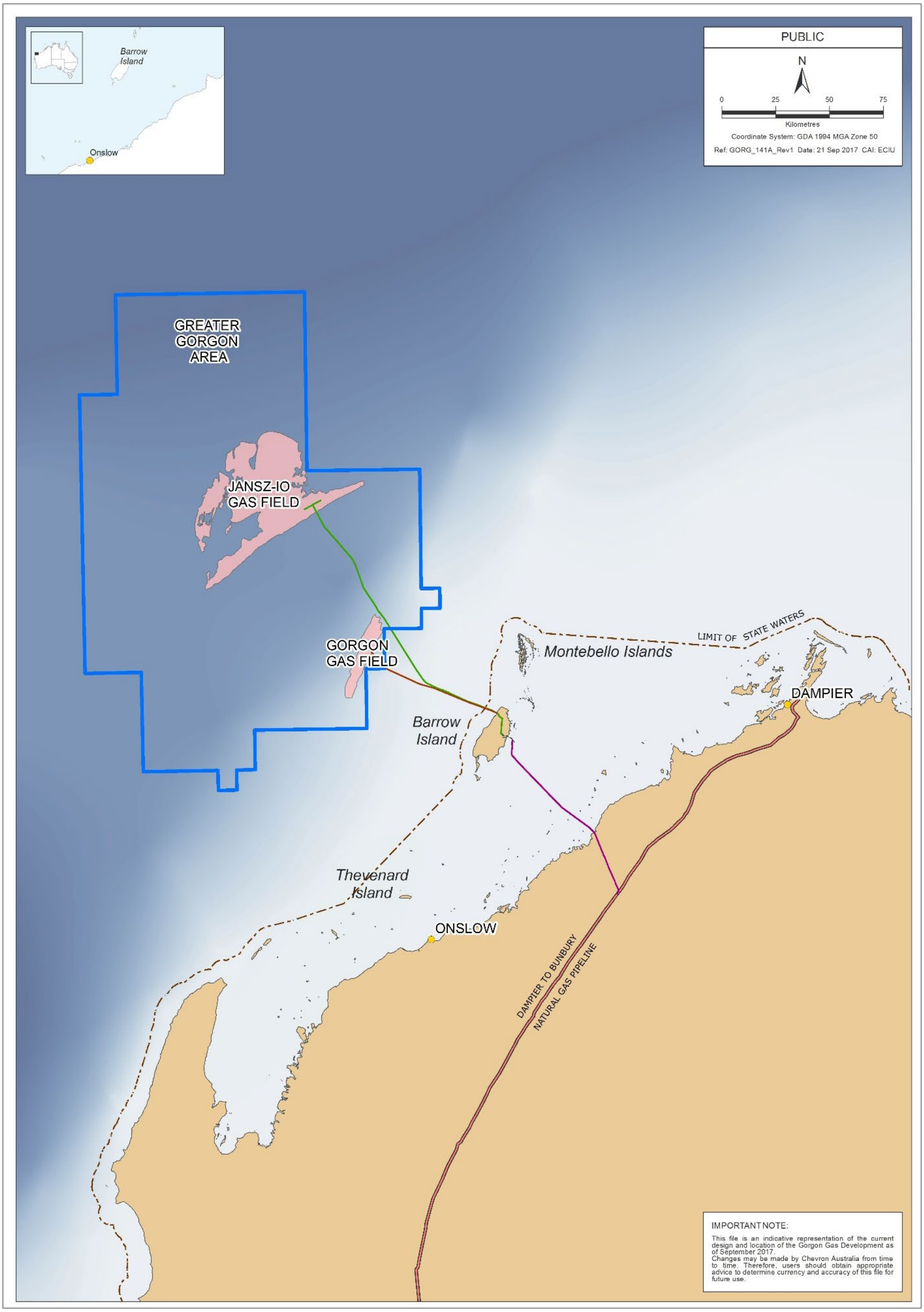


Figure 1-1: Location of Gorgon Gas Development and Greater Gorgon Area

1.4.1 Status of implementation

Construction of the Gorgon Gas Development started in December 2009 and 3-train LNG operations began in July 2018.

In the last 12 months:

- A scheduled major maintenance turnaround occurred for Train 1 (April/May 2023). Turnarounds are routine major maintenance shutdowns, which involve numerous inspections, repairs, and equipment changeouts.
- First gas was achieved from the Gorgon Stage 2 project.
- As of October 2023, more than 8.5 million tonnes of greenhouse gas (GHG) (carbon dioxide equivalent [CO_2e]) have been injected since safely starting the CO_2 injection system in 2019.
- The Gorgon DomGas facilities have continued to deliver natural gas to WA since 2016. The DomGas Plant can produce up to 300 terajoules per day of domestic gas.

2 Terrestrial and subterranean environment state

Table 2-1: EPR requirements for terrestrial and subterranean environment

Item	Source	Section in this EPR
Results of monitoring and any measurable impacts from the Project, including any changes from the baseline	MS 800, Schedule 3(1i) MS 769, Schedule 3(1i) EPBC 2003/1294 and 2008/4178, Schedule 3(1i)	2.1
Conclusions as to the Project stressors (if any) causing the impacts identified	MS 800, Schedule 3(1ii) MS 769, Schedule 3(1ii) EPBC 2003/1294 and 2008/4178, Schedule 3(1ii)	Not applicable (N/A)[1]
Any mitigation measures applied during the Reporting Period, and results of that mitigation	MS 800, Schedule 3(1iii) MS 769, Schedule 3(1iii) EPBC 2003/1294 and 2008/4178, Schedule 3(1iii)	N/A[2]
Any changes to monitoring sites	MS 800, Schedule 3(1iv) MS 769, Schedule 3(1iv) EPBC 2003/1294 and 2008/4178, Schedule 3(1iv)	2.1
Any changes to monitoring sites below the minimum number required	Terrestrial and Subterranean Environment Monitoring Program (TSEMP) (Ref. 1), Section 3.4	N/A[3]
Any changes to ecological elements	TSEMP (Ref. 1), Section 5	2.1
Threatened or listed fauna cared for, injured, or killed within the Terrestrial Disturbance Footprint (TDF)	Terrestrial and Subterranean Environment Protection Plan (Ref. 2), Section 7.2	2.2

1 *No Project-related adverse impacts to ecological elements (as listed in Condition 6.1 of MS 800 and MS 769, and Condition 5.1 EPBC 2003/1294 and 2008/4178) were identified outside the TDF during the Reporting Period; therefore, reporting is not applicable at this time.*

2 *No mitigation measures were implemented in response to Project-related adverse impacts outside the TDF during the Reporting Period; therefore, reporting is not applicable at this time.*

3 *No changes were made to the TSEMP monitoring sites during the Reporting Period.*

2.1 Monitoring results

The objective of the Terrestrial and Subterranean Environment Monitoring Program (TSEMP; Ref. 1), as defined by Ministerial Conditions, is to establish a statistically valid ecological monitoring program to detect any Material or Serious Environmental Harm to the ecological elements outside the TDF.

The ecological elements considered at risk from the Gorgon Gas Development that require monitoring on Barrow Island are listed in the TSEMP (Ref. 1).

At Risk zones (located within the relevant TDF—a zone where potential impacts are predicted to occur) and Reference zones (located in comparable areas beyond the TDF) were established for each monitoring program to detect changes attributable to Gorgon Gas Development activities.

Where applicable, monitoring data are presented in time-series control charts, which are used to diagnose trends in population abundance. Trends identified in control charts act as early-warning signals to guide a tiered management approach. A management response is triggered if a parameter demonstrates a trend towards or changes beyond statistical deviations (± 1, ± 2, or ± 3 statistical deviations [e.g. standard deviation (SD)]) from baseline conditions or other reference point (e.g. the zero centre-line of a ratio), as defined in the TSEMP (Ref. 1).

Since 2016, annual differences between the standardised At Risk and Reference zone population density metric (standardised density difference ratio) have been applied to control charts for mammals and birds to improve the diagnosis of trends. Alternative analyses are applied to groundwater and surface water landform monitoring data, where control charting is inappropriate for comparing trends over time.

The 2022–2023 monitoring results for the ecological elements listed in the TSEMP (Ref. 1) are summarised in the following tables and all monitoring programs met the requirements of the TSEMP (Ref. 1). Note: Surveys for terrestrial fauna were undertaken between June and September 2022, before the Reporting Period (Ref. 27; Ref. 28; Ref. 29; Ref. 30). Surveys for seabirds were undertaken between November 2022 and March 2023 (Ref. 31), and vegetation was surveyed in May 2023 (Ref. 32).

Ecological element: Flora / vegetation
Taxon, feature, or species
• Coastal complex and dune system • Creeks and seasonal drainage lines • Limestone slopes and ridges
Objective
To detect loss of diversity—attributable to the Gorgon Gas Development and Jansz Feed Gas Pipeline—over time.
Changes to monitoring sites
Four vegetation associations (C3b1, C7b1, L7d2 and L9g1) were not monitored during the Reporting Period. These vegetation associations were last surveyed in 2021 and will be revisited in 2025.
Methodology
• Survey method: Biennial survey of 70 vegetation monitoring transects across three dominant habitat types and 11 vegetation associations encompassing both At Risk (38 transects) and Reference (32 transects) zones, undertaken in June 2023 (Figure 2-1). Parameters comprised: percentage foliage cover (PFC); total species richness; known, suspected, or potential non-indigenous species (NIS); and plant health. • Analysis method: An exponentially weighted moving average (EWMA) control chart approach was applied to total species richness, PFC, and plant health. A permutation-based multivariate analysis of variance was used to examine if there were differences in floristic composition and health of plants between the At Risk and Reference sites, or between years. The site type by year interaction was also tested for significance, and if a significant interaction was detected, 2-dimensional ordination plots were developed to investigate changes.
Results
• Comparisons between TDF transects and Reference transects (TDF/Reference log ratio) indicated no declines in total species richness, PFC, or plant health (Figure 2-3, Figure 2-4, Figure 2-5). • No deviations outside of the −3 SD control limit occurred for any monitoring parameter for any individual vegetation association surveyed. • The total species richness and perennial species richness for vegetation association D5a1 deviated outside the −2 SD control limit resulting in a review of management triggers, discussed below. This vegetation association is classified under the ‘creeks and seasonal drainage lines’ habitat type and described as ‘Low open shrubland of *Acacia bivenosa* with scattered *Stylobasium spathulatum* and occasional low scattered shrubs including *Melaleuca cardiophylla, Petalostylis labicheoides* and

Ecological element: Flora / vegetation
Trichodesma zeylanicum over closed hummock grassland of *Triodia angusta* with occasional *T. wiseana* over occasional scattered *Diplopeltis eriocarpa* and *Indigofera monophylla* shrubs'. • No new species to Barrow Island or known, suspected or potential NIS were identified, nor have any been detected across all years of this monitoring program.
Discussion and conclusions
• Declines in total species richness and perennial species richness for vegetation association D5a1 were recorded in 2013 and 2015 respectively and were attributable to the relative increase in these parameters at Reference transects in comparison to TDF transects, rather than a decline in TDF transects. • Monitoring has not detected an adverse impact (attributable to the Gorgon Gas Development) on total species richness or PFC within the At Risk zone since vegetation monitoring began in 2009. • Dry seasonal conditions in the Reporting Period resulted in most plants (67%) being rated in 'fair' health. This was about double the number rated as 'fair' in 2021, when rainfall preceding the survey was above average and most plants were rated as being in 'good' health. The trend of better plant health in years with higher rainfall has been observed during previous monitoring surveys. • The 2023 monitoring was the fifth time the 12 transects that were affected by fire in October 2013 (caused by lightning) were assessed. Monitoring indicates that the vegetation in these transects continues to progress towards a similar structure to that recorded before the event. • Multivariate analysis of variance indicated that there was a significant effect of survey year on floristic composition and PFC for five associations, and a significant effect of treatment (TDF vs Reference) on floristic composition and PFC for nine associations. There were no significant year-by-treatment interactions for any association, indicating that TDF sites are not changing more significantly over time than their associated Reference sites. • No potential adverse impacts on vegetation within the TDF were detected for any vegetation association within the coastal complex and dune system habitat, or the limestone slopes and ridges habitat. • Overall, results from control charts, the multivariate analysis of species assemblages, a targeted management trigger review of association D5a1, and other general results, suggested that TDF transects had not changed more significantly over time compared to the Reference transects between 2021 and 2023, with no evidence of impacts attributable to the Gorgon Gas Development.

Figure 2-1: Vegetation Monitoring Survey Transects for the Reporting Period

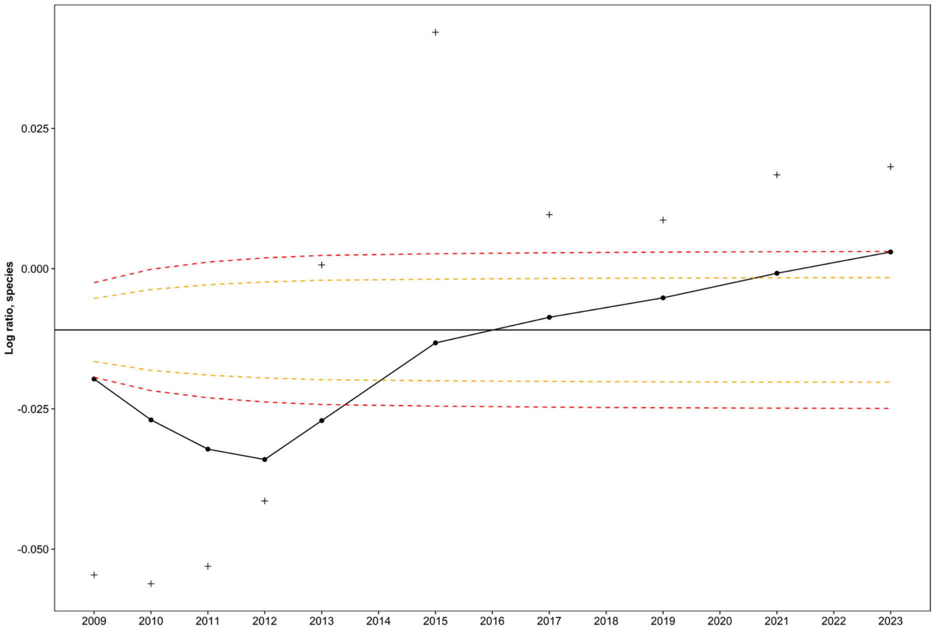


Figure 2-2: Exponentially weighted moving average (EWMA) control charts for total species richness

Crosses = the calculated log response ratio metric for the ratio of the At Risk TDF population (from pooled potential impact sites) to the Reference population (from pooled Reference sites). Solid dots = smoothed log response ratio metric based on an EWMA. Solid horizontal line = random effects estimate of all sampled seasons. Red dotted lines = ±3 SD control limits. Orange dotted lines = ±2 SD control limits.

Figure 2-3: EWMA control charts for percent foliage cover

Crosses = the calculated log response ratio metric for the ratio of the At Risk TDF population (from pooled potential impact sites) to the Reference population (from pooled Reference sites). Solid dots = smoothed log response ratio metric based on an EWMA. Solid horizontal line = random effects estimate of all sampled seasons. Red dotted lines = ±3 SD control limits. Orange dotted lines = ±2 SD control limits

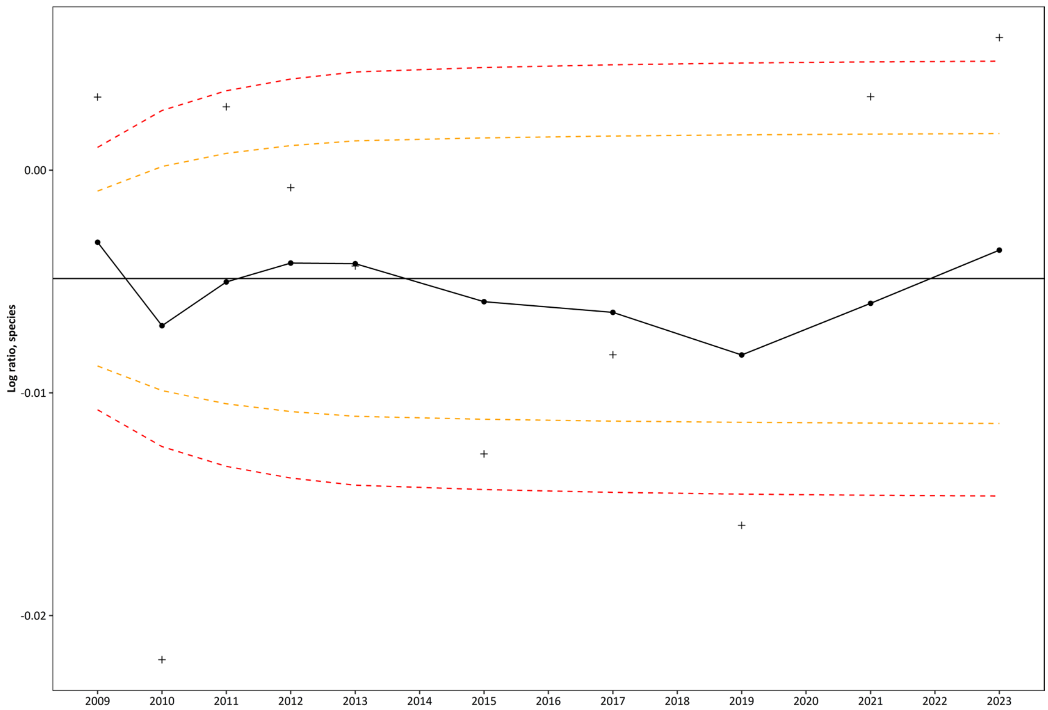
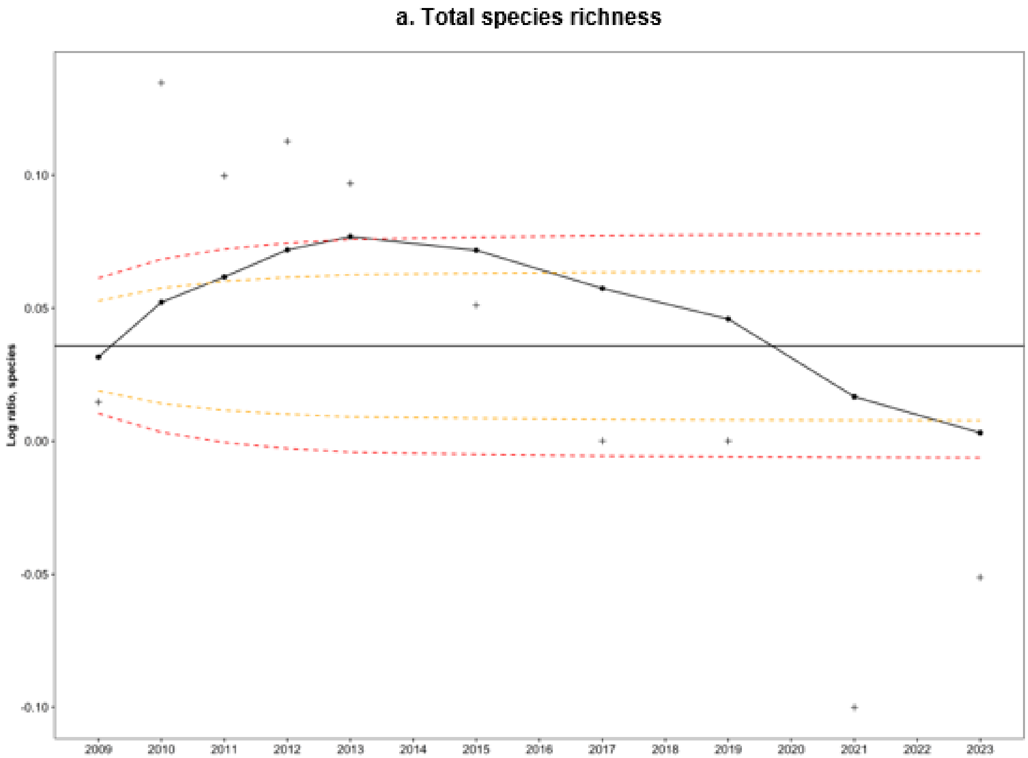


Figure 2-4: EWMA control charts for vegetation health

Crosses = the calculated log response ratio metric for the ratio of the At Risk TDF population (from pooled potential impact sites) to the Reference population (from pooled Reference sites). Solid dots = smoothed log response ratio metric based on an EWMA. Solid horizontal line = random effects estimate of all sampled seasons. Red dotted lines = ±3 SD control limits. Orange dotted lines = ±2 SD control limits.



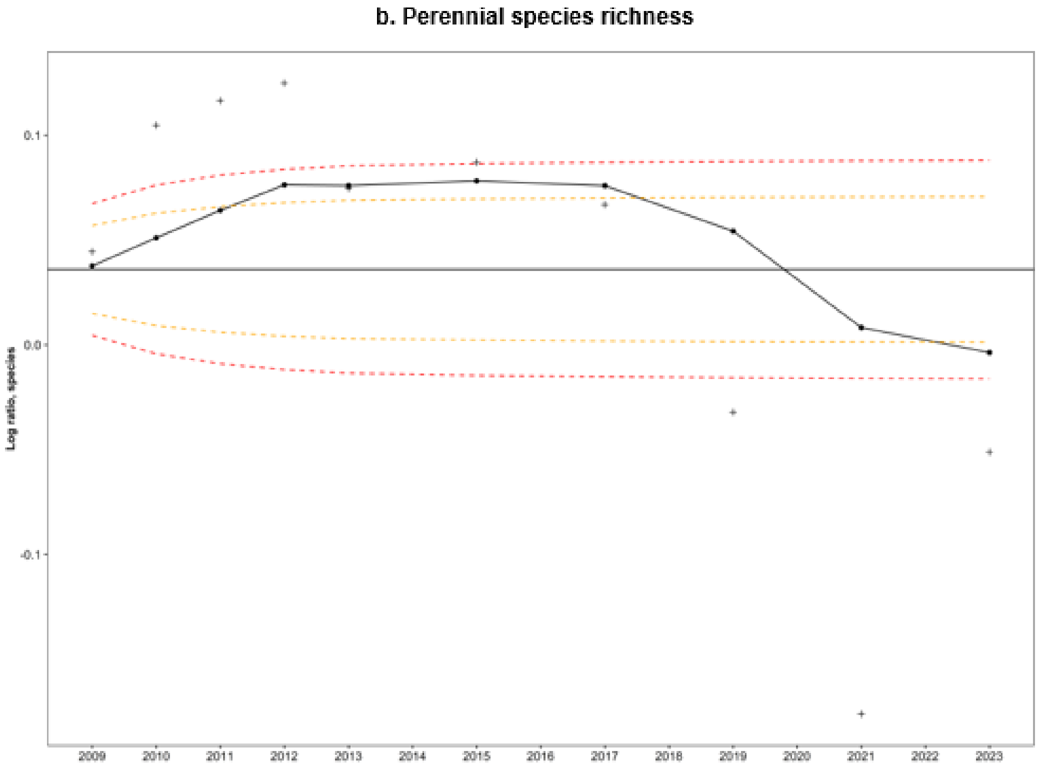


Figure 2-5: EWMA control charts for mean species richness at Vegetation Association D5a1 (a. Total and b. Perennial)

Crosses = the calculated log response ratio metric for the ratio of the At Risk TDF population (from pooled potential impact sites) to the Reference population (from pooled Reference sites). Solid dots = smoothed log response ratio metric based on an EWMA. Solid horizontal line = random effects estimate of all sampled seasons. Red dotted lines = ±3 SD control limits. Orange dotted lines = ±2 SD control limits.

Ecological element: Fauna / habitat

Taxon, feature or species

White-winged Fairy-wren (Barrow Island) (*Malurus leucopterus edouardi*)

Objective

To detect variation in abundance—attributable to the Gorgon Gas Development and Jansz Feed Gas Pipeline—over time

Source: J. Kalau

Changes to monitoring sites

There were no substantial changes to monitoring sites in during the Reporting Period.

Methodology

- Survey method: Diurnal distance sampling across 25 transects (each up to 13.1 km long and orientated east–west at 500 m spacing across Barrow Island) to compare the densities of White-winged Fairy-wrens (WWFWs) within the At Risk and Reference zones during September 2022 (Figure 2-6). The combined total length of the transects was 198 km (85 km in the Reference zone; 113 km in the At Risk zone). The locations of observed WWFWs along the transects were recorded by taking a GPS fix at each animal's location.
- Analysis method: WWFW observations were converted to density estimates using distance sampling software, with a truncation distance of 70 m applied. Changes in relative density were determined by the degree of variation observed between At Risk and Reference zones and were plotted using time-series control charts to understand trends in abundance between zones over time.

Results

- The estimated density of WWFWs within the Reference zone was 0.13 (± 0.03) individuals per hectare (ind/ha) and the estimated density within the At Risk zone was 0.35 (± 0.07) ind/ha.
- The population estimate of WWFWs within the Reference zone was 1,941 (± 407) individuals and the population estimate within the At Risk zone was 3,655 (± 720) individuals.
- The Barrow Island-wide density estimate was 0.22 (± 0.03), with an overall population estimate of 5,596 (± 849) WWFWs.
- The ratio between the estimated At Risk and Reference zone densities decreased from 4.30 in 2021 to 2.69 in 2022, owing to a larger increase in density within the Reference zone relative to the At Risk zone. The EWMA metric deviated outside the +1 SD control limit for the second consecutive year, resulting in a review of management triggers, discussed below (Figure 2-7).
- Linear regression analysis showed a decline in WWFW density over time that was significant within both the At Risk (R^2 = 0.33, $F_{1,12}$ = 5.9, P = 0.03) and Reference zones (R^2 = 0.45, $F_{1,12}$ = 9.7, P = 0.009) (Figure 2-8).

Discussion and conclusions

- The density of WWFWs within the At Risk zone has always been greater than that within the Reference zone (Figure 2-8) due to a highly correlated association with their preferred habitat, *Melaleuca cardiophylla*, which is more prominent within the At Risk zone.
- Linear modelling indicates that WWFW density has declined, generally, over time within both zones but that the declines do not differ significantly between zones. This suggests that the declines are more likely due to broad environmental conditions across Barrow Island rather than any Project-related effects in the At Risk zone.
- Noise within the At Risk zone associated with construction and general operational activities of the Gorgon Gas Development was initially identified as a possible environmental stressor for WWFWs. Noise could potentially interfere with the communications and resulting social structure of WWFWs, which rely on calling to establish and maintain territories and to attract mates. Although noise generated from initial construction and ongoing general operational activities may result in some disturbance, this is likely to have been, and continues to be, localised in area and does not appear to have impacted the population adversely.

Ecological element: Fauna / habitat
• Summer rainfall has also been thought to be important for the WWFW on Barrow Island—the key driver for variation in abundance estimates is presumed to be rainfall. WWFWs can also breed outside regular breeding months if there is good rainfall, which would be expected to result in increased recruitment into the adult population. Significant correlations were found between the population of WWFWs and two rainfall indices, indicating that WWFW numbers increase following significant rainfall, with a 6-month lag time. The rainfall before the 2022 survey was 54% above the long-term average, which may account for the increase in estimated abundance of WWFWs recorded across Barrow Island during the Reporting Period. • Overall, results indicate the variation in WWFW abundance is likely driven by variability in rainfall and other environmental conditions, with no evidence of impacts attributable to the Gorgon Gas Development.

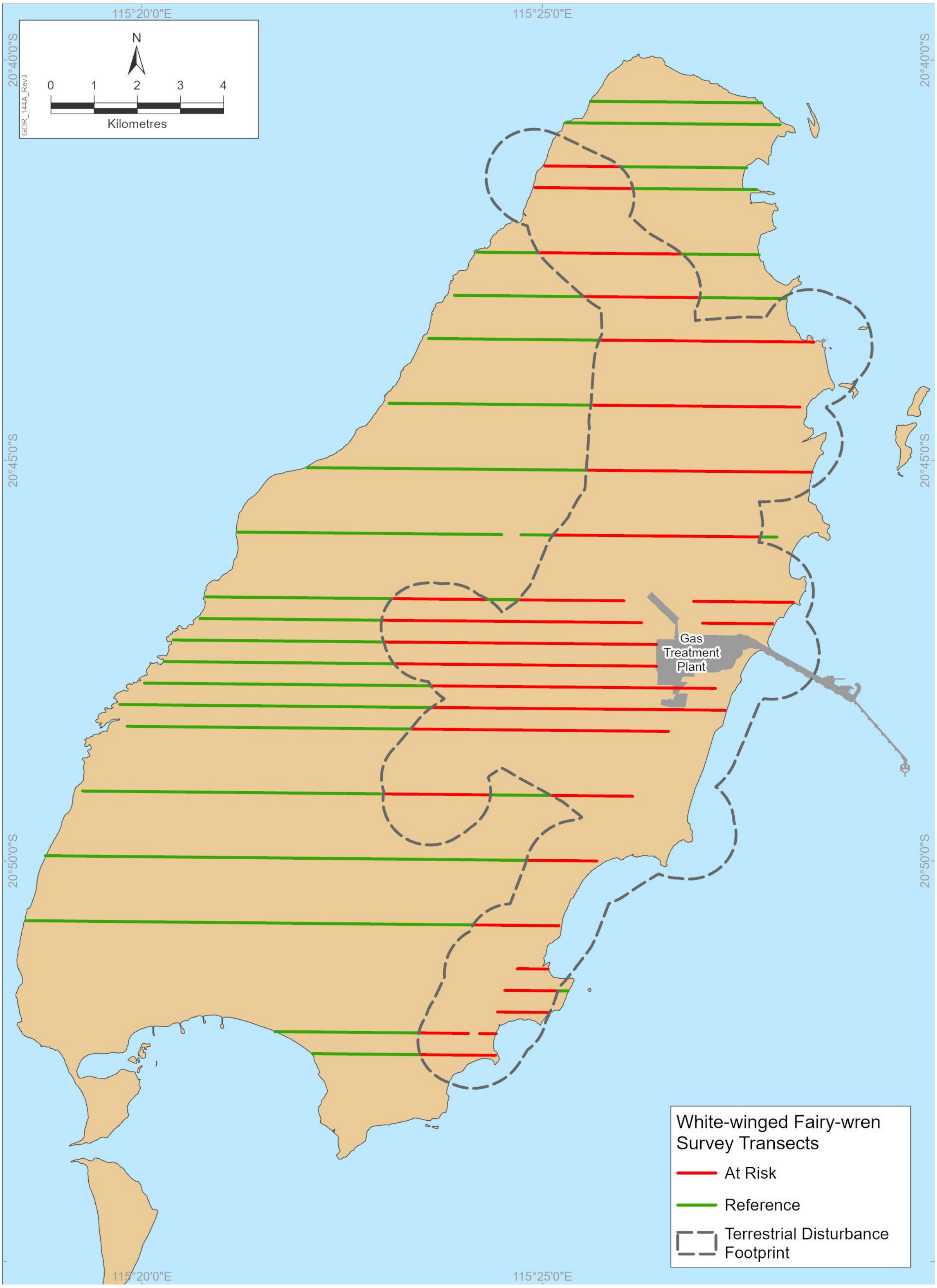


Figure 2-6: White-winged Fairy-Wren Survey Transects for the Reporting Period

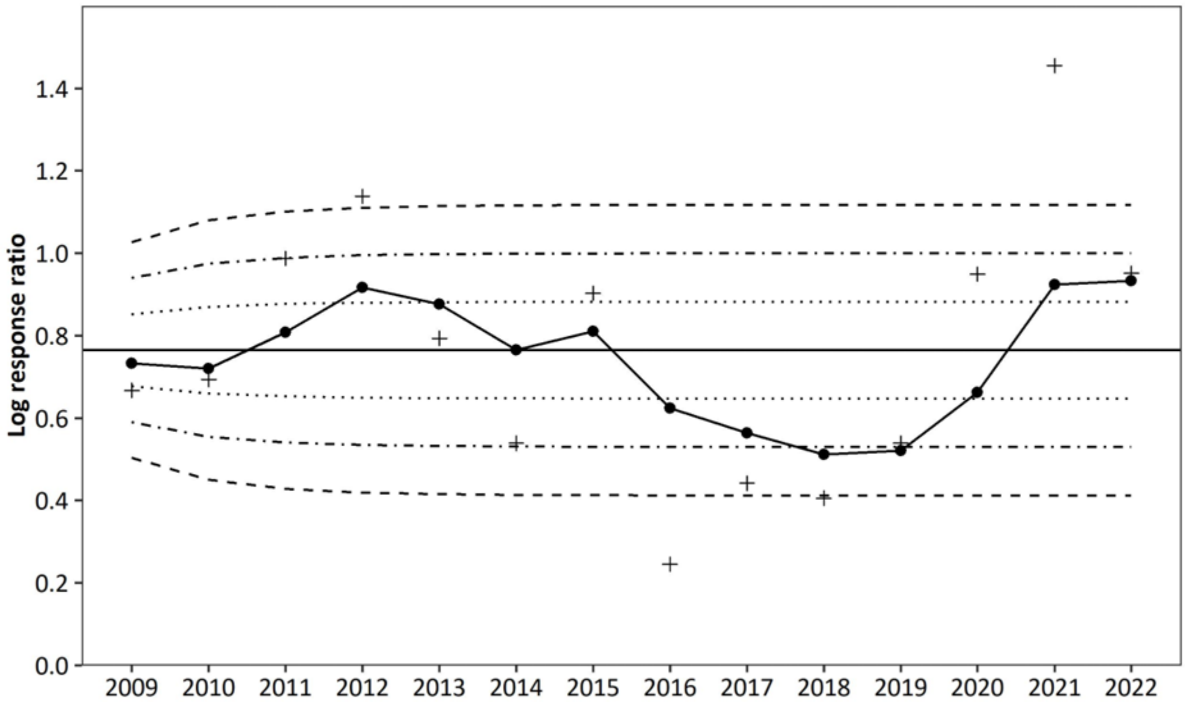


Figure 2-7: EWMA control chart for White-winged Fairy-wren density at Barrow Island

The response variable is the log of the At Risk: Reference zone density estimate ratio.

EWMA Chart: + = log ratio of observed data; • = smoothed standardised difference metric based on exponentially weighted 3-year moving average; dotted curves represent ±1 SD, ±2 SD, and ±3 SD

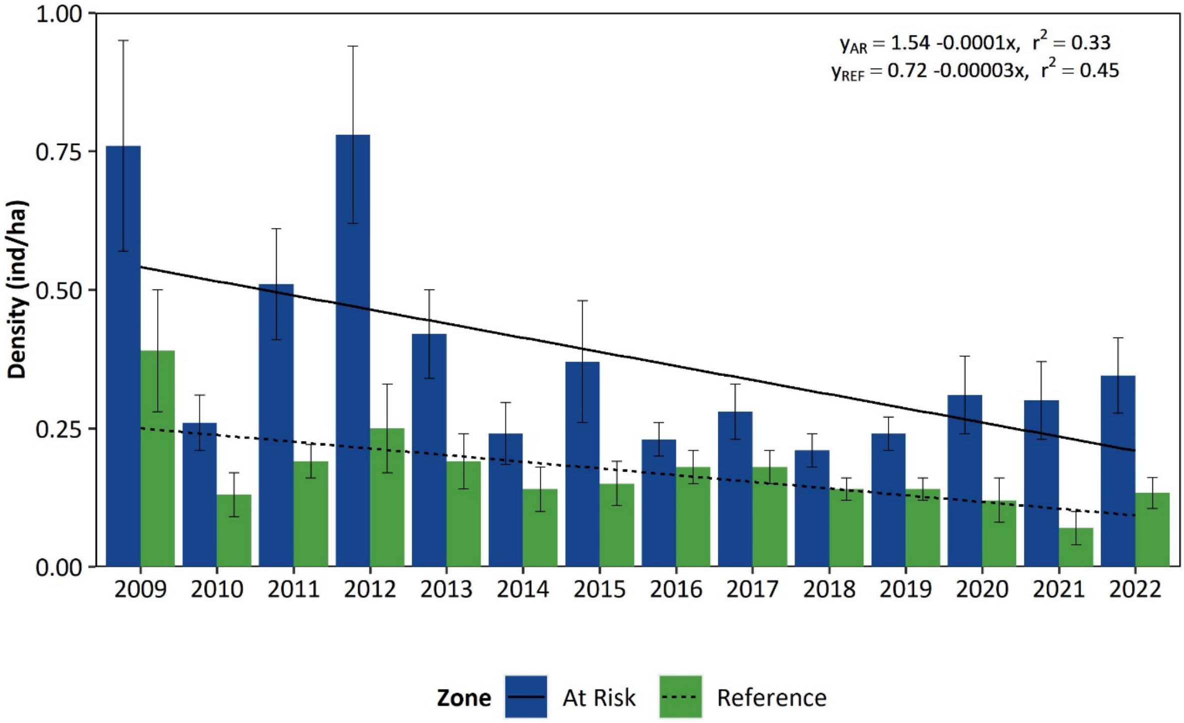


Figure 2-8: Annual estimates and trend over time of White-winged Fairy-wren densities within the At Risk and Reference Zones

Ecological element: Fauna / habitat

Taxon, feature, or species

Barrow Island Euro (*Osphranter robustus isabellinus*)

Objective

To detect variation in abundance—attributable to the Gorgon Gas Development and Jansz Feed Gas Pipeline—over time.

Source: J. Kalau

Changes to Monitoring Sites

There were no substantial changes to monitoring sites in during the Reporting Period.

Methodology

- Survey method: Because the remotely piloted aircraft (RPA) thermal detection aerial surveys for the Barrow Island Euro were successful in 2021, this was the sole method used for this species in 2022.
- Fifty transects (ranging from 2–5.2 km long and orientated east–west across Barrow Island) were flown to compare the densities of Barrow Island Euros within the At Risk and Reference zones during June 2022 (Figure 2-9). The combined total length of the transects was 221 km (102 km in the Reference zone; 119 km in the At Risk zone).
- Transects were flown at 30 m above ground level (AGL), with a forward speed of 5 m/s and a camera pitch of 20° below horizon. The 'white hot' thermal palette was selected as the most appropriate for animal detection.
- An in-field zoologist reviewed the video footage in real time to identify different species. If the animal could not be immediately identified with confidence, the camera zoom was adjusted and if this still did not allow for identification, the RPA was lowered to a maximum of 20 m AGL, and the camera zoom used again if necessary. In these instances, all animals were reliably identified.
- Analysis method: Barrow Island Euro observations were converted to density estimates using distance sampling software, with a truncation distance of 100 m applied. Changes in relative density were determined by the degree of variation observed between At Risk and Reference zones and were plotted using time-series control charts to understand trends in abundance between zones over time.

Results

- The estimated density of Barrow Island Euros within the Reference zone was 0.18 (± 0.09) ind/ha and the estimated density within the At Risk zone was 0.10 (± 0.05) ind/ha.
- The estimated abundance of Barrow Island Euros within the Reference zone was 2,614 (± 1,310) individuals and the estimated abundance within the At Risk zone was 1,044 (± 547) individuals.
- The Barrow Island-wide density estimate was 0.15 (± 0.07) ind/ha, with an overall population estimate of 3,658 (± 1,711) Barrow Island Euros.
- The ratio between the At Risk and Reference zone densities decreased from 0.67 in 2021 to 0.55 in 2022, owing to a proportionally greater increase in density within the Reference zone.
- The EWMA metric deviated outside the −1 SD control limit for the third consecutive year, resulting in a review of management triggers, discussed below (Figure 2-10, Figure 2-11).

Discussion and Conclusions

- The whole of Island population estimate for Barrow Island Euros has been relatively stable over time, with highest population estimates recorded in the last 3 years. Based on available metrics, the population models used are considered to be reliable and there is growing evidence that the Barrow Island Euro population may have been previously underestimated.
- Summer rainfall has previously been thought to be important for the Barrow Island Euro—the driver for variation in abundance estimates has been presumed to be rainfall. Analysis found no significant correlations between the time since significant rain fell or the amount of rainfall received preceding monitoring and the Barrow Island Euro population. Although not significant, the slopes of the correlations suggest that, generally, population estimates were higher during wetter periods. Barrow Island Euros are

Ecological element: Fauna / habitat
understood to be more physiologically sensitive to water stress and so rainfall would be expected to be important as a population driver, but the relationship may be more complex than can currently be assessed. • Despite relatively stable Barrow Island-wide population estimates, the ratio of the density estimates indicates that there has been a shift in estimated density and abundance from the At Risk zone to the Reference zone from the commencement of monitoring in 2009, through to 2022. Trend analysis indicated that Barrow Island Euro density has not changed significantly over time within the Reference zone but has shown a U-shaped response over time within the At Risk zone. Therefore, changes within the At Risk zone are more likely to be Project-related or natural factors acting at a local scale, rather than broad environmental conditions. The decline in the At Risk to Reference density ratio from 2012–2016 was suggested to be possibly due to noise effects and/or Project-related mortality. However, current analysis showed no correlation between the change in abundance estimates within the At Risk zone and recorded deaths. • Despite the significant increase in density estimates within the At Risk zone since 2020, the increase has been proportionally less compared with that in the Reference zone, causing a declining ratio to be below the −1 SD control limit for the last three years. Several hypotheses have not been tested, including that the At Risk zone may be closer to carrying capacity, resulting in less capacity for the population to increase when conditions are good, and animals may shift out into the Reference zone. Another untested hypothesis is that the presence of free-standing water may be important to the Barrow Island Euro—this species is physiologically sensitive to water stress, which may account for local shifts in abundance. Therefore, the presence of free-standing water, when available, may be important to the Barrow Island Euro, especially during prolonged periods of below average rainfall. Shifts observed between the At Risk and Reference zone may be in response to water availability—Barrow Island rainfall is spatially variable. More rain was recorded falling on the north and west coasts (mainly Reference zone) compared to the east coast (mainly At Risk zone) between June 2021 and May 2022. Following significant rainfall in May 2022, free-standing water was more apparent within creeks or freshwater seeps on the west coast, seasonal flats, and roadside puddles on gravel roads located in the south and south-west within the Reference zone. • Despite variability evident in the At Risk and Reference zones, abundance estimates indicate a stable, whole of island population of Euros, with no evidence of impacts attributable to the Gorgon Gas Development.

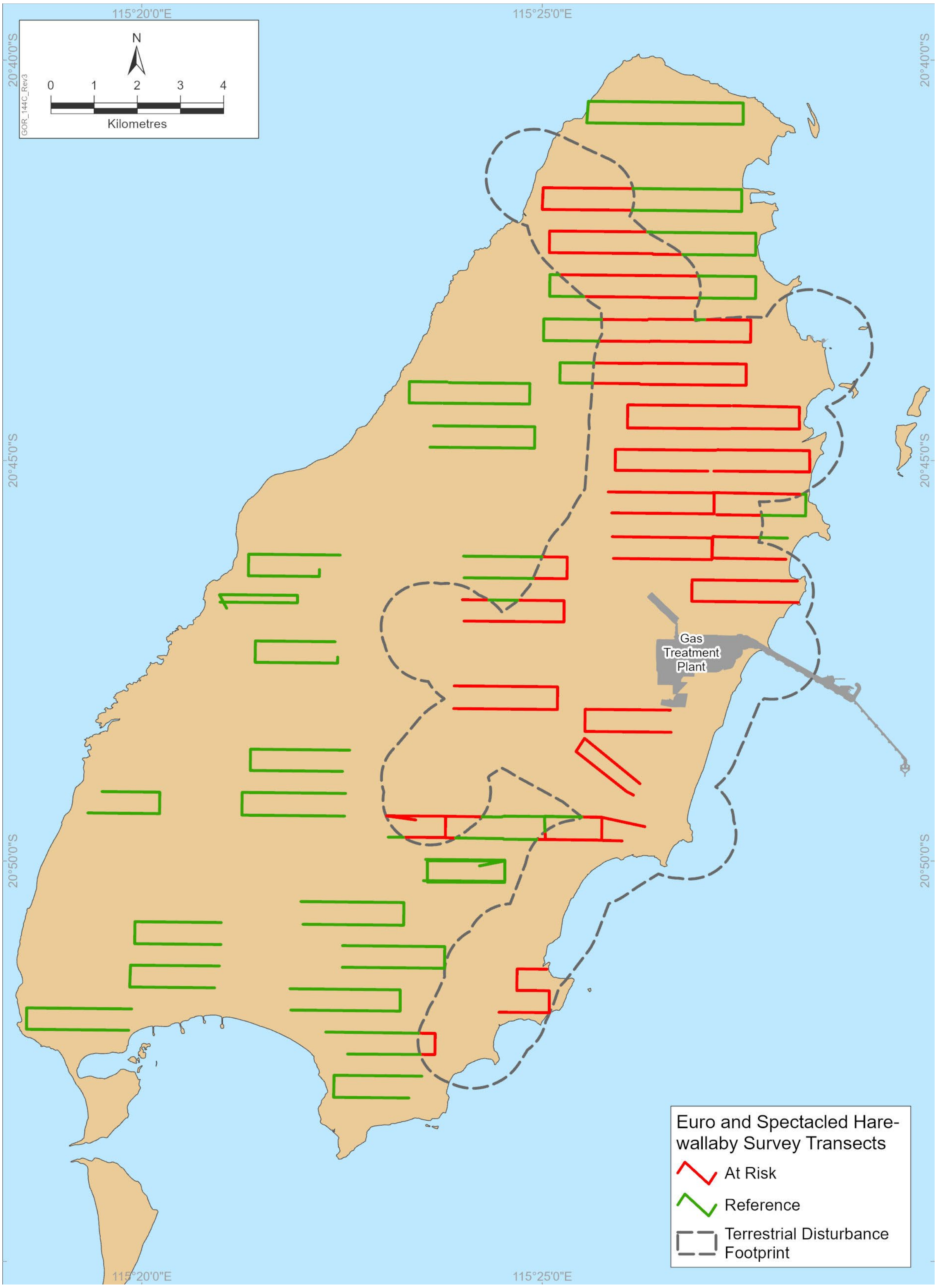


Figure 2-9: Euro and Spectacled Hare-wallaby (Barrow Island) Survey Transects for the Reporting Period

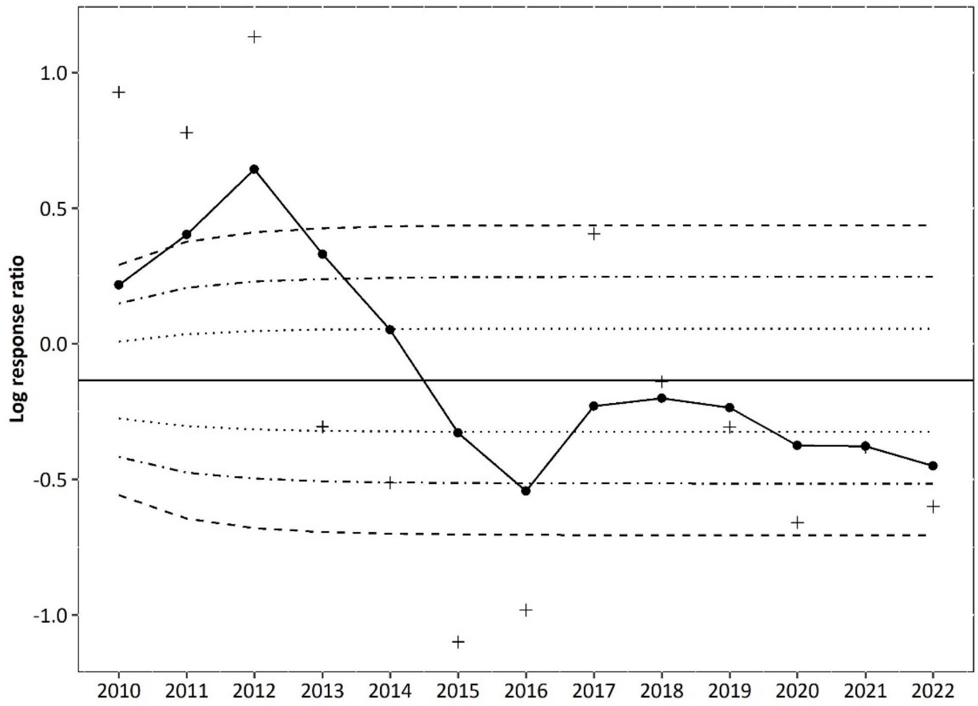


Figure 2-10: EWMA control chart for Barrow Island Euro density at Barrow Island

The response variable is the log of the At Risk: Reference zone density estimate ratio.
EWMA Chart: + = log ratio of observed data; • = smoothed standardised difference metric based on exponentially weighted 3-year moving average; dotted curves represent ±1 SD, ±2 SD, and ±3 SD.

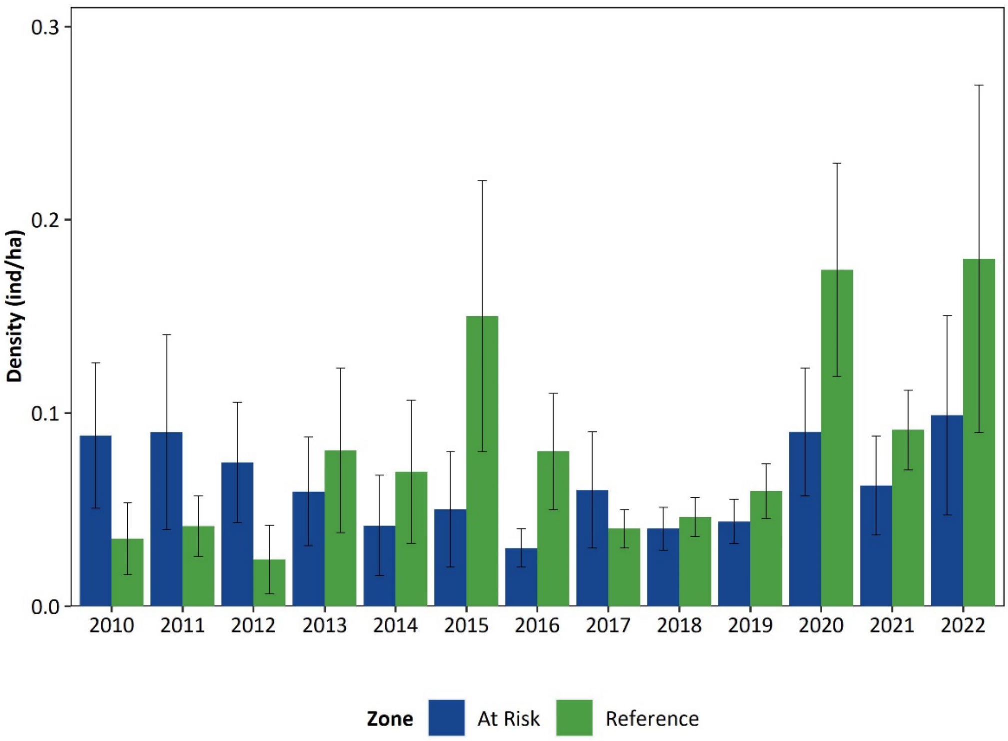


Figure 2-11: Annual estimates of Barrow Island Euro densities within the At Risk and Reference Zones

Ecological element: Fauna / habitat	
Taxon, feature, or species	
Spectacled Hare-wallaby (Barrow Island) (*Lagorchestes conspicillatus conspicillatus*)	
Objective	
To detect variation in abundance—attributable to the Gorgon Gas Development and Jansz Feed Gas Pipeline—over time.	

Changes to monitoring sites

There were no substantial changes to monitoring sites during the Reporting Period.

Methodology

The survey method and data analysis used for the Spectacled Hare-wallaby were the same as those used for the Barrow Island Euro.

Results

- The estimated density of Spectacled Hare-wallabies within the Reference zone was 0.49 (± 0.13) ind/ha and the estimated density within the At Risk zone was 0.26 (± 0.08) ind/ha.
- The estimated abundance of Spectacled Hare-wallabies within the Reference zone was 7,071 (± 1,868) individuals and the estimated abundance within the At Risk zone was 2,747 (± 873) individuals.
- The Barrow Island-wide density estimate was 0.39 (± 0.09) ind/ha, with an overall population estimate of 9,818 (± 2,334) Spectacled Hare-wallabies.
- The ratio between the At Risk and Reference zone densities decreased from 0.77 in 2021 to 0.53 in 2022, owing to a decrease in density within the At Risk zone, whereas the Reference zone remained similar. The EWMA metric remained within control limits for the third consecutive year (Figure 2-12, Figure 2-13).

Discussion and conclusions

- The results from the 2022 monitoring indicates the ratio of population densities in the At Risk to Reference zone for Spectacled Hare-wallabies is within control limits. After deviating outside the EWMA −1 SD control limit in 2019, the ratio between the At Risk and Reference zones returned to within control limits and has remained so for the last three years.
- It might be assumed that Spectacled Hare-wallaby numbers would increase in 2022 due to significant rainfall received in 2021, with above average rainfall of 385.5 mm (40% above the long-term average). However, a slight decline in the number of individuals was observed across Barrow Island in 2022. Current and historical analysis suggests that there were no significant correlations between the amount of rainfall or time since rainfall preceding the surveys and the population estimate of Spectacled Hare-wallabies. Summer rainfall is thought to be important for smaller species on Barrow Island, such as the Golden Bandicoot and WWFW, but may not be as important for the Spectacled Hare-wallaby, which do not seem to be as sensitive to water stress and have highly developed physiological mechanisms to conserve body water.
- The whole of Island population estimate for Spectacled Hare-wallabies has varied considerably over the years, as has the ratio of density estimates. No impacts on the abundance of Spectacled Hare-wallabies appear to be attributable to the Gorgon Gas Development in 2022—the At Risk to Reference density ratio remained within control limits, and there were no significant trends in density estimates over time within each zone.

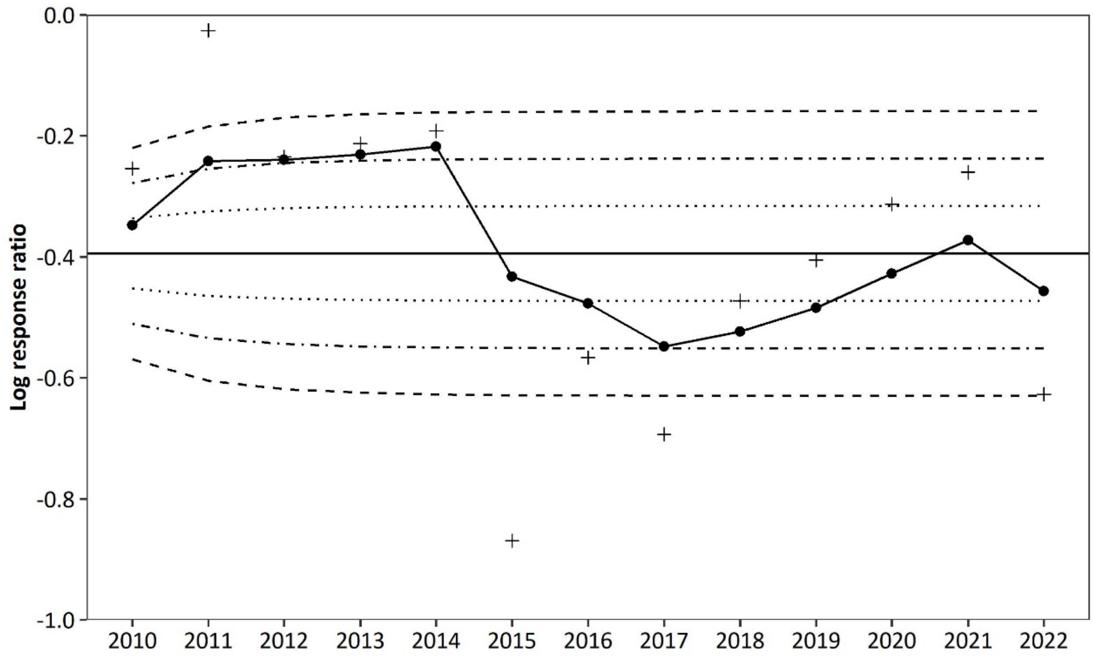


Figure 2-12: EWMA control chart for Spectacled Hare-wallaby density at Barrow Island

The response variable is the log of the At Risk: Reference zone density estimate ratio.
EWMA Chart: + = log ratio of observed data; • = smoothed standardised difference metric based on exponentially weighted 3-year moving average; dotted curves represent ±1 SD, ±2 SD, and ±3 SD.

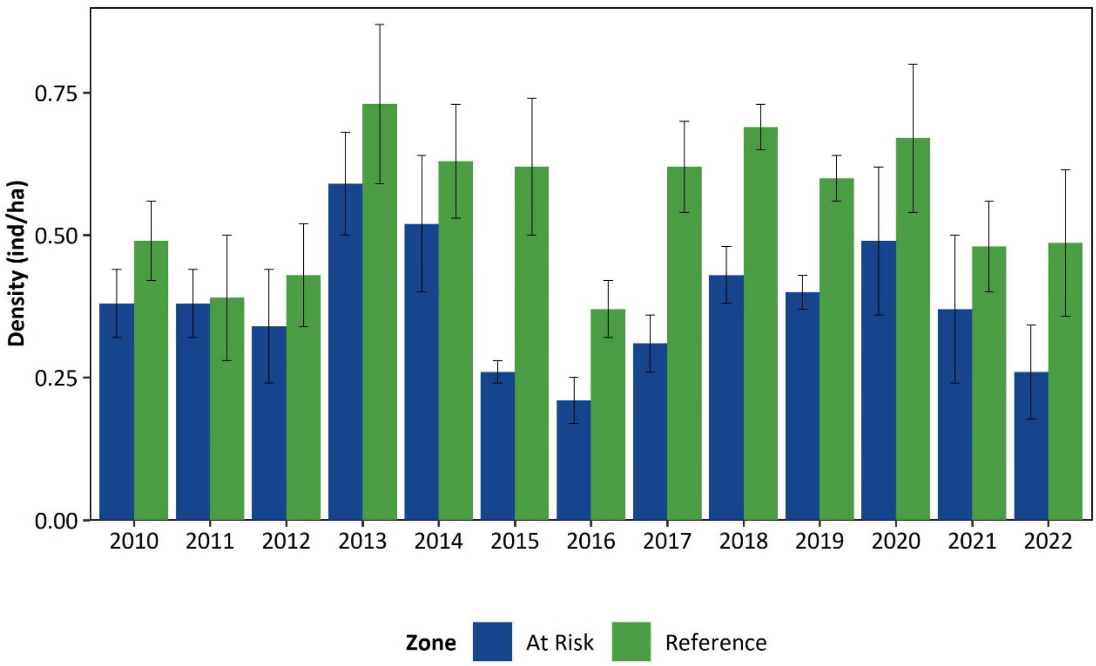


Figure 2-13: Annual estimates of Spectacled Hare-wallaby densities within the At Risk and Reference Zones

Ecological element: Fauna / habitat	
Taxon, feature, or species	
Burrowing Bettong, Boodie (Barrow and Boodie Islands) (*Bettongia lesueur Barrow and Boodie Islands subspecies)*	
Objective	
To detect variation in abundance—attributable to the Gorgon Gas Development and Jansz Feed Gas Pipeline—over time.	

Changes to monitoring sites

There were no substantial changes to monitoring sites during the Reporting Period.

Methodology

- Survey method: Annual capture-mark-recapture sampling using baited cage traps at 25 active Burrowing Bettong warrens (10 in the Reference zone, 15 in the At Risk zone) for three consecutive nights in August 2022.
- Analysis method: The capture-mark-recapture analyses included all capture histories from available data for the 25 sampled warrens using a robust Huggins model design, which included a closed population component (across nights) and open population component (across years) to derive 'at warren' abundance estimates. Changes in relative abundance were determined by the degree of variation observed between At Risk and Reference zones and were plotted using time-series control charts to understand trends in abundance between zones over time.
- Note: The analyses included capture histories from 2012 and 2015–2022. Data from 2011 was removed from the analysis due to lack of data (only three warrens were monitored). Data from 2013 and 2014 was unavailable at the time of analysis and was treated as missing data for this analysis. To account for differences in number of traps and number of trapping nights across years, all historical data from warrens that were not monitored in 2022 were excluded from the analysis, and only data from the first three nights of trapping for each warren were retained to align with the most recent sampling design.

Results

- The EWMA control chart for Burrowing Bettong abundance at monitored warrens has deviated outside the −1 SD control limit for the first time since 2012, with a decline in the ratio observed since 2019 (Figure 2-15). This deviation resulted in a review of management triggers, discussed below.
- From 2018 to 2022 there has been a general decline in the abundance estimates at warrens in both zones (Figure 2-16; Figure 2-15). The rate of decline or increase has changed between the At Risk and Reference zones, resulting in a change in the At Risk to Reference ratio, as shown in Figure 2-15. For example, the reduction in abundance from 2019–2020 at warrens in the Reference zone was less than that at warrens in the At Risk zone and the increase in abundance estimates from 2020–2021 was greater in the Reference zone compared to the At Risk zone (Figure 2-16). Although the reduction in abundance from 2021–2022 in the At Risk zone was less than that compared to the Reference zone resulting in a slight upward trend in the ratio from 2021, the EWMA metric still declined in 2022 because it is based on a 3-year moving average.
- Most Burrowing Bettong warrens have recorded a decline over time, within both At Risk and Reference zones, ranging from 24% to 100% decrease. Only four warrens/warren clusters have recorded an increase from 2012 to 2022: B012/B013 (43%), B039 (108%), B064 (28%) and B070 (13%).
- In 2022, five warrens/warren clusters recorded an increase in the number of individuals from 2021–2022: one Reference warren (B070) and four At Risk warrens (B003, B012/B013, B035 and B101). Conversely, 12 warrens/warren clusters recorded a decrease in the number of individuals from 2021–2022: six Reference warrens (B002, B005, B061, B062, B064 and B069) and six At Risk warrens (B009, B034, B036/B037, B038, B071 and B128). No Burrowing Bettongs were recorded at three Reference warrens (B006, B062 and B063) and one At Risk warren (B034); Note: B006 and B063 also had no Burrowing Bettongs recorded the previous year.
- In terms of demographics, 153 individual Burrowing Bettongs were recorded in 2022. Monitoring results showed an observed sex ratio of males to females of 1:1.03, with a similar proportion of males

Ecological element: Fauna / habitat
(75 individuals) and females (77 individuals) observed. Examination of sex ratios at individual warrens showed most warrens had an equal sex ratio of females to males. Sex ratios within individual warrens ranged from a bias towards females at warrens B038 (1:2.00), B069 (1:1.75), B064 (1:1.71) and B039 (1:1.67) to warrens with a bias towards males, such as B128 (1:0.33), B035 (1:0.60), B071 (1:0.67) and B001 (1:0.67).
Discussion and conclusions
• The results from the 2022 monitoring indicate that the EWMA metric for Burrowing Bettongs has deviated outside the −1 SD control limit for the first year since 2012, resulting in a review of management triggers. However, this was a reflection of the 3-year moving average for this metric and the reduction in abundance from 2021–2022 in the At Risk zone was less than that compared to the Reference zone. • Although the number of individuals caught at each warren has varied considerably (some warrens have remained relatively stable while others have shown recent recovery), most warrens have shown a continued decline over the years of monitoring. This is reflected in a significant decline in Burrowing Bettong abundance of the monitored warrens over time in both the At Risk and Reference zones. There was a high correlation between the two zones, suggesting that the declines are likely due to similar factors acting across all warrens. • Two possible factors—rainfall and vehicle/fauna interactions—that may be contributing to this decline in Burrowing Bettong abundance were investigated further. – No significant correlations were found between the abundance of Burrowing Bettongs from the 25 monitored warrens and several rainfall indices, including time since significant rainfall and the amount of rainfall preceding the monitoring surveys. This suggests that rainfall is not a key factor driving the decline observed since 2012. Despite above average rainfall received in 2021 and significant rainfall received three months before the 2022 monitoring survey, abundance estimates for Burrowing Bettongs declined within both zones. – No significant correlations were identified between the percentage change in Burrowing Bettong abundance per year and the cumulative number of vehicle/fauna interactions (five years prior) for both zones and for the whole of Barrow Island, indicating that no additional impact to the decline in Burrowing Bettong abundance could be detected from road deaths and suggests other more localised factors are likely to be impacting individual warrens or warren clusters. Further evidence of this is some warrens showed a continued decline over the years of monitoring, some warrens remained relatively stable and some showed a historical decline and recent recovery. This variation has been shown in other studies of Burrowing Bettongs on Barrow Island; interpreting this variation is difficult because some individuals move between warrens, not all individuals using a warren may be trapped during a sampling period, and not all warrens in an area are monitored or known. • Outcomes suggest the detected changes in the abundance of Burrowing Bettongs may be linked to more localised factors and do not appear attributable to Gorgon Gas Development. However, drivers affecting the abundance of Burrowing Bettong and correlations across both the At Risk and Reference zones will continue to be closely monitored to better understand trends.

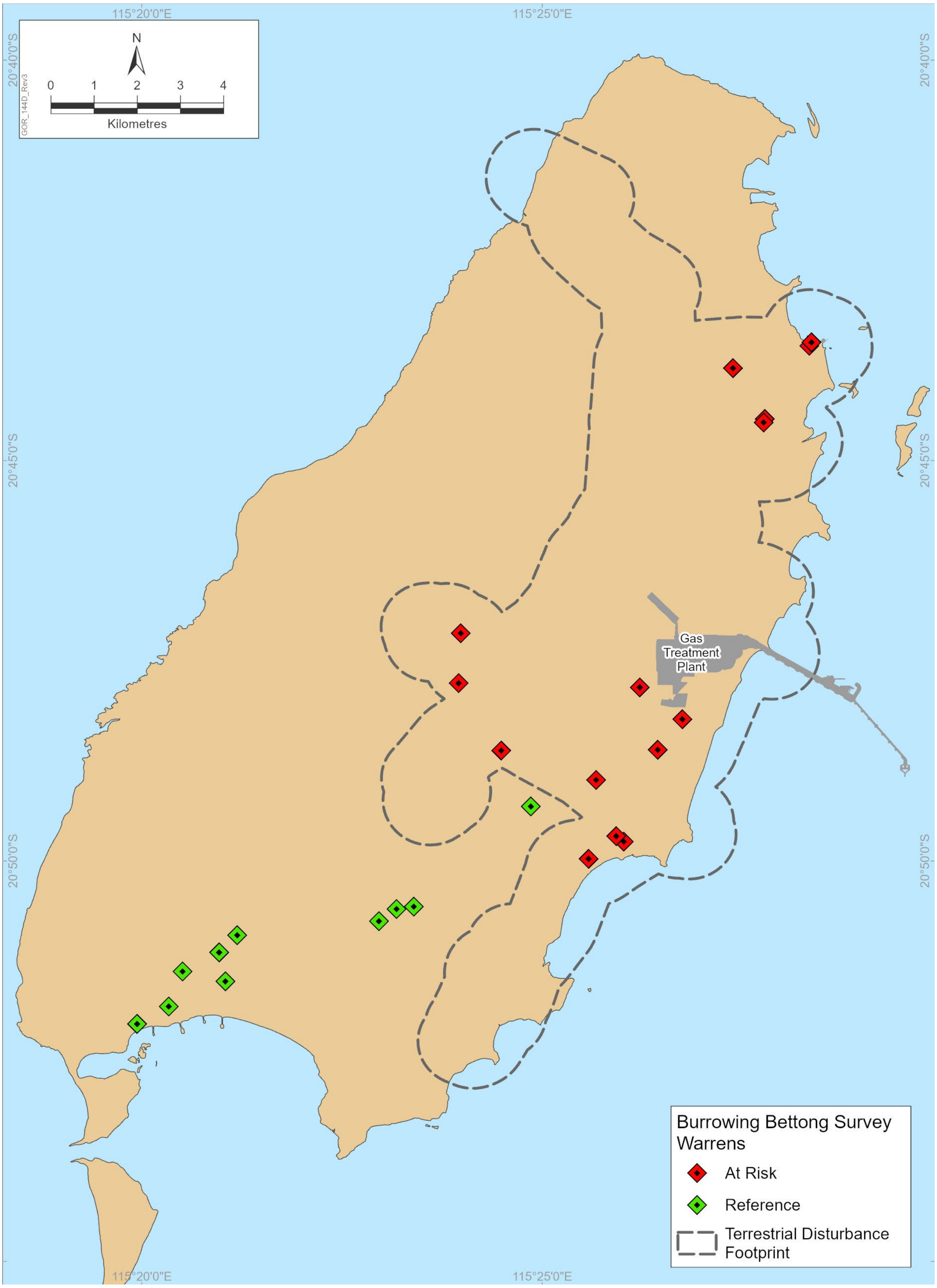


Figure 2-14: Burrowing Bettong Warrens surveyed for the Reporting Period

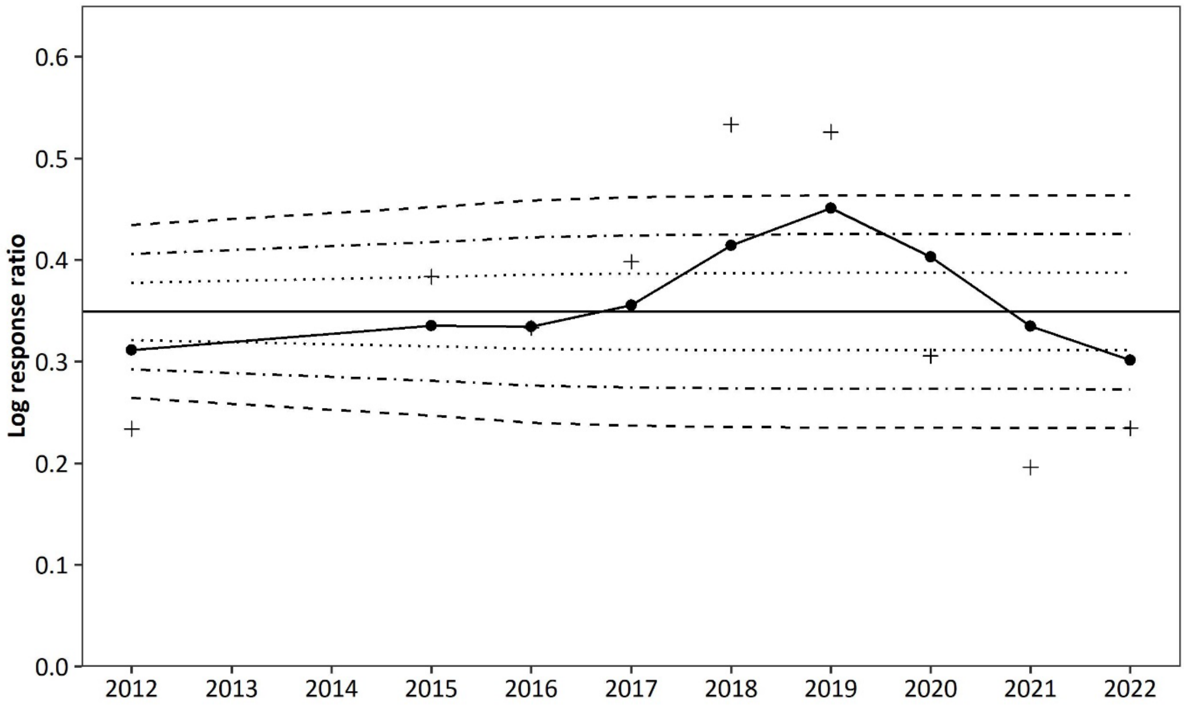


Figure 2-15: EWMA control chart for Burrowing Bettong (Boodie) abundance at monitored warrens

The response variable is the log of the At Risk: Reference zone abundance estimate ratio.
EWMA Chart: + = log ratio of observed data; • = smoothed standardised difference metric based on exponentially weighted 3-year moving average; dotted curves represent ±1 SD, ±2 SD, and ±3 SD.

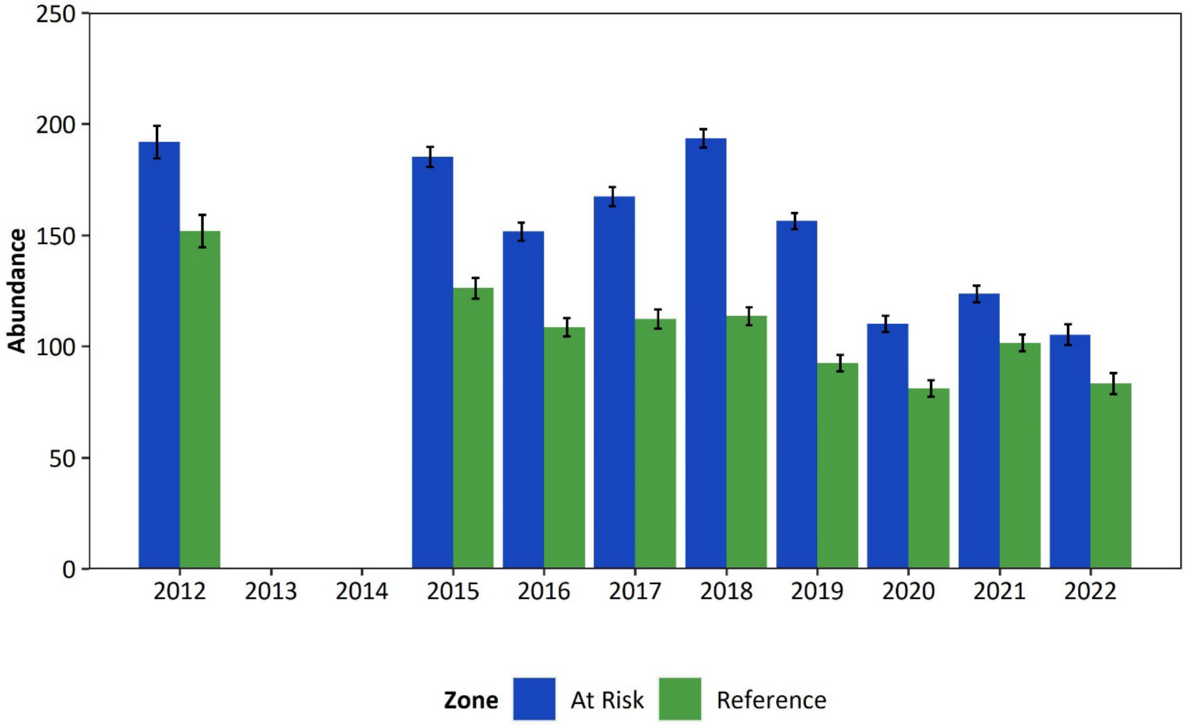


Figure 2-16: Annual estimates of Burrowing Bettong abundance at monitored warrens within the At Risk and Reference Zones

Note: See Methodology section for details on the missing 2013 and 2014 data.

Ecological element: Fauna / habitat

Taxon, feature, or species

Wedge-tailed Shearwater (*Ardenna pacifica*)

Objective

To detect variation in abundance and demographics—attributable to the Gorgon Gas Development and Jansz Feed Gas Pipeline—over time.

Changes to monitoring sites

There were no changes to monitoring sites during the Reporting Period.

Methodology

- Survey method: Three fixed long-term transects (100 m × 10 m) on each of Double Island North, Double Island South (At Risk islands), and Ah Chong Island (Reference island) were surveyed twice during the summer breeding season (Figure 2-17).
- For each survey, all burrows within transects were counted and their contents identified using a purpose-built burrow scope to determine breeding status. The first survey was undertaken during the early egg incubation period (November 2022) to derive breeding participation estimates. The second survey was undertaken during late chick provision and just before fledging (March 2023) to determine fledging success estimates (burrows that contained live, well-developed fledglings were considered fledged).
- Analysis method: The breeding performance metrics used for control charting were:
  - Burrow density (per 100 m^2) = total number of burrows (active and inactive) within the transects
  - Breeding participation (%) = number of breeding attempts / total number of burrows (active and inactive)
  - Fledging success (%) = number of developed chicks / number of breeding attempts derived from the first field visit.
- Changes were determined by the degree of variation observed between At Risk and Reference islands, and were plotted using time-series control charts to understand trends over time.

Results

- Wedge-tailed Shearwater burrow density was similar between the Ah Chong Island (10.8 ± 2.4 nests per 100 m^2) and Double Island South (10.7 ± 2.9 nests per 100 m^2), both of which were double that reported from Double Island North (4.8 ± 1.6 nests per 100 m^2) where the nesting habitat and substrate differs. Burrow density at all three monitoring locations was either the same or very similar to 2021–2022.
- EWMA control charts for both At Risk islands are trending down relative to Ah Chong Island, indicating that Ah Chong Island has had greater growth in burrow density in the long term, relative to Double Island North and Double Island South. The burrow density metric at Double Island South remained within the control limit for the 2022–2023 season, and the metric for Double Island North deviated outside −1 SD, attributable to the differences in habitat type (Figure 2-18).
- Wedge-tailed Shearwater breeding participation was again highest at Double Island North (60.7 ± 7.3%) in 2022–2023, and higher than that reported during the 2021–2022 monitoring period. Breeding participation was also higher at Ah Chong Island (45.9 ± 5.0%) and Double Island South (42.6 ± 12.0%), again increasing from 2021–2022 levels.
- Control charts indicate that increases in breeding participation are greater at Double Island North relative to Ah Chong Island, resulting in an upward trending metric for Double Island North, and a deviation outside of the +1 SD control limit for the 2022–2023 season, resulting in a review of management triggers. At Double Island South, the rate of change in breeding participation from season to season closely mirrors that recorded at Ah Chong Island, resulting in no notable long-term trend between these sites, and the metric for breeding participation remained within the control limits for the 2022–2023 season (Figure 2-18).
- Wedge-tailed Shearwater fledging success was variable across the islands for the season, marginally increasing at Double Island South to 56.5 ± 14.7%, substantially decreasing at Double Island North from

Ecological element: Fauna / habitat
61.8 ± 15.5% down to 26.9 ± 13.8% and remaining constant at Ah Chong Island (61.8 ± 1.7%), when compared to the previous season. • Due to the large natural variation year to year for this metric at all sites, the fledging success for 2022–2023 remained within control limits for both At Risk islands. An unusually high percentage of dead chicks was found at burrows on Double Island North (9.0%) this season compared to Ah Chong (1.6%) and Double Island South (1.0%). Inspection of the carcasses indicated that these chicks were underweight and had most likely died from starvation.
Discussion and conclusions
• A slight increase in burrow density was observed on both Double Island South and Ah Chong Islands, but not at Double Island North. This reflects an increased excavation of burrows in the predominantly sandy habitat on those two islands compared to the rocky habitat of Double Island North but does not indicate an increase in recruitment. • Breeding participation rates were similar to previous seasons and fell within the expected range. • Fledgling success showed a slight improvement on Double Island South and Ah Chong Island compared to the previous season, reaching levels close to the long-term average for both islands. However, fledgling success at Double Island North was significantly lower than the other islands (27% compared with 56% on Double Island South and 62% on Ah Chong Island), and lower than its long-term mean of 46%. The cause for the lower fledgling success may be related to food provision during the late fledgling development stage—if adults cannot supply enough food for their nestlings and chicks, starvation results. This is a common occurrence throughout the region. Furthermore, in this season, the percentage of breeding attempts resulting in dead chicks was higher on Double Island North (9%) compared to 1% on Double Island South and Ah Chong Island. The exact reasons for this difference between islands remain unexplained and may be related to foraging site selection by adults from the different populations. • As a whole, observed trends in abundance, breeding participation and fledgling success, are likely linked to regional and seasonal variability in oceanographic conditions as well as, localised variations in foraging and nesting site selection. There is no evidence to suggest observed variations in abundance and demographic parameters are attributable to the Gorgon Gas Development.

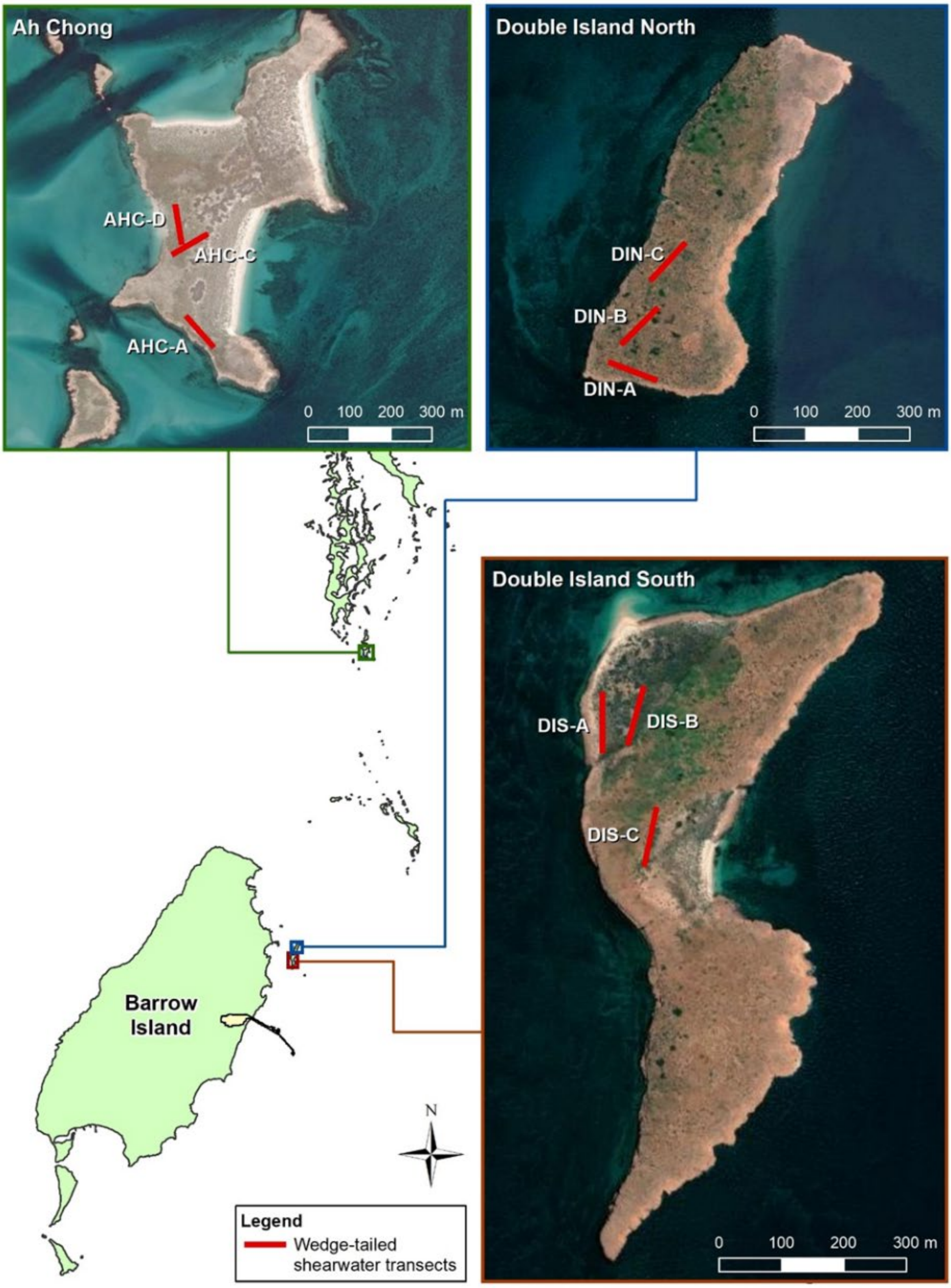


Figure 2-17: Wedge-tailed Shearwater survey transects for the Reporting Period

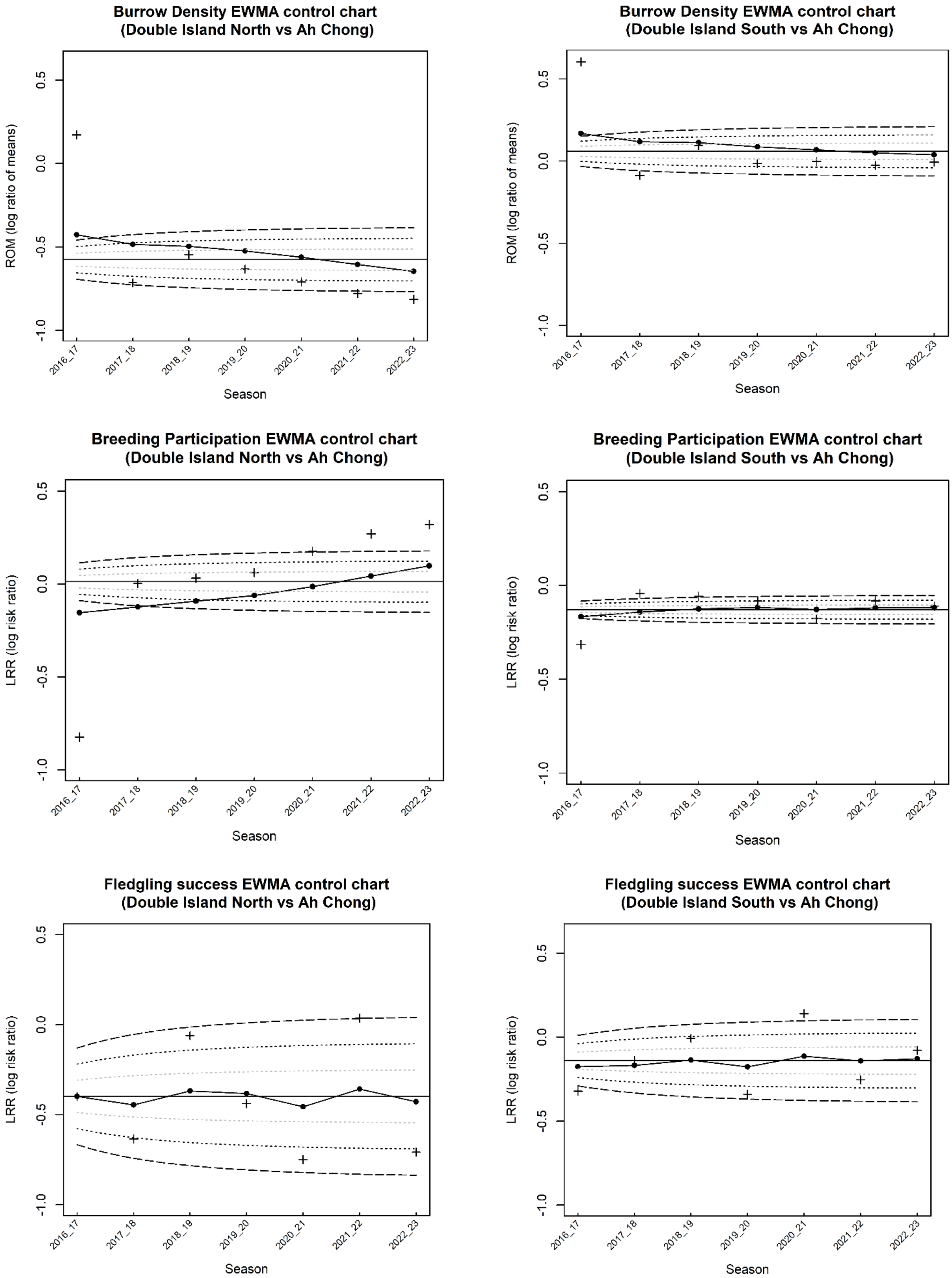


Figure 2-18: Wedge-tailed Shearwater EWMA control charts for nest density (top), breeding participation (middle), and fledging success (bottom) between At Risk islands (Double Island North and South) and Reference island (Ah Chong)

+ = standardised difference metric; • = smoothed standardised difference metric based on exponentially weighted 3-year moving average; dotted curves represent ±1 SD, ±2 SD, and ±3 SD.

Ecological element: Fauna / habitat

Taxon, species, or feature

Bridled Tern (*Onychoprion anaethetus*)

Objective

To detect variation in abundance and demographics—attributable to the Gorgon Gas Development and Jansz Feed Gas Pipeline—over time.

Changes to monitoring sites

There were no changes to monitoring sites during the Reporting Period.

Methodology

- Survey method: Three fixed long-term transects (100 m × 10 m) on each of Double Island North, Double Island South (At Risk islands), and Parakeelya Island (Reference island) were surveyed twice during the summer breeding season (Figure 2-19).
- For each survey, all nest sites within transects were counted and their contents identified to determine breeding status. The first survey was undertaken during the early egg incubation period (January 2023) to derive breeding participation and nest density estimates. The second survey was undertaken during late chick provision and just before fledging (March 2023) to determine fledging success estimates (either through direct sighting of a chick, or other indicators such as guano [sign of chick presence but no actual chick observed] in the nest scrape).
- Analysis method: The breeding performance metrics used for control charting were:
  - Nest density (per 100 m^2) = total number of nests (active and inactive) within the transects
  - Breeding participation (%) = number of breeding attempts / total number of nests (active and inactive)
  - Fledging success (%) = number of fledglings evident / number of breeding attempts derived from the first field visit.
- Changes were determined by the degree of variation observed between At Risk and Reference islands, and were plotted using time-series control charts to understand trends over time.

Results

- Bridled Tern nest density was similar between Parakeelya Island (8.4 ± 0.8 nests per 100 m^2), Double Island South (9.9 ± 2.7 nests per 100 m^2) and Double Island North (9.6 ± 2.1 nests per 100 m^2). Burrow density at all three monitoring locations was similar to 2021–2022 and remained within the control limit for the season (Figure 2-20).
- Breeding participation was also similar between Parakeelya Island (41.8 ± 6.0%), Double Island South (51.0 ± 11.0%) and Double Island North (42.7 ± 13.4%). This parameter was marginally higher at all locations, with mean increases of 1.4–1.9% recorded during 2022–2023 when compared to the previous season.
- Control charts for breeding participation recorded an increasing trend at Double Island South and Double Island North, relative to Parakeelya Island. At Double Island North, the metric remained within control limits for the season, but has been increasing towards +1 SD for two consecutive years. At Double Island South, the metric deviated outside the +1 SD control limit in 2022–2023, resulting in a review of management triggers (Figure 2-20).
- Fledging success decreased at Double Island North and Double Island South and increased at Parakeelya Island when compared to the previous season, remaining within the control limits for the 2022–2023 season (Figure 2-20).

Discussion and conclusions

- The current season was the third consecutive year of La Niña oceanographic conditions. Unlike the previous breeding season (2021–2022) of Bridled Terns, when eggs were laid early, this time the eggs were laid later, in mid-December. As a result, fledglings this season emerged between late February and early March 2023.

Ecological element: Fauna / habitat
• Nest density for Bridled Terns remained stable in 2022–2023, similar to the previous season, and stayed within the range recorded since 2018–2019. • Breeding participation rate for Bridled Terns was similar to previous seasons and within the expected range. Control charts for breeding participation did record an increasing trend at Double Island South and Double Island North, relative to Parakeelya Island indicating the relative increases observed on At Risk islands have been greater than that observed at the Reference site. • Fledgling success for Bridled Terns was slightly lower on At Risk islands compared to last season, and higher at the Reference island. However, the difference was not significant. • As a whole, trends in abundance, breeding participation and fledgling success are likely linked to regional and seasonal variability in oceanographic conditions as well as, localised variations in foraging and nesting site selection. There is no evidence to suggest observed variations in abundance and demographics parameters are attributable to Gorgon Gas Development.

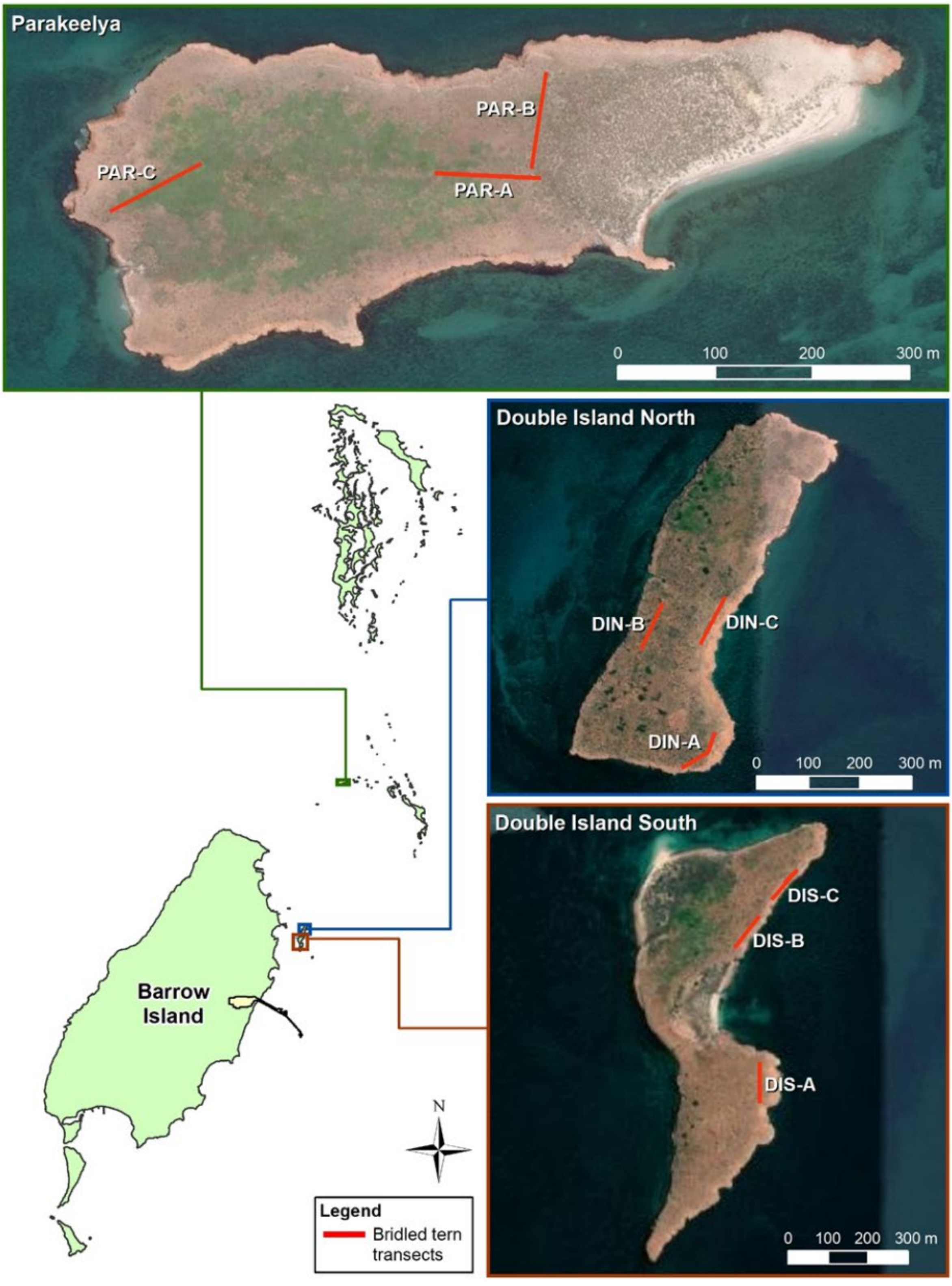


Figure 2-19: Bridled Tern survey transects for the Reporting Period

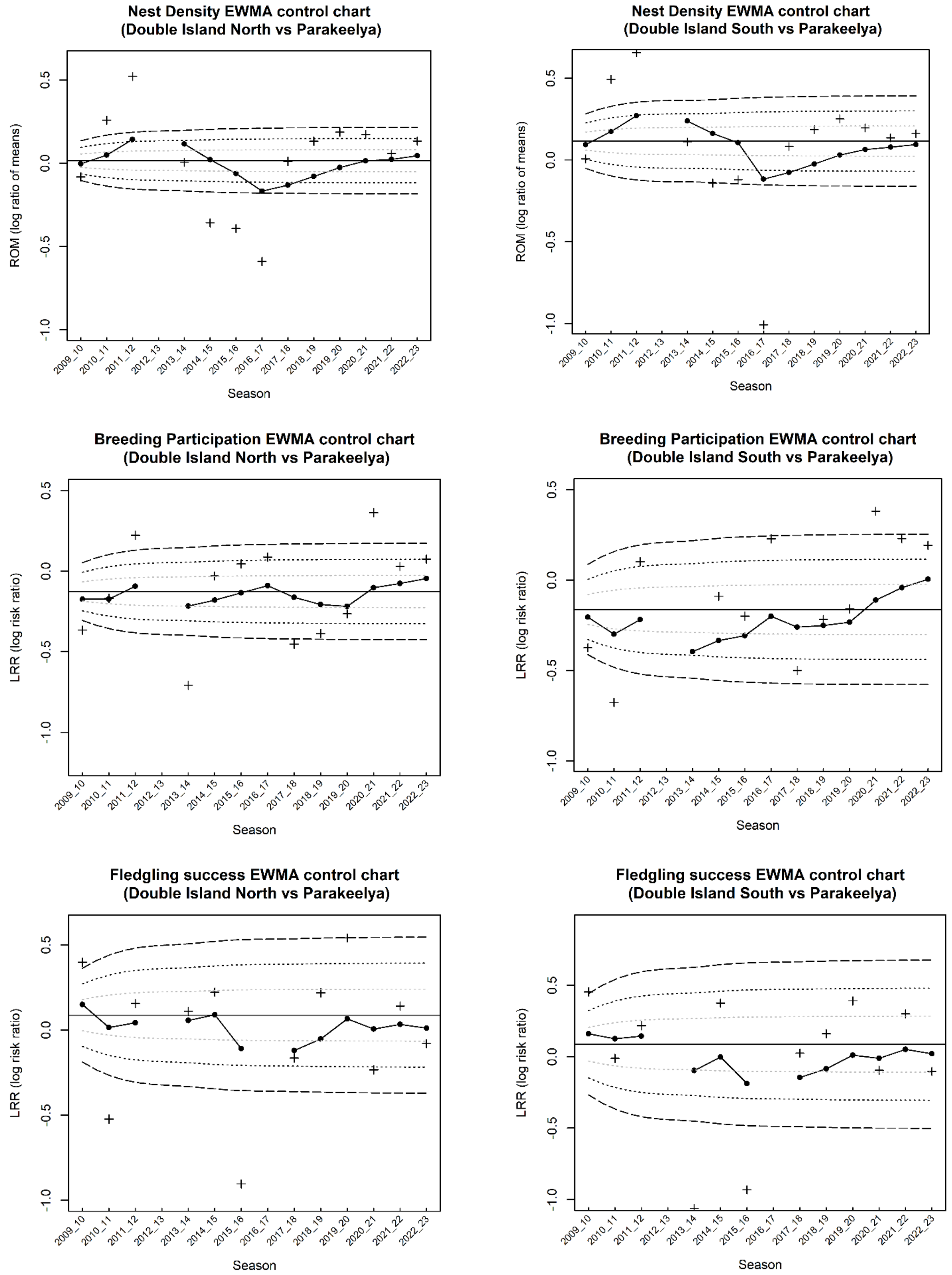


Figure 2-20: Bridled Tern control charts for nest density (top), breeding participation (middle), and fledging success (bottom), between the At Risk islands (Double Island South and North) and Reference island (Parakeelya)

+ = standardised difference metric; • = smoothed standardised difference metric based on exponentially weighted 3-year moving average; dotted curves represent ±1 SD, ±2 SD, and ±3 SD.

Note: No Bridled Tern monitoring occurred in 2012–2013 and fledging success could not be estimated in 2016.

Ecological element: Groundwater / ecological communities
Taxon, feature, or species
Superficial aquifer
Objective
To detect variation in groundwater parameters—attributable to the Gorgon Gas Development and Jansz Feed Gas Pipeline—over time.
Changes to monitoring sites
There was no deviation from the Operational Sampling and Analysis Quality Plan (SAQP) (Ref. 3), except for adopting pre-operations baseline values for individual monitoring wells in the assessment. Pre-operations baseline values comprise the minimum and maximum values for each analyte at each well for these periods: • June 2015 to February 2017 – for GTP monitoring wells and monitoring wells near the Permanent Wastewater Disposal (PWD) wells • September 2011 to February 2017 – for monitoring wells near the Temporary Wastewater Injection Plant (TWIP) wells.
Methodology
Monitoring frequency • Since November 2016, biannual sampling has been undertaken in accordance with the Operational SAQP (Ref. 3). • During the Reporting Period, two groundwater monitoring events (GMEs) were undertaken (July 2022 and April 2023). **Sampling scope** • Groundwater samples were collected from 14 monitoring wells within the GTP, two monitoring wells near the PWD wells on Road 5, and two monitoring wells near the TWIP wells. Samples were collected using low-flow and passive sampling techniques. • Physical parameters (including water level, pH, electrical conductivity, redox potential [ORP], dissolved oxygen [DO], and temperature) were recorded in the field. • Samples were also sent to a National Association of Testing Authorities accredited laboratory for further analysis. **Sample analysis** *GTP monitoring wells – shallow* • Laboratory analysis was conducted for physical parameters, major cations, major anions, mercury, monoethylene glycol (MEG), methyldiethanolamine (MDEA), benzene, toluene, ethylbenzene, and xylenes (BTEX), total recoverable hydrocarbons (TRH), and dissolved organic carbon (DOC). *GTP monitoring wells – deep* • Laboratory analysis was conducted for physical parameters, major cations, major anions, mercury, MEG, MDEA, and DOC. *Monitoring wells near PWD wells* • Laboratory analysis was conducted for physical parameters, major cations, major anions, mercury, MEG, MDEA, BTEX, TRH, DOC, and nutrients. • Based on the primary analytical results, some wells were analysed for additional analytes such as an additional dissolved metals suite. *Monitoring wells near TWIP wells* • Laboratory analysis was conducted for physical parameters, major cations, major anions, BTEX, TRH, DOC, and nutrients. • Based on the primary analytical results, some wells were analysed for additional analytes such as TRH silica gel clean-up (SGC), polycyclic aromatic hydrocarbons (PAH), monocyclic aromatic hydrocarbons (MAH), or an additional dissolved metals suite. Field and laboratory results were compared against baseline values and published water quality criteria guidelines or limits of reporting (LORs) where applicable. Changes in selected groundwater parameters are used as an indirect habitat indicator for stygofauna.

Ecological element: Groundwater / ecological communities
Results
• *GTP monitoring wells* • Analysis of results for the GTP monitoring wells indicated that parameters were generally within the range of baseline results, were not detected above the LOR, or were below assessment criteria (as outlined in the Operational SAQP [Ref. 3]), except for: • Physical parameters: Some pH, DO, salinity, and ORP values were recorded outside the baseline values at GTP wells during the July 2022 and April 2023 GMEs. • The groundwater at GW-GTP-01A, GW-GTP-01B and GW-GTP-03A remain high in DO content from low levels during pre-operations, in line with previous monitoring periods. • Generally, a trend towards an oxidising redox state was observed at most well locations during the April 2023 GME, with results at most wells exceeding maximum baseline values. In the July 2022 GME, GW-GTP-03B reported a mildly reducing to mildly oxidising state, compared to a mildly reducing state recorded during the baseline. In the April 2023 GME, three wells reported a change of redox state to oxidising from their baseline states of mildly reducing to mildly oxidising (GW-GTP-02A), reducing to mildly oxidising (GW-GTP-04B) and reducing to oxidising (GW-GTP-24A). • Note: MDEA was not detected above LOR in the GTP wells during the July 2022 or April 2023 GMEs, with the exception of results from GW-GTP-03A, GW-GTP-03B, GW-GTP-04A, GW-GTP-04B and GW-GTP014A from the April 2023 GME which, during QA/QC, were found to be as a result of sample contamination. MDEA was not detected above LOR during the subsequent GME in August 2023 (outside of this Reporting Period). • *Monitoring wells near TWIP wells* • Analysis of results for the monitoring wells near the TWIP wells indicated that parameters were generally within the range of baseline results, were not detected above the LOR, or were below assessment criteria (as outlined in the Operational SAQP [Ref. 3]), except for: • Nitrate concentration (as N) reported at DWDB1-MW2 (8.43 mg/L) and DWDB2-MW3 (24.7 mg/L) in July 2022 exceeded the assessment criterion of 1.70 mg/L and the maximum pre-operations baseline values of 8.3 mg/L and 22 mg/L, respectively. In April 2023, the nitrate concentration (as N) reported at DWDB1-MW2 increased to 9.02 mg/L and at DWDB2-MW3 decreased to 14.6 mg/L. These results exceeded the assessment criterion of 1.70 mg/L, with DWDB1-MW2 also exceeding the maximum pre-operations baseline value. The nitrate concentration decreased in DWDB2-MW3 compared to previous GMEs, although it remained within the same order of magnitude as previous monitoring events. An exceedance of the assessment criteria for two consecutive GMEs triggered further investigation of existing data and relevant information. The results were consistent with the pre-operations baseline values, therefore, further management action was not required. • Elevated results, above the baseline maximum values, for calcium, magnesium and chloride were reported at DWDB1-MW2 in July 2022 and April 2023, and at DWDB2-MW3 in July 2022. There are no assessment criteria for these analytes. These results triggered further analysis of metals at these locations, with barium detected at concentrations that exceeded the maximum baseline values at DWDB2-MW3 (0.429 mg/L) in July 2022 and at DWDB1-MW2 (0.894 mg/L) in April 2023. There is no assessment criterion for barium for these wells. • Naphthalene and BTEX were not detected above the LOR in either well, although the LOR (0.005 mg/L) for naphthalene was greater than the assessment criterion (<0.001 mg/L) at both wells in July 2022 and April 2023. • TRH $>C_{16}$–C_{34} Fraction F3 was detected in both wells at a concentration (0.12 mg/L) marginally above the assessment criterion (0.1 mg/L) in April 2023. This result also exceeded the baseline maximum value (0.1 mg/L) at DWDB2-MW3. TRH was not detected above the LOR in July 2022. The initial results of subsequent monitoring in August 2023 (outside of this Reporting Period) indicate that TRH $>C_{16}$–C_{34} Fraction F3 was not detected above the LOR at both wells. Further management action was not required. • *Monitoring wells near the PWD wells* • Analysis of results for the monitoring wells near the PWD wells indicated that parameters were generally within the range of baseline results, were not detected above the LOR, or were below assessment criteria (as outlined in the Operational SAQP [Ref. 3]), except for: • Physical parameters: Groundwater conditions at GW-RD5-02 and GW-RD5-03 have shown a trend of decreasing salinity since operations commenced. In the April 2023 GME, the groundwater salinity at both wells was reported as ‘fresh’ with current concentrations of total dissolved salts of 864 mg/L at GW-RD5-02 and 741 mg/L at GW-RD5-03.

Ecological element: Groundwater / ecological communities
• The redox state of GW-RD5-02 was reported as reducing to mildly reducing during the baseline; however, in the July 2022 GME, was reported as mildly oxidising. • Levels of nitrate (as N) were reported at GW-RD5-02 in July 2022 (1.94 mg/L) and April 2023 (2.04 mg/L), with concentrations marginally exceeding the assessment criterion of 1.70 mg/L. These concentrations were above the maximum pre-operations baseline value (0.3 mg/L) for this well. An exceedance of the assessment criteria for two GMEs triggered further investigation of existing data and relevant information as well as continued routine monitoring. • In the July 2022 and April 2023 GMEs, GW-RD5-02 exceeded the pH maximum pre-operations baseline value of 7.24, but was within the assessment criterion range (6.5–8.5). • Naphthalene was not detected above the LOR in July 2022 or April 2023; however, the LOR (0.005 mg/L) was greater than the assessment criterion of 0.001 mg/L at both PWD wells.
Discussion and conclusions
• Groundwater monitoring during the Reporting Period is considered to have been completed in accordance with the TSEMP (Ref. 1) and the Operational SAQP (Ref. 3). • The results from the groundwater monitoring program, as per the Operational SAQP, generally indicated that no significant observable variations to relevant groundwater parameters were attributable to the Gorgon Gas Development during the Reporting Period.

Ecological element: Surface water landforms
Taxon, feature, or species
Geomorphological profile of drainage lines and claypans
Objective
To detect impacts to surface water landforms—attributable to the Gorgon Gas Development and Jansz Feed Gas Pipeline—over time.
Changes to monitoring sites
No changes to monitoring sites. All 14 sites were transitioned to direct field inspection in 2020 after two or more years had elapsed since clearing or earthworks, and remote sensing had not identified any Project-related impact (Figure 2-21).
Methodology
• Detecting changes to surface water landforms at risk of erosion or sedimentation is undertaken annually using remote sensing and/or direct field inspection of Reference sites (upstream of the disturbance, e.g. road, pipeline right-of-way) and At Risk sites (downstream of the disturbance) or by direct field inspection after heavy or cyclonic rainfall. • A review of aerial imagery was undertaken in December 2022 comparing imagery from November 2021. A site field inspection was also undertaken in September 2022.
Results
Above average rainfall occurred on Barrow Island in April (39.6 mm), May (283.2 mm) and June 2022 (45.0 mm). Following this rainfall, no significant erosion or sedimentation was observed at any of the 14 monitoring sites via aerial imagery or direct field inspection in September 2022.
Discussion and conclusions
Monitoring to date has not detected impacts (attributable to the Gorgon Gas Development) to surface water landforms.

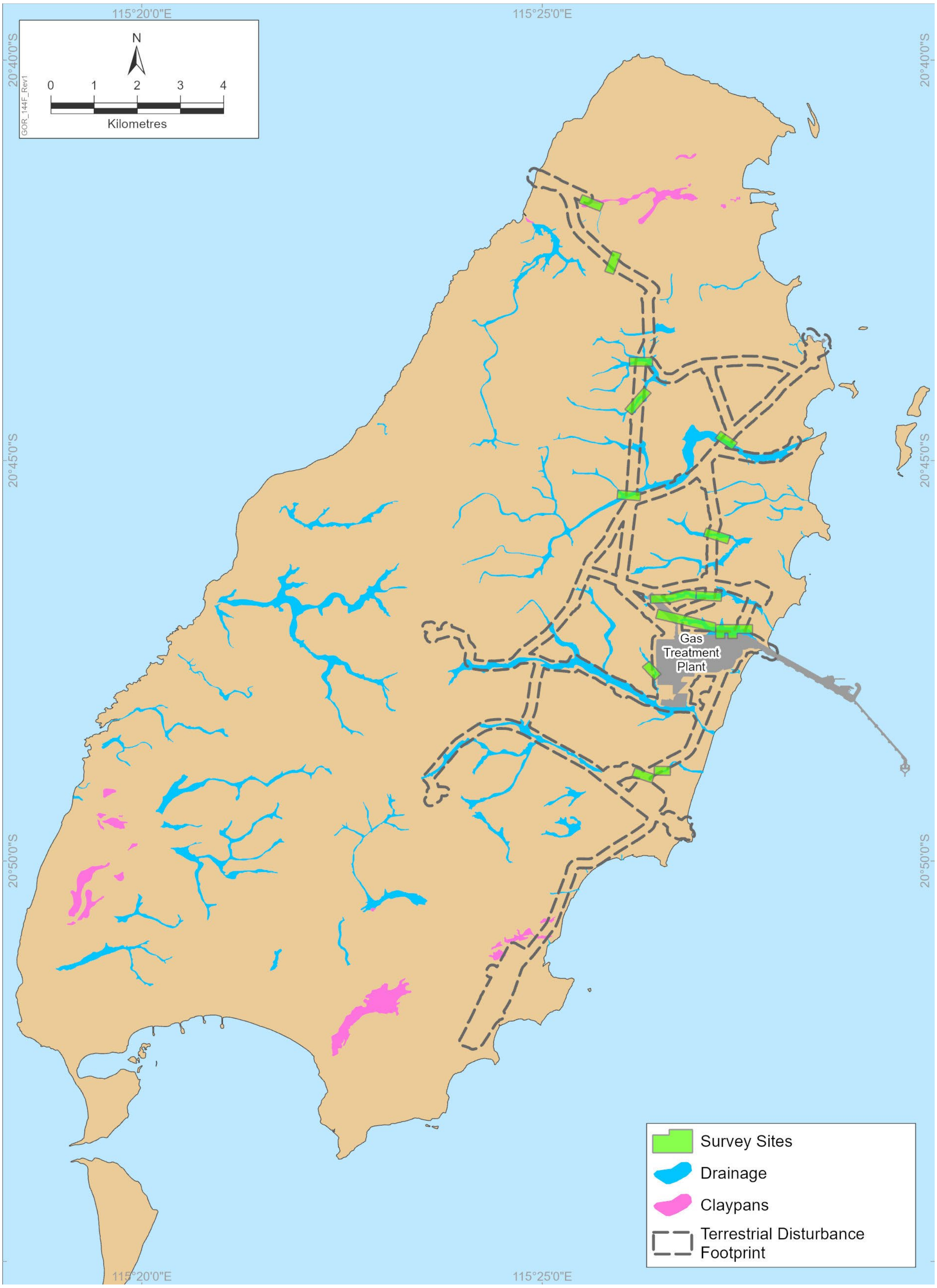


Figure 2-21 Surface Water Landform sites surveyed for the Reporting Period

2.2 Event data

The Threatened or Listed fauna reporting undertaken during the Reporting Period is summarised in the following table.

Event data: Threatened or Listed fauna reporting
Reporting requirement
Threatened or Listed fauna cared for, injured, or killed within the TDF
Results
• Table 2-2 lists the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and WA *Biodiversity Conservation Act 2016* (BC Act) Threatened or Listed fauna injured or killed during the Reporting Period both in and outside the TDF. This includes where cause was attributed to the Gorgon Gas Development or cause was listed as unknown. • In the deceased fauna records, the Golden Bandicoot represented 56% of the records, followed by the Spectacled Hare-wallaby (18%), Burrowing Bettong (12%), Euro (6%), Welcome Swallow (2%) and WWFW (2%). The Wedge-tailed Shearwater, Crested Tern, Red-capped Plover, Red-necked Stint and Silver Gull each represented ~1% of the deceased records (Table 2-2). The predominant cause of death for these species was vehicle strike (75%). The mortality counts for these species represent only a small proportion (~≤1%) of estimated abundance for Barrow Island species. • Injured fauna records included three Golden Bandicoots which were subsequently released and, two Spectacled Hare-wallabies injured by vehicle strike that were not able to be captured for assessment and care therefore, the outcome was recorded as unknown.
Fauna interaction: Management initiatives, activities, and improvements
• Additional awareness material was provided to the workforce during the Reporting Period, to highlight operational risks to fauna and reinforce reporting commitments, in the form of site notices, toolbox talks, and attendance of ecologists and environmental specialists at pre-start meetings. • Maximum vehicle speed limitations altered from 40km/h during Civil Twilight hours to 40km/h between Sunrise/Sunset. This resulted in a greater period of time per day where maximum speed was 40km/h, therefore reducing the maximum speed (from 60kmh) during the period of higher risk of fauna / vehicle interactions. • Additional fauna road signs have been installed in areas considered higher risk of fauna / vehicle interactions. • The development of an online Fauna Event tool has commenced to support direct upload of fauna event information into the reporting database. • Investigation of additional safeguards is ongoing to further reduce the incidence of vehicle strikes.

Table 2-2: EPBC Act and BC Act Threatened or Listed Fauna recorded as injured or deceased during the Reporting Period in and outside the TDF

Common Name	Species Name	No. Injured[1]	No. Deceased[2]
White-winged Fairy-wren (Barrow Island)	*Malurus leucopterus edouardi*	0	3
Barrow Island Euro	*Osphranter robustus isabellinus*	0	11
Burrowing Bettong, Boodie (Barrow and Boodie Islands)	*Bettongia lesueur Barrow and Boodie Islands subspecies*	0	23
Crested Tern	*Sterna bergii*	0	1
Golden Bandicoot (Barrow Island)	*Isoodon auratus barrowensis*	3	107
Red-capped Plover	*Charadrius ruficapillus*	0	1
Red-necked Stint	*Calidris ruficollis*	0	1
Silver Gull	*Chroicocephalus novaehollandiae*	0	2

Common Name	Species Name	No. Injured[1]	No. Deceased[2]
Spectacled Hare-wallaby (Barrow Island)	*Lagorchestes conspicillatus conspicillatus*	2	35
Wedge-tailed Shearwater	*Ardenna pacifica*	0	2
Welcome Swallow	*Hirundo neoxena*	0	4

1 *Includes injured fauna where the cause of injury is attributed to the Gorgon Gas Development or where the cause of injury is unknown; does not include fauna where the injury was from natural causes.*

2 *Includes fauna deaths where the cause of death is attributed to the Gorgon Gas Development, and sick or injured fauna that were cared for and subsequently euthanised; does not include fauna where the death was from natural causes. Note: Does not include cared for fauna that is held temporarily, and that is not believed to be sick, diseased or abandoned (i.e. captured and temporarily held for relocation).*

2.3 Changes to the Terrestrial and Subterranean Environment Monitoring Program

In accordance with the variation to EPBC 2003/1294 and EPBC 2008/4178 conditions, issued 7 August 2023, the TSEMP (Ref. 1) will be revised and resubmitted to DCCEEW by 30 June 2024, and subsequently to DWER.

3 Terrestrial and marine quarantine

Table 3-1: EPR requirements for terrestrial and marine quarantine

Item	Source	Section in this EPR
Results of the audit and monitoring programs	MS 800, Schedule 3(2i) EPBC 2003/1294 and 2008/4178, Schedule 3(2i)	3.1, 3.2
Detected introduction(s) of non-indigenous terrestrial flora or fauna (NIS) and marine pest species, including procedure breaches and 'near misses'[1] including special reference to weeds	MS 800, Schedule 3(2ii) EPBC 2003/1294 and 2008/4178, Schedule 3(2ii)	3.2, 3.3
Consequences of the introduction	MS 800, Schedule 3(2iii) EPBC 2003/1294 and 2008/4178, Schedule 3(2iii)	3.2
Modification, if any, to the Quarantine Management System (QMS) because of: • audits and monitoring • detected introductions • 'best practice' improvements.	MS 800, Schedule 3(2iv) EPBC 2003/1294 and 2008/4178, Schedule 3(2iv)	3.4
Eradication actions if any taken; reasons for any action or non-action; changes to improve procedures and outcomes and progress	MS 800, Schedule 3(2v) EPBC 2003/1294 and 2008/4178, Schedule 3(2v)	3.2
Mitigation actions	MS 800, Schedule 3(2vi) EPBC 2003/1294 and 2008/4178, Schedule 3(2vi)	3.2
Results of any QMS-related studies, where conducted, to improve performance	MS 800, Schedule 3(2vii) EPBC 2003/1294 and 2008/4178, Schedule 3(2vii)	N/A[2]
Weed management incidents: • new infestations • proliferations	MS 800, Schedule 3(2viii) EPBC 2003/1294 and 2008/4178, Schedule 3(2viii)	N/A[3]
Weed eradication performance and • areas treated • results against measurable indicators and limits	MS 800, Schedule 3(2xi) EPBC 2003/1294 and 2008/4178, Schedule 3(2ix)	N/A[3]
Targets proposed for the next year	MS 800, Schedule 3(2x) EPBC 2003/1294 and 2008/4178, Schedule 3(2x)	3.2

1. *Although MS 800 refers to 'near misses', 'intercept' is the appropriate term, and therefore is used below. The term 'intercept' is used throughout the QMS (Ref. 5).*
2. *No QMS-related studies were implemented during the Reporting Period; therefore, reporting is not applicable at this time.*
3. *No proliferations of existing weeds or new weed establishments were recorded during the Reporting Period; therefore, reporting is not applicable at this time.*

3.1 Audits

CAPL audits of the quarantine management measures described in the QMS (Ref. 5) are conducted at least every two years during operations. No audits were undertaken during the Reporting Period. Corrective actions identified during the previous Reporting Period have been completed.

No regulator audits were carried out on the QMS during the Reporting Period.

3.2 Monitoring results

A quarantine surveillance program determines the presence or absence of NIS (plants, invertebrates, and vertebrates) on Barrow Island and Marine Pests in the waters surrounding Barrow Island.

The results of surveillance programs implemented during the Reporting Period are summarised in the following tables.

Surveillance program: Plant NIS
Objective
To detect the presence and/or proliferation of plant NIS (weeds) on Barrow Island attributable to Gorgon Gas Development activities.
Methodology
• Repeated weed surveillance at identified risk localities within the Gorgon Gas Development tenure and surrounding areas. • Repeated weed inspections of areas where weeds were previously recorded as a follow-up measure to ensure any further weed detections are controlled immediately. • Validation of the weed surveillance program was completed by undertaking a Botanist Assurance field visit (weed inspection, surveillance and control within designated areas on Barrow Island).
Results
• Weed species detected and controlled within the Gorgon Gas Development tenure or surrounding areas under weed surveillance during the Reporting Period: – Buffel Grass (*Cenchrus ciliaris*) – Blackberry Nightshade (*Solanum nigrum*)* – Common Sowthistle (*Sonchus oleraceus*)* – Whorled Pigeon Grass (*Setaria verticillata*) – Bulrush (*Typha* sp.) plants were detected in drains at Butler Park accommodation camp – Tomato (*Solanum lycopersicum*) detected within drains around the GTP. • Surveillance associated with Kapok (Aerva javanica) detected in the 2016–2017 Reporting Period continued. There were no detections of kapok bush during the Reporting Period. • No new Weed Hygiene Zones were required to be established during the Reporting Period. ** includes seeded individuals*
Conclusions
No introduction or proliferation of weed species (attributable to the Gorgon Gas Development) was recorded during the Reporting Period.

Surveillance program: Invertebrate NIS
Objective
To detect the presence and/or proliferation of invertebrate NIS on Barrow Island, attributable to Gorgon Gas Development activities.
Methodology
• Surveillance effort focused on identified risk localities and used multiple surveillance system components (SSCs). • The SSCs used for the Reporting Period included: light traps, baited traps (including sticky traps), biologist structured and unstructured surveys, suction sampling, and workforce observations/reporting.
Results
• These NIS invertebrates were recorded during the Reporting Period: – 104 Jumping Spiders (*Menemerus nigli*) were detected associated with infrastructure including the Materials Offloading Facility (MOF), Butler Park, the airport, the old airport, Terminal Tanks and the GTP (see below). It has not been detected in the natural environment on Barrow Island. – 255 Maritime Earwigs (*Anisolabis maritima*) were detected in sticky traps at the MOF. These were detected as part of an ongoing Quarantine Response (NIS detected in the previous two Reporting Periods). – One Longicorn Beetle (*Coleocoptus senio*) was detected (between WA Oil base and the airport). This species was discussed with subject matter experts (SMEs) and the Quarantine Expert Panel (QEP). The QEP considered that it was not possible to confirm beyond a reasonable doubt that the longicom beetle is non-indigenous to Barrow Island and recommended the species status remains as 'indeterminate'. A surveillance program remains in place on Barrow Island. • No Indian House Crickets (*Gryllodes sigillatus*) were detected. Successful eradication of this non-indigenous species from Barrow Island was declared in October 2022. A targeted monitoring program remains in place within the GTP. • During the previous Reporting Period, CAPL reported that *M. nigli* is an NIS, which was introduced to Barrow Island as a result of and after the Gorgon Gas Development commenced. – In accordance with MS 800 Conditions 9.2 and 10.3, the QEP wrote to the Minister for Environment on 16 September 2021 to notify them of this establishment. CAPL will continue to engage with the Minister, the QEP and other SMEs on this matter. – The consequences of introduction are yet to be determined; however, initial advice from SMEs is that it is anticipated that *M. nigli* will have a low to negligible impact on Barrow Island's biodiversity. Eradication or mitigation measures are yet to be determined following further advice from the Minister. – CAPL has implemented control measures, including treating high-risk assets with insecticide before moving them out of the GTP. – Targets are developed in response to introductions of NIS. Delineation surveillance continues to be undertaken and, following further advice from the Minister, this will determine the response or management program and targets accordingly. • Identification of some specimens from the 2022–2023 surveillance program is still pending, and any NIS detections will be included in the 2024 EPR.
Conclusions
Menemerus nigli is an NIS, which was introduced to Barrow Island as a result of and after the Gorgon Gas Development commenced. This declaration was made during the 2021–2022 Reporting Period. During this Reporting Period (2022–2023), delineation is continuing, to establish the extent of this species on Barrow Island. All other NIS detected during the Reporting Period were controlled immediately or are under an ongoing Quarantine Response.

Surveillance program: Vertebrate NIS
Objective
To deetect the presence and/or proliferation of vertebrate NIS on Barrow Island attributable to Gorgon Gas Development activities.
Methodology
• Surveillance effort focused on identified risk localities and used several SSCs. • The SSCs used for the Reporting Period included: biologist unstructured surveys, biologist structured surveys (night and day), cage traps, Elliot traps, pitfall traps, hair cards, environmental acoustic recognition sensors, print acquisition for wildlife sensors, and workforce observations/reporting.
Results
Surveillance implemented during the Reporting Period detected species native to Barrow Island, including Golden Bandicoot (*Isoodon auratus barrowensis*) and Common Rock Rat (*Zyzomys argurus*)
Conclusions
No introductions of vertebrate NIS, attributable to Gorgon Gas Development activities, were recorded during the Reporting Period.

Surveillance program: Marine pests
Objective
Detect the presence of Marine Pests in the waters around Barrow Island, attributable to Gorgon Gas Development activities.
Methodology
• The Marine Pest Surveillance Program conducted at Barrow Island during the Reporting Period included analysis of environmental deoxyribonucleic acid (eDNA) from settlement arrays (including 16 plates each) and water samples. DNA present on settlement arrays and in water samples was analysed using next-generation sequencing methodology, or real-time polymerase chain reaction testing, and the results compared against a reference database of targeted Marine Pests. • Surveillance and sampling locations focused on high-risk localities around operational areas. • Forty-five settlement plates (soaked for either two or six months) were collected. Three replicates were taken from each array and analysed. Each replicate contained two plates that were scraped and pooled.
Results
• Six sampling events from four settlement arrays were completed for eDNA analysis during the Reporting Period (in September and December 2022, and January, April, June, and July 2023). No Marine Pests were detected during this or previous Reporting Periods[1].
Conclusions
No introduction of Marine Pests, attributable to Gorgon Gas Development activities, was recorded during the Reporting Period.

1 *The outcome of eDNA analysis of settlement plate arrays and water samples from 2021–2022 Reporting Period are also presented in this Report, as results were not available during the previous Reporting Period.*

3.3 Event data

The quarantine detections recorded during the Reporting Period are summarised in the following table.

Event data: Quarantine detections
Reporting requirement
Detected introduction(s) of NIS and Marine Pest species, procedure breaches, and intercepts, with special reference to weeds.
Results
• During the previous Reporting Period, one quarantine introduction was declared. This species is still present and under a delineation and surveillance response (Jumping Spider, *Menemerus nigli*; see invertebrate NIS surveillance results above for further detail). • During the Reporting Period four Quarantine Incidents, 27 Quarantine Intercepts, and 14 Quarantine Procedural Deviations were recorded (see Section 12 for quarantine event terminology). • Four Level 1 Quarantine incidents included: Typha within the drains around Butler Park (accommodation), tomato pieces and seedlings within the drain around the GTP, Helicopter seeds (*Tipuana tipu*) within cargo when shrink wrap had been removed (detected on the MOF) and Cigarette Beetles (*Lasioderma serricorne*) within personal stores of tea (detected at the Operations Complex Building). All non-indigenous species associated with these incidents were collected, contained and removed. Surveillance was implemented and, in each case, no additional specimens were detected. • Most Quarantine Intercepts were associated with NIS invertebrates (22%) and seed material (59%). • During this Reporting Period, CAPL engaged with the QEP to review the species status of *Euborellia annulipes* (European Earwig) and it was determined that it was likely an NIS. Therefore, 12 historical records of detection on Barrow Island (between 2013 and 2022) were reclassified from 'uncertain' to Quarantine Incidents (Level 1). These detections each involved collecting single specimen, mostly within accommodation facilities on Barrow Island. At the request of the QEP, a targeted surveillance program is underway on Barrow Island.
Conclusions
• Delineation and surveillance activities for *M. nigli* continues, which was declared during the previous Reporting Period as introduced to Barrow Island, as a result of and after the Gorgon Gas Development commenced. • All other NIS detected during the Reporting Period were responded to and controlled immediately following detection. • Quarantine first-response and eradication activities for the Indian House Cricket (*Gryllodes sigillatus*)[1] were completed during the Reporting Period (October 2022). Activities included monitoring and treatments. There have been no detections of this species on Barrow Island since 31 December 2021. More than 3,000 monitoring stations were deployed around the GTP, MOF, the surrounding native vegetation, and targeted satellite sites. • Surveillance will continue for Buffel Grass (*Cenchrus ciliaris*) and Kapok Bush (*Aerva javanica*) until CAPL is confident no residual seed banks remain. • Following the Quarantine Incidents, Intercepts, and Procedural Breaches recorded, actions were taken to reinforce quarantine training, procedures, and Gorgon Gas Development quarantine requirements.

1 *Detected in a previous Reporting Period.*

3.4 Changes to the Quarantine Management System

Following the review of the QMS (Ref. 5) during the previous Reporting Period, the updated QMS was submitted to the DWER in February 2022 and DCCEEW in October 2022. CAPL are yet to receive approval for the updated QMS and continue to engage with DWER and DCCEEW on this matter.

In accordance with the variation to EPBC 2003/1294 and 2008/4178 conditions, issued 7 August 2023, the QMS will be revised and resubmitted to DCCEEW by 30 June 2024 and subsequently to DWER.

4 Marine turtles

Table 4-1: EPR requirements for marine turtles

Item	Source	Section in this EPR
Results of all marine turtle monitoring carried out by the Proponent, including any detected changes to the Flatback Turtle population	MS 800, Schedule 3(3i) EPBC 2003/1294 and 2008/4178, Schedule 3(3i)	4.1, 4.5
Reportable incidents involving harm to marine turtles	MS 800, Schedule 3(3ii) EPBC 2003/1294 and 2008/4178, Schedule 3(3ii)	4.2
Changes to the marine turtle monitoring program	MS 800, Schedule 3(3iii) EPBC 2003/1294 and 2008/4178, Schedule 3(3iii)	4.1
Conclusions about the status of Flatback and other marine turtle populations on Barrow Island	MS 800, Schedule 3(3iv) EPBC 2003/1294 and 2008/4178, Schedule 3(3iv)	4.1, 4.4
Changes (if any) to the Long-term Marine Turtle Management Plan	MS 800, Schedule 3(3v) EPBC 2003/1294 and 2008/4178, Schedule 3(3v)	4.4
Findings of the annual audit and review on the effectiveness of lighting design features, management measures, and operating controls including details of light management initiatives and activities undertaken during the year	MS 800, Schedule 3(3vi) EPBC 2003/1294 and 2008/4178, Schedule 3(3vi)	4.2
Results of studies undertaken	MS 800, Schedule 3(3vii) EPBC 2003/1294 and 2008/4178, Schedule 3(3vii)	4.1
Noise monitoring results and a discussion on the success (or otherwise) in meeting noise emission targets	MS 800, Schedule 3(3viii) EPBC 2003/1294 and 2008/4178, Schedule 3(3viii)	N/A[1]

1. *No specific noise emission targets for the Gorgon Gas Development apply to environmental receptors; noise monitoring is considered in relation to monitoring results for the Flatback Turtle population. As reported in the 2010–2015 Five-year EPR (Ref.6): 'Given the results to date, the difficulty in detecting any onshore noise or vibration effects from Project activities on the beaches, and endorsement from the Marine Turtle Expert Panel (and subsequent regulatory approval), the noise and vibration monitoring program was suspended after the 2011–2012 season.' Therefore, reporting for this item is not applicable.*

4.1 Monitoring results

An objective of the Long-term Marine Turtle Management Plan (LTMTMP) (Ref. 7), as defined by Ministerial Conditions, is to establish a statistically valid monitoring program to measure and detect changes to the Flatback Turtle population on Barrow Island.

Key demographic parameters were identified as necessary for understanding the population dynamics and population viability of the Flatback Turtle rookery on Barrow Island. A mainland Reference site (Mundabullangana) was also established. Where relevant, data related to these key parameters are also captured at Mundabullangana for comparison with the Barrow Island Flatback Turtle data (Ref. 7).

Changes in key demographic parameters are measured using time-series control charts. Trends identified in control charts act as early-warning signals to guide a tiered management approach. A management response is triggered if a demographic parameter demonstrates a trend towards, or changes beyond statistical deviations (± 1, ± 2, or ±3 SD, standard error [SE], mean or median absolute deviation [MAD]) from baseline conditions (Ref. 7).

The 2022–2023 results (Ref. 8) for the monitoring programs listed in the LTMTMP, including any changes detected to the Barrow Island Flatback Turtle population, are summarised in the following tables.

Monitoring program: Flatback Turtle abundance and distribution

Objective

To measure and detect changes to the abundance, distribution, and nesting behaviour of adult Flatback Turtles.

Changes to program

Six out of a planned 60 monitoring nights at Mundabullangana were not completed due to the presence of rainfall and strong winds.

Methodology

- Flatback Turtle abundance and distribution monitoring was undertaken between 22 November 2022 and 27 January 2023 on six beaches north and south of the GTP on Barrow Island, as shown in Figure 4-1. Monitoring at Mundabullangana was undertaken between 5 November 2022 and 13 January 2023 on the beaches shown in Figure 4-2.
- Capture-recapture sampling of nesting adult female Flatback Turtles was used to estimate these demographic parameters:
  - annual nester abundance
  - adult female survival probability
  - adult female breeding omission probability
  - nesting activity
  - clutch frequency
  - internesting interval.
- Only key demographic parameters are control-charted—including annual nester abundance, adult female breeding omission probability and clutch frequency. The adult survival probability control chart is no longer presented as this parameter has been modelled and plotted as a constant mean value over all seasons and does not have the potential to exceed the control limits.
- Variation in modelled estimates can occur when models are re-run each year with additional data. Therefore, minor variations from year to year might occur in the historical control-charted parameter estimates presented in this EPR.

Results

Annual nester abundance

- Population size modelling using a capture-mark-recapture multi-state open robust design (MSORD) estimated an annual nester abundance of 2,205 female turtles on the six monitored beaches at Barrow Island (95% confidence interval [CI]: 2,179–2,231) and 1,821 female turtles on the two monitored beaches at Mundabullangana (95% CI: 1,738–1,905) as shown in Figure 4-3.
- The abundance estimates for Barrow Island and Mundabullangana, comparing inter-rookery abundance trends, remained within the EWMA control limits (Figure 4-4a), with the abundance estimate increasing at both locations when compared to the previous season (see Figure 4-3).

Monitoring program: Flatback Turtle abundance and distribution
• The annual nester abundance at Barrow Island again exceeded the +3 SD control limit (Figure 4-4b). The parameter at Barrow Island and Mundabullangana both show a significant increasing linear trend. *Adult female survival probability* • The estimated annual survival probability for nesting Flatback Turtles on Barrow Island was 0.939 (95% CI: 0.936–0.941) and at Mundabullangana was 0.908 (95% CI: 0.892–0.921). *Adult female breeding omission probability* • The breeding omission probability of a Flatback Turtle nesting at Barrow Island in a season (if the turtle nested the previous season) was estimated as 0.57 (95% CI: 0.54–0.60). This parameter exceeded the −1 SD control limit, returning from +1 SD exceedance in 2021–2022 and a +3 SD exceedance in the previous year (Figure 4-4c). The breeding omission probability at Mundabullangana was 0.28 (95% CI: 0.23–0.34), indicating that there was a lower probability of a turtle that nested in the previous season skipping the next nesting season at Mundabullangana compared to Barrow Island. The breeding omission probability at Mundabullangana shows a significant decreasing linear trend. *Clutch frequency* • The estimated clutch frequency at Barrow Island was 4.2 clutches per female per season (95% CI: 4.1–4.4), exceeding the +1 SD control limit (Figure 4-4d). This parameter shows no significant linear trend. At Mundabullangana, the estimated mean clutch frequency was 4.0 clutches per female per season (95% CI: 3.6–4.3) and shows a significant increasing linear trend since baseline. *Internesting interval* • The mean internesting interval for Flatback Turtles at Barrow Island was 14.1 ± 1.8 days and showed no significant trend. At Mundabullangana, the mean internesting interval for Flatback Turtles was 13.8 ± 3.6 days and showed no significant trend. *Nesting activity (spatial and temporal distribution)* • When compared to baseline, the nesting population has demonstrated temporal and spatial variation in how they use certain beaches at Barrow Island. The nesting population's use of certain beaches has likely varied due to changes in coastal processes, notably at Inga, Bivalve, and Terminal beaches, which have recorded a reduction and redistribution of nesting habitat (see Section 9 on Coastal Stability). Concurrently, the same beaches have recorded a shift in the location and change in the pattern of their nesting activities and, in the case of Bivalve beach, a significant decreasing trend in use of the beach.

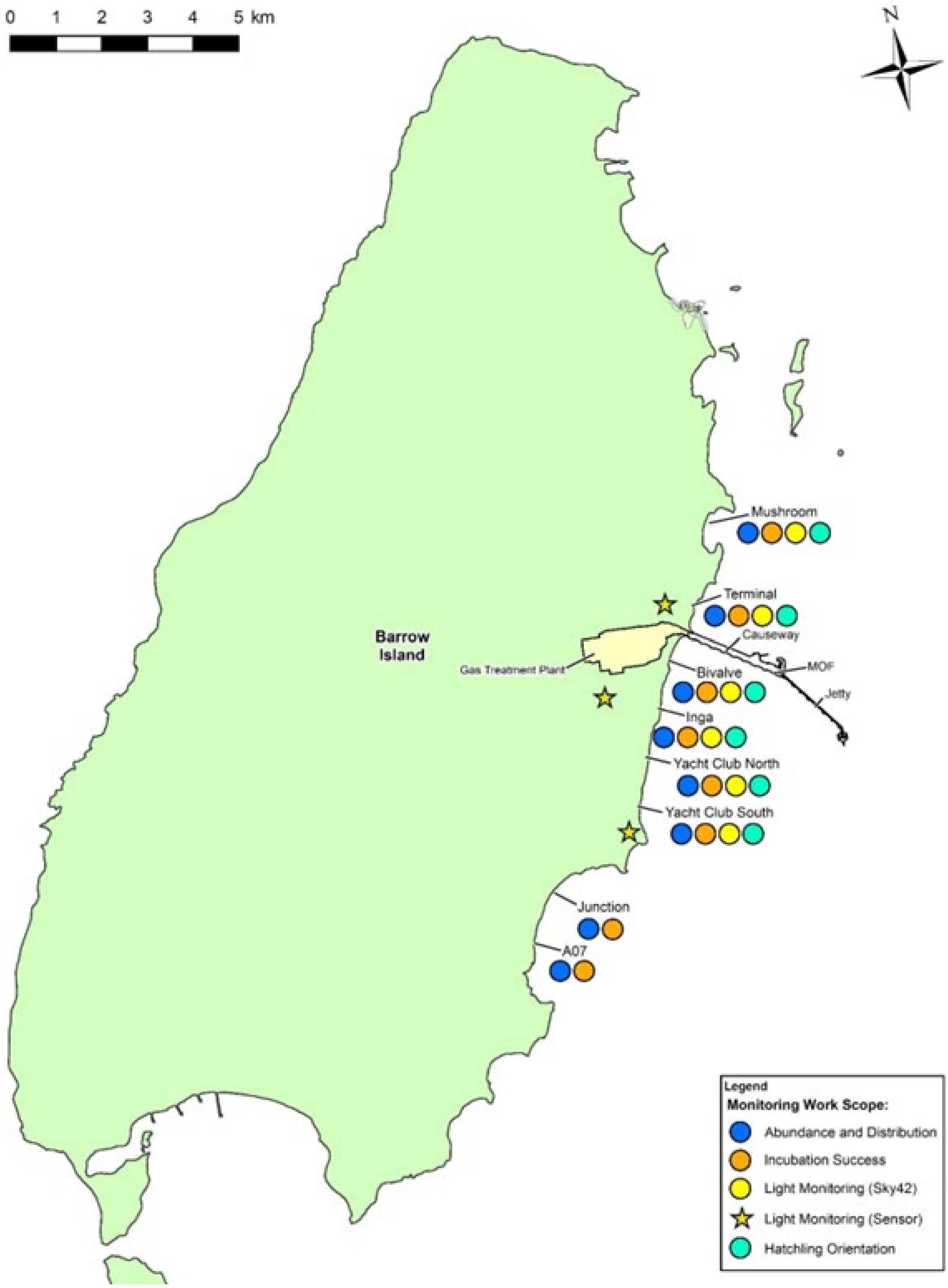


Figure 4-1: Flatback Turtle beaches on Barrow Island surveyed during the Reporting Period

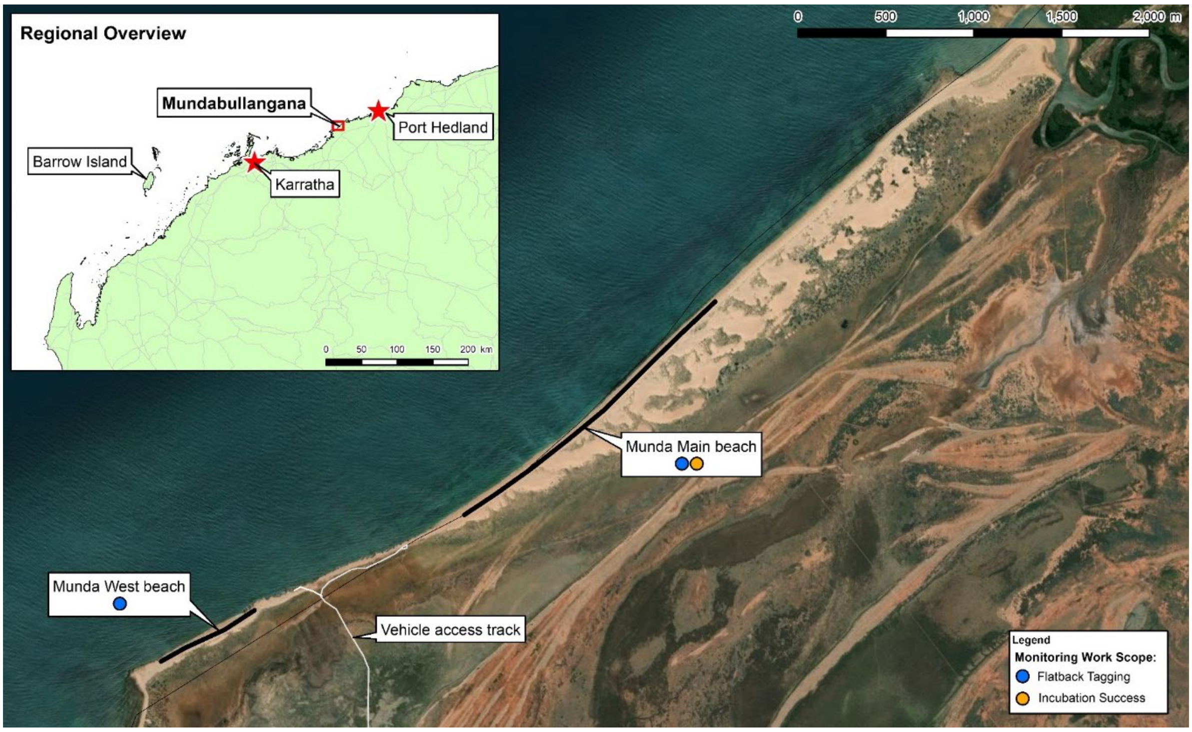


Figure 4-2: Flatback Turtle beaches at Mundabullangana surveyed during the Reporting Period

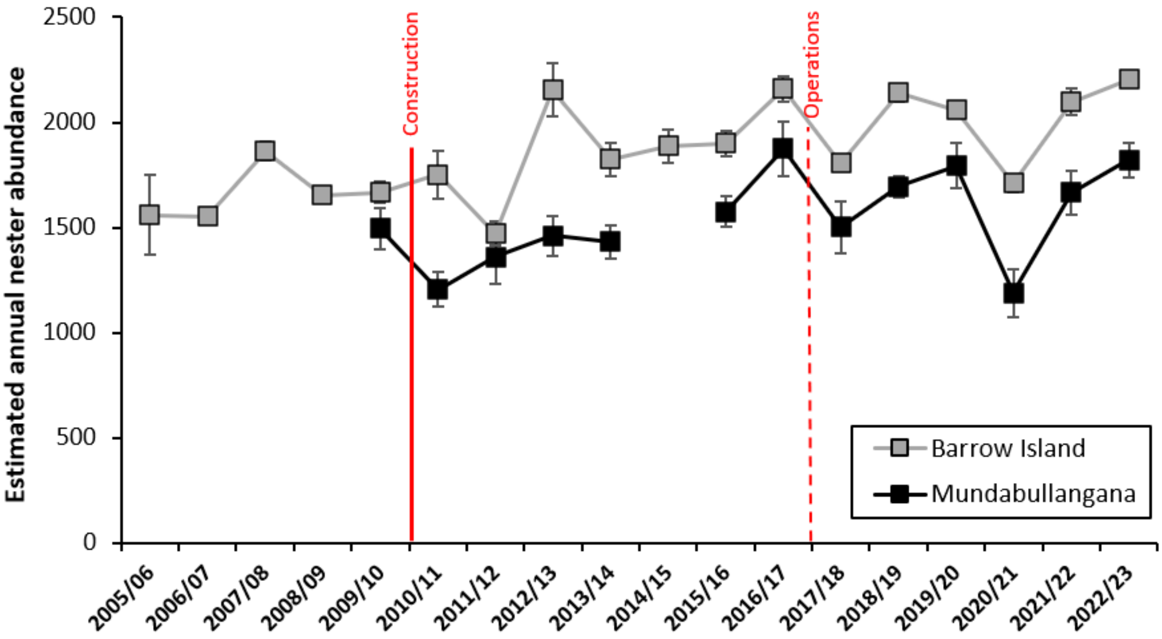


Figure 4-3: Annual abundance estimates at Barrow Island and Mundabullangana between 2005–2006 and 2022–2023[1]

1. *Error bars indicate 95% confidence intervals. Red line indicates start of construction. Red dashed line indicates start of operations. No estimate is available for 2014–2015 at Mundabullangana due to limited sampling in that season.*

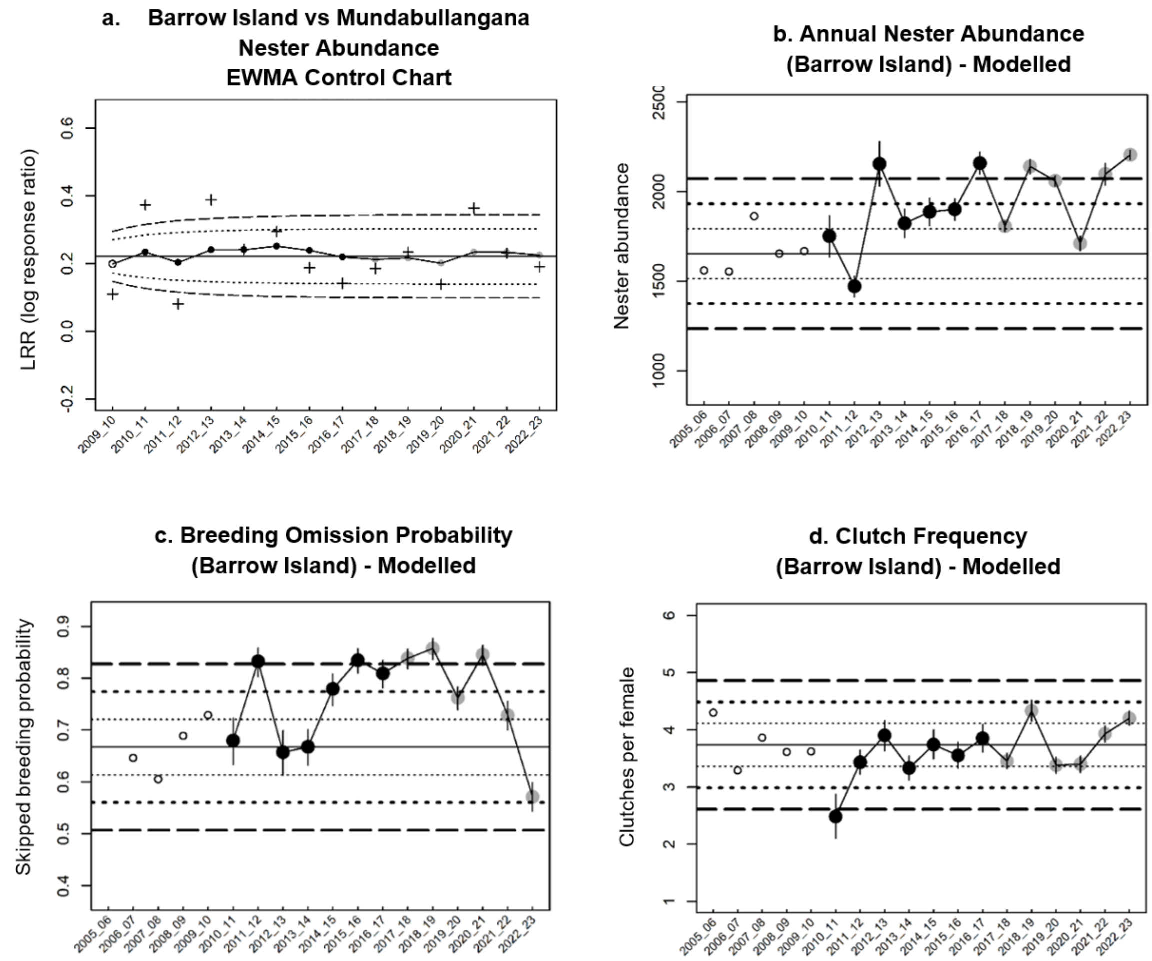


Figure 4-4: Control charts for Flatback Turtle population demographic metrics at Barrow Island including (a) annual nester abundance for Barrow Island vs Mundabullangana, (b) annual nester abundance at Barrow Island, (c) breeding omission probability at Barrow Island, and (d) clutch frequency at Barrow Island[1]

1 *Open dots = baseline estimate derived from empirical data, black dots = construction parameter estimate, grey dots = operations parameter estimate, solid horizontal line = long-term expected estimate derived from baseline estimates (mean or median), dotted lines = ±1 SE (or 1 MAD for annual nester abundance), small dashed lines = ±2 SE (or 2 MAD), long dashed lines = ±3 SE (or 3 MAD). Error bars indicate 95% CI. Note: There is no annual abundance estimate for Mundabullangana in 2014–2015 due to limited sampling in that season.*

Monitoring program: Flatback Turtle incubation success

Objective

To measure and detect changes to Flatback Turtle incubation success.

Changes to program

No changes were made to the Flatback Turtle incubation success monitoring program during the Reporting Period.

Methodology

- Flatback turtle incubation success monitoring was undertaken on Inga, Bivalve, Terminal, and Mushroom beaches, between 29 November 2022 and 13 February 2023 (see Figure 4-1). Monitoring at Mundabullangana was undertaken between 5 November 2022 and 13 January 2023 on the beaches shown in Figure 4-2.
- Monitoring marked nests to estimate these parameters:
  - egg hatching probability
  - hatchling emergence probability
  - incubation duration
  - incubation temperature
  - clutch fate
  - clutch size.
- Only key demographic parameters for Barrow Island are control-charted; these include median egg hatching probability and median hatchling emergence probability for complete clutches. Incomplete clutches are those disturbed by other turtles or predators, lost during incubation, mixed with another clutch, or inundated.

Incubation success results

Egg hatching probability

- The median egg hatching probability at Barrow Island (complete clutches) was 90.5%, which was similar to all clutches at Mundabullangana (92.6%). The parameter remained within management control limits (Figure 4-5a).

Hatchling emergence probability

- The median hatchling emergence probability at Barrow Island (complete clutches) was 89%, which was similar to Mundabullangana (92%). The parameter remained within management control limits (Figure 4-5b).

Incubation duration

- The mean incubation duration at Barrow Island and Mundabullangana was 48.7 ± 2.6 and 49.8 ± 3.0 days, respectively.

Incubation temperature

- The mean daily clutch temperature during incubation at Barrow Island and Mundabullangana was 30.8 ± 1.6 °C and 30.7 ± 1.9 °C, respectively.

Clutch fate

- Of the 173 marked clutches at Barrow Island, 124 (74%) were considered complete. The remaining 44 incomplete clutches were either disturbed by another turtle or predator (n=36), lost during incubation (n=6), or mixed with another clutch (n=6). All disturbance events occurred during incubation (as indicated by the temperature logger data). The percentage of marked clutches that were categorised as incomplete

Monitoring program: Flatback Turtle incubation success
at Barrow Island (all beaches combined) in each season since 2010–2011 does not show a significant increasing or decreasing trend.
Clutch size
• The mean clutch size at excavation was 47.3 ± 9.9 eggs at Barrow Island and 48.6 ± 7.4 eggs at Mundabullangana.

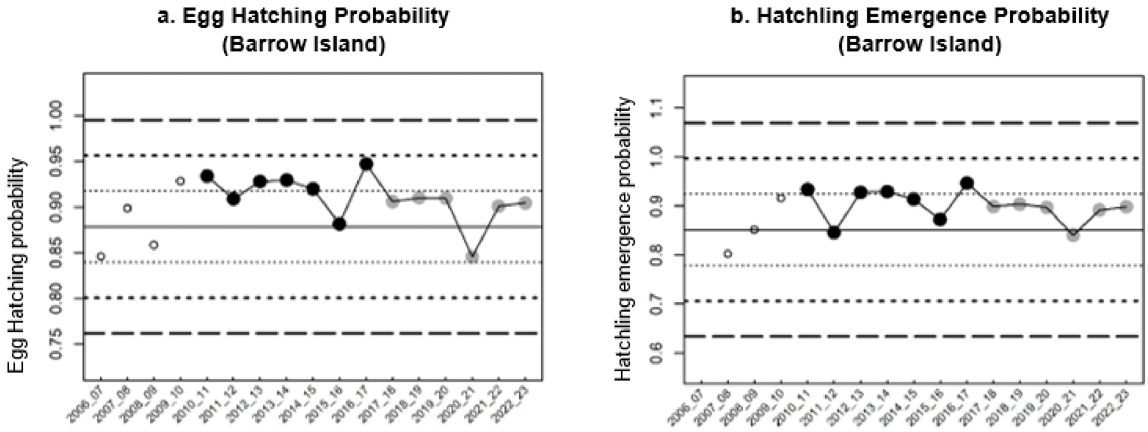


Figure 4-5: Control chart for (a) egg hatching probability and (b) hatchling emergence probability for complete clutches[1]

1 *Open dots = baseline estimate derived from empirical data, black dots = construction parameter estimate, grey dots = operations parameter estimate, solid horizontal line = long-term expected estimate derived from baseline estimates (mean or median), dotted lines = ±1 SE (or 1 MAD), small dashed lines = ±2 SE (or 2 MAD), long dashed lines = ±3 SE (or 3 MAD).*

Monitoring program: Hatchling orientation	
Objective	
To measure and detect variation in dispersal patterns of Flatback Turtle hatchlings following emergence from the nest.	
Changes to program	
No changes were made to the hatchling orientation monitoring program during the Reporting Period.	
Methodology	
• Measure artificial light (magnitude and bearing) on marine turtle nesting beaches using specialised light-measurement cameras. • Measure the orientation (fan spread angle [disorientation] and fan offset angle [from most direct line to the ocean—misorientation]) of marine turtle hatchling tracks on beaches. These parameters are control-charted for Bivalve and Terminal beaches.	

Monitoring program: Hatchling orientation
Light results
• Sources of night-time light emissions included the GTP, ground flare, Butler Park, and offshore infrastructure including the MOF, LNG Jetty head, LNG tanker (when present). • The level of brightness at each monitoring site demonstrated a spatial relationship with the distance from the GTP and associated infrastructure (i.e. brighter values were recorded at closer sites and darker values at more distant sites). • Night-time light emissions (whole-of-sky) were brightest at Bivalve Beach followed by (in order of descending magnitude) Inga, Terminal, Yacht Club North (YCN), Yacht Club South (YCS), and Mushroom beaches.
Hatchling orientation results
• No exceedances in the modelled hatchling post-emergence spread (disorientation) or offset (misorientation) occurred at Bivalve or Terminal beaches during the Reporting Period (Figure 4-6 [a–d]). • In addition to the modelled control chart estimates for Bivalve and Terminal beaches, measures of orientation on these and other Barrow Island beaches (i.e. YCS, YCN, Inga, and Mushroom) indicated: • The smallest mean fan spread angle was at Inga and largest at YCS. This was the third consecutive season that YCS has recorded the largest fan spread angle. • Fan spread angle was significantly smaller on Terminal Beach compared to baseline. There was no significant difference in the fan spread angle at YCS, YCN, Bivalve, or Mushroom beaches when compared to baseline. Comparison of the fan spread angle at Inga was not possible due to the limited number of samples recorded at baseline. • The smallest mean fan offset angle was at Mushroom and the largest was at Bivalve beaches. • There was no significant difference in the fan offset angle at YCS, YCN, Bivalve, Terminal or Mushroom beaches when compared to the baseline. Comparison of the fan offset angle at Inga Beach was not possible due to the limited number of samples recorded at baseline. • Hatchlings generally orientated in a seaward direction and, similar to 2021–2022, a larger proportion of hatchling fan spread and offset angles were in a southerly direction compared to the baseline, across all beaches. There were no new light sources detected that may explain the southerly shift in hatchling spread and offset angles. • There were no hatchling disorientation events and no observations were made of hatchlings orienting directly inland towards light sources associated with the Gorgon Gas Development.

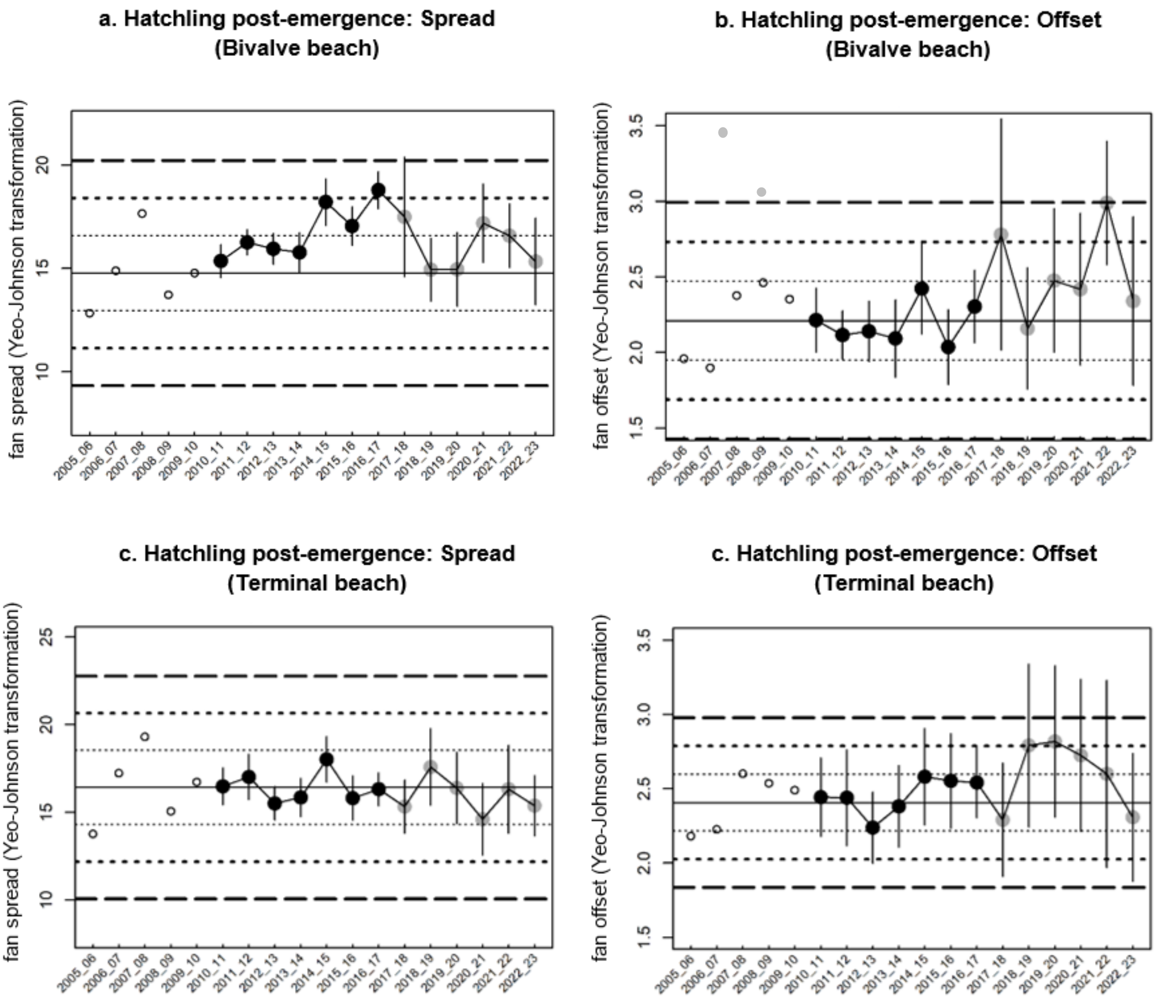


Figure 4-6: Control charts for hatchling post-emergence dispersion: Fan spread and offset estimates at Terminal and Bivalve beaches[1]

1 Open dots = baseline estimate derived from empirical data, black dots = construction parameter estimate, grey dots = operations parameter estimate, solid horizontal line = long-term expected estimate derived from baseline estimates (mean or median), dotted lines = ±1 SE (or 1 MAD), small dashed lines = ±2 SE (or 2 MAD), long dashed lines = ±3 SE (or 3 MAD). Error bars indicate 95% CI.

4.1.1 Flatback Turtle tagging – A07 and Junction beaches

A study was initiated during 2017–2018 to better understand the spatial and temporal variation in nesting beach usage and beach fidelity for those turtles encountered at A07, Junction, and Camp beaches, which are not monitored during the routine Flatback Turtle Abundance and Distribution Monitoring Program. This study was continued during the Reporting Period, with additional tagging effort at two of the study beaches—A07 and Junction.

The additional monitoring effort at A07 and Junction beaches identified 497 turtles that were not encountered on the routine beaches (Mushroom, Terminal, Bivalve, Inga, YCN, and YCS) during the season, and hence excluded from the population size MSORD modelling. This was 24% of all individual turtles encountered at all Barrow Island beaches this season, which was consistent with previous seasons (seasonal monitoring commenced at these beaches in 2017–2018). The 497 turtles at A07 and Junction beaches included 475 remigrant turtles (96%) and 22 new turtles (4%).

4.1.2 Incubation success – A07, Junction, YCS, and YCN beaches

To better understand the hatch/emergence success and incubation environment of Flatback Turtles clutches on A07, Junction, YCS, and YCN beaches, CAPL continued a study during the Reporting Period that had been started at Inga Beach in 2016–2017. The study used the same methodology as the routine Incubation Success Program.

For the 2022–2023 season, egg hatching probability (complete clutches) for A07, Junction, YCS and YCN beaches was 88.1 ± 14.1%, 77.2 ± 32.6%, 81.8 ± 16.9% and 84.9 ± 8.9%, respectively. The egg hatching probability at those beaches where Flatback Turtles have demonstrated a change in the spatial distribution of their nesting activity (i.e. Inga, Bivalve, and Terminal) was similar to the other monitored beaches this season (i.e. A07, Junction, YCS, YCN, and Mushroom) combined.

For the 2022–2023 season, hatchling emergence probability (complete clutches) for A07, Junction, YCS and YCN beaches was 87.4 ± 13.7%, 77.0 ± 32.6%, 79.9 ± 17.8% and 81.9 ± 13.1%, respectively.

4.1.3 Track census and beach temperature assessment

A marine turtle track census and beach temperature assessment was undertaken in December 2022 and January 2023 (Ref. 11). The objectives of the study were to:

- survey Barrow Island Flatback Turtle distribution and abundance and compare with previous marine turtle track census programs, and
- assess beach sand temperatures on selected beaches outside of those routinely monitored for nesting activities.

A total of 22 beaches were surveyed for marine turtle nesting activity over a period of five days (8–12 December 2022). Sand and air temperature loggers were deployed at four beaches for a period of 48 days (7 December 2022 to 25 January 2023). Turtle track data from beaches routinely monitored for nesting activity, along with beach temperature data from those beaches were also compared with the findings of the 2022-2023 study.

The study highlighted the relatively low level of turtle activity at the additionally surveyed beaches. Track counts showed notable spatial and temporal variations within and between species, and from a geographical perspective, beaches in the east and south-east contained more Flatback Turtle tracks, while those in the north-east and south-west were dominated by Green Turtle tracks. This was expected as there is a dominant Flatback Turtle rookery to the east of the island.

Based on the available data, the use of unmonitored beaches by Flatback Turtles is consistent with that found in historical surveys. Overall, it is not apparent that Flatback Turtles from the eight beaches routinely monitored for nesting activity are nesting in high abundance outside of the routinely monitored beaches, nor are they moving to other adjacent beaches.

The 2022–2023 study recorded sand temperatures that were generally consistent across the four additional beaches over the 48-day monitoring period. In comparison, sand temperatures at the beaches routinely monitored for Flatback Turtle nesting activities in the east were typically warmer than the four additional beaches located towards the southern and northern ends of the island. These differences in sand temperatures between beaches should be interpreted with a degree of caution given that point–source data can be influenced by a number of variables, including methodological factors, meteorological factors as well as microclimatic factors. Additionally, the temperature measures are from indicative nesting sites from known nesting beaches rather than actual Flatback Turtle nests and developing marine turtle embryos affect their own incubation microclimate by producing metabolic heat and other waste products. Therefore, the values have limitations when predicting outcomes such as embryo survival and hatchling sex ratios within a beach.

4.1.4 Population modelling

The development of a mathematical age-structured model for the Barrow Island Flatback Turtle population continued throughout the Reporting Period. This model helps inform ongoing studies into the distribution and incubation success of Flatback Turtles on Barrow Island, and the dispersal and survivorship of Flatback Turtle hatchlings. The current model is being developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the University of Tasmania and tracks the age-distribution of turtles distributed among a finite number of sites (beaches) within the Barrow Island Flatback Turtle rookery. The model will aim to demonstrate population trajectories based on a range of scenarios and risks, and will be parametrised with data for Flatback Turtles collected as part of Flatback Turtle and coastal stability monitoring programs (see Section 9 on Coastal Stability) and other published data.

4.2 Event data

Incidents involving harm to marine turtles reported during the Reporting Period are summarised in the following table.

Event data: Harm to marine turtles
Reporting requirement
Reportable incidents[1] involving harm to marine turtles.
Results
There were no reportable incidents during the Reporting Period involving harm to marine turtles as a result of the Gorgon Gas Development.

1 *Reportable incidents are defined in the LTMTMP (Ref. 7) as: 'Harm or mortality to listed marine turtles attributable to the Gorgon Gas Development, and significant impacts detected by the monitoring program on matters of national environmental significance relevant to this Plan'*

4.3 Audit and review

Findings of the annual audit and review of lighting design features, management measures, and operating controls, including details of light management initiatives and activities undertaken during the Reporting Period, are summarised in the following table.

Stressor: Light
Audit results
• An internal audit of the LTMTMP, which included lighting design features, management measures, and operating controls, was conducted by a third party (Ref. 10). The audit commenced on 3 August 2023 and focused on: – permanent lighting – temporary onshore lighting – LNG and condensate vessel lighting – vessel lighting (other than LNG ships and condensate vessels)

Stressor: Light
– marine turtle studies. • The LTMTMP audit reported one Finding, two Recommendations, two Observations and two assessments of Good Practice related to lighting management measures and controls. Details of the audit finding are described in the Gorgon Gas Development and Jansz Feed Gas Pipeline: Compliance Assessment Report 2023 (Ref. 9). • A Lighting Effectiveness Review was undertaken for the Reporting Period (Ref. 10). Between 10 August 2022 and 9 August 2023, 23 site lighting inspections undertaken, from which 14 actions were identified, all of which were closed out within a satisfactory timeframe. • The Lighting Effectiveness Review identified six Recommendations, in addition to those identified in the LTMTMP audit. • Three recommendations made in the 2021–2022 annual lighting audit and effectiveness review were actioned and closed out within the allocated timeframe.
Light management initiatives, activities, and reasonably practicable lighting improvements
• Site planning sessions continued for operational activities occurring before and during the marine turtle nesting season with the potential to affect marine turtle behaviour. • Marine turtle awareness communications were sent to staff and contractors at the start of and throughout the turtle season, highlighting the relationships between lighting management and impacts on marine turtles. These were incorporated into routine prestart and contractor meetings and site notices. • Marine turtle awareness information was made available to ships entering the Port of Barrow Island via a Turtle Season Marine Notice accessible via the CAPL website, in addition to routine information contained within the Port of Barrow Island Information Manual (all available from https://australia.chevron.com/our-businesses/barrow-island/barrow-island-port). • Personnel engagement continued via marine turtle nesting and turtle hatchling tours to raise awareness of the environmental commitments associated with marine turtles. Additional information on the marine turtle nesting season, monitoring programs, and lighting management was also disseminated through the accommodation televisions. • Lighting along the LNG Jetty and MOF was switched off, except where required for work and safety reasons. • Mobile solar-powered lighting towers are gradually replacing traditional diesel-powered lighting towers. These towers have been programmed to meet optimal turtle lighting requirements for wavelength and light intensity.
Conclusions on the effectiveness of lighting design features, management measures, and operating controls
• CAPL considers lighting design features, management measures, and operating controls are 'effective' if the environmental objectives of the LTMTMP are met, and if they reduce potential adverse impacts to Barrow Island marine turtle populations. • The brightness of artificial light at Barrow Island varied across survey nights due to the presence of cloud and an LNG/condensate tanker, which was present on 5 of the 7 monitoring nights. Sources of night-time light emissions were similar to the previous year—the main sources were the LNG site, ground flare, MOF, the Jetty Head, the LNG/condensate tanker, and Butler Park. • Night-time light emissions were highest at Bivalve followed by (in order of descending magnitude) Inga, Terminal, YCN, YCS, and Mushroom beaches. There was no significant difference in hatchling sea-finding behaviours at YCS, YCN, Bivalve, Terminal or Mushroom beaches when compared to baseline. The level of brightness at each monitoring site demonstrated a spatial relationship with the distance from the GTP and associated infrastructure (i.e. brighter values were recorded at closer sites and darker values at more distant sites). • Overall, analysis of hatchling sea-finding parameters on monitored beaches demonstrated that Gorgon Gas Development lighting did not adversely affect the sea-finding ability of hatchlings during the Reporting Period, and emergent Flatback Turtle hatchlings continued to orientate successfully towards the ocean. • Given the above, no changes to lighting design features, management measures, and operating controls were required during the Reporting Period, beyond the improvements and initiatives undertaken to reduce artificial lighting.

4.4 Changes to the Long-term Marine Turtle Management Plan

No amendments to the LTMTMP (Ref. 7) were proposed and/or approved during the Reporting Period.

In accordance with the variation to EPBC 2003/1294 and 2008/4178 conditions, issued 7 August 2023, the LTMTMP will be revised and resubmitted to DCCEEW by 30 June 2024, and subsequently to DWER.

4.5 Discussion and conclusion

The Flatback Turtle nester abundance at Barrow Island during the Reporting Period was the highest ever recorded and showed an increasing, significant linear trend, which aligns with results at Mundabullangana. The driving factors behind the increasing trend in the number of nesters at Barrow Island and Mundabullangana remain unclear. One possible explanation is related to known external threats to Flatbacks that occur away from their nesting habitat and their historical impact to the overall population. For example, in 2000 the species was listed Vulnerable under the EPBC Act, and mandatory use of turtle excluder devices for commercial fisheries operating in the waters of northern Australia was introduced shortly after. However, if a conservation effort had improved Flatback Turtle survivorship of all age classes, it would be expected that the increase in abundance of adult nesters at Barrow Island and Mundabullangana would be via a higher recruitment rate of new neophyte turtles to the nesting population. The raw tagging data provides no indication that this is the case, as evidenced by the decreasing proportion of new untagged turtles encountered at both locations. Furthermore, if the populations were recovering with high levels of recruitment, they might exhibit a lower average clutch frequency due to the theory that new inexperienced recruits lay fewer clutches compared to experienced nesters. The estimated clutch frequency at Barrow Island this season was higher than in previous seasons, and at Mundabullangana, clutch frequency was also high showing a significant increasing trend. Based on a suggested positive correlation between nesting experience and clutch frequency, these findings indicate that the populations at Barrow Island and Mundabullangana are experiencing aging dynamics, rather than characteristics associated with an increase in the number of neophytes (Ref. 8).

Regardless of the driving factor behind the increases, the significant increasing trend in annual nester abundance at Barrow Island indicates that the cumulative area of nesting habitat on the island may have supported a larger population in the past. Consequently, the habitat should possess the necessary capacity to support the seasonal reproductive activities of a larger abundance of annual nesters, as measured by successful nesting, egg incubation, hatching, and ultimately, an increased output of hatchlings. However, the presence of the marine infrastructure at Barrow Island has likely caused a notable reduction in the size of the available optimal nesting habitat at certain beaches (Inga: −87%; Bivalve: −57%; Terminal: −60%; Ref. 22). Although the overall (i.e. island-wide) rate of disturbance to marked clutches at Barrow Island does not show a significant increasing trend since 2010–2011, it is important to note that impacts of nesting density on egg hatching probability is likely localised to certain habitat areas rather than equally across all nesting habitat and may also occur when a particular density threshold is surpassed at the habitat (Ref. 8).

The breeding omission probability at Barrow Island this season (0.57) exceeded a lower control limit for the first time during the post-baseline period (−1 SD). In contrast to the previous eight seasons where it exceeded an upper control limit (ranging between 0.73 and 0.84), the lower probability this season indicates a reduced likelihood of Barrow Island Flatback Turtles skipping a nesting season if they had nested during the previous season. This pattern in breeding omission probability was also reported for Mundabullangana, which had a lower breeding omission this season (0.28) compared to the previous season (0.48).

The nesting population's use of certain beaches has also likely varied due to changes in coastal processes, notably at Terminal, Bivalve and Inga beaches, which have recorded a reduction and redistribution of optimal nesting habitat. Concurrently, the same beaches have recorded a shift in the location and change in the pattern of their nesting activities and, in the case of Bivalve, a significant decreasing trend in use of the beach.

From a biological standpoint, the temperature experienced during incubation plays a crucial role in embryo development, directly influencing its growth rate, incubation duration, fitness, survival, and the determination of sex (based on pivotal temperature). Therefore, because the monitored beaches at Barrow Island exhibit incubation temperatures that correlate with their spatial position (i.e. beaches located farther north tend to be cooler than those situated further south), localised variations in embryo development across Barrow Island can be anticipated.

To influence the survival rate of the developing embryo, the incubation temperature must exceed an upper thermal tolerance range (TTR) for the species at which death can occur (i.e. >33 °C). Despite marked clutches regularly recording incubation temperatures above the upper TTR this season, no relationship was found between the percentage of the incubation duration spent above the TTR and egg hatching probability. However, a relationship was found between the percentage of incubation duration spent above the TTR and the spatial position of the beach, with clutches marked on the southerly beaches from A07 to YCN recording a significantly higher percentage above the TTR compared to clutches marked on northerly beaches from Inga to Mushroom.

In terms of the influence of incubation temperature on hatchling sex, this is determined during the thermosensitive period of incubation and the temperature experienced by the embryo in relation to the pivotal temperature (i.e. the temperature at which an equal ratio of males and females occurs) and the transitional range of temperature (i.e. the range in temperature outside which maximum masculinisation and maximum feminisation occurs). This is specific to marine turtle species and location, neither of which are known for Flatback Turtles at Barrow Island. As a proxy, the pivotal temperature for Flatback Turtles at Thevenard Island (~75 km from Barrow Island) was used (30.0 °C; Ref. 33). The clutch temperature during the thermosensitive period of marked clutches at the cooler, northern beaches at Barrow Island (i.e. Bivalve, Terminal, and Mushroom) overlapped with the pivotal temperature value for Flatbacks and therefore were more likely to have produced a greater proportion of male hatchlings this season compared to those beaches further south that were warmer and consistent with previous seasons. However, without understanding the transitional range of temperature at Barrow Island, it is unknown what the actual male:female ratio is likely to have been.

When combined, the hatchling orientation offset values for Bivalve and Terminal show a significant increasing trend since baseline. This is likely due to the spatial shifts in nesting activities that have occurred at both beaches since baseline resulting in different sea-finding cues used by hatchlings, rather than sources of light attributed to the Gorgon Gas Development. Bivalve and Terminal beaches are closest to the LNG site and, as expected, recorded the highest and third highest whole-of-sky and zenith brightness values out of the monitored beaches, respectively. The brightness values were also shown to increase temporally across the survey period due to both greater cloud cover, which is known to influence brightness, and the presence of LNG/condensate vessels. However, no identified new sources of light visible at any monitoring site were detected that were attributed to the Gorgon Gas Development (including temporary lighting towers or flaring events), nor were light emissions from the LNG site shown to increase, supporting the suggestion that spatial shifts are driving the observed patterns in hatchling orientation at these beaches.

Outcomes of the monitoring program and additional studies and investigations into observed deviations in demographic parameters, and nesting behaviour, indicate that the Flatback Turtle population nesting on Barrow Island remains demographically healthy, with consistently high survival rates observed for nesting females.

CAPL continues to engage with the Marine Turtle Expert Panel and other SMEs on outcomes of the LTMTMP monitoring program and relevant results from the coastal stability monitoring program (see Section 9). This includes evaluation of additional risk-based studies to better understand the risks to Flatback Turtles at Barrow Island from the Gorgon Gas Development marine facilities and those that aim to improve the understanding of the Flatback turtle population.

5 Short-range endemics and subterranean fauna

Table 5-1: EPR requirements for short-range endemics and subterranean fauna

Item	Source	Section in this EPR
Results of survey and studies to locate outside the GTP footprint and Additional Support Area (ASA) those remaining short-range endemics (SRE) and subterranean fauna species previously found only within the GTP footprint and ASA	MS 800, Schedule 3(4i)	5.1

5.1 Monitoring results

The Short-Range Endemics and Subterranean Fauna Monitoring Plan (SRESFMP) (Ref. 12) focuses on surveys to locate and identify those SRE and subterranean fauna species that had only previously been located within the GTP footprint and the ASA. Several of these species were confirmed outside the GTP footprint and ASA before construction commenced, and a further 2 subterranean fauna species were identified during construction (Ref. 12). Therefore, the ongoing focus of the SRESFMP is to locate these taxa:

- terrestrial SRE fauna: *Idiommata* sp.
- subterranean stygofauna SRE fauna: *Oniscidea* sp. nov. 1. and *Pilbaracandona* sp. nov. 1.
- subterranean troglofauna SRE fauna: *Symphyla* sp.

The SRESFMP was amended in 2019, in consultation with relevant regulatory agencies, to reduce the monitoring frequency for subterranean fauna and terrestrial SRE fauna from yearly to five-yearly.

In preparation to undertake the five-yearly SRE survey for 2023, analysis of the *Idiommata* sp. DNA sequence was undertaken by the Western Australian Museum (WAM), which confirmed that the DNA sequence from the *Idiommata* sp. was conspecific to 6 other species within the WAM Genbank Archive and that the species was conclusively placed within the *Aurecocrypta* genus. The individual Brush-footed Trapdoor Spider specimen collected on Barrow Island has now been identified as *Aurecocrypta* sp. MYG319 and matched with genetic sequences from other individuals recorded widely throughout the Western Pilbara (Ref. 4).

This outcome, received in June 2023, confirms the Brush-footed Trapdoor Spider species collected on Barrow Island is not restricted to the GTP site as previously suspected. As such, it is no longer necessary to continue conducting targeted surveys in search of this terrestrial species.

Condition 5.1 of MS 800 and Section 4.0 of the SRESFMP outline notification and reporting requirements if a target species is detected. In accordance with reporting requirements, both DWER and the WA Department of Biodiversity, Conservation and Attractions (DBCA) were notified following confirmation of species identification.

Targeted subterranean fauna sampling was undertaken between June and September 2023 and results were not available at the time of reporting. Therefore, 2023 subterranean fauna monitoring results will be presented in the next EPR.

6 Fire management

Table 6-1: EPR requirements for fire management

Item	Source	Section in this EPR
Incidence of fires caused by the Proposal, and fires that impact on the Proponent's facilities, including details of cause, lessons learnt, and recommended actions	MS 800, Schedule 3(5i) MS 769, Schedule 3(2i) EPBC 2003/1294 and 2008/4178, Schedule 3(4i)	6.1
Material or Serious Environmental Harm caused by fire directly attributable to the Proposal	MS 800, Schedule 3(5ii) MS 769, Schedule 3(2ii) EPBC 2003/1294 and 2008/4178, Schedule 3(4ii)	N/A[1]
Any changes to the Gorgon Gas Development Fire Management Plan (Ref. 13) including: • management responses to address Material or Serious Environmental Harm caused by fire directly attributable to the Proposal improvement to fire management practices.	MS 800, Schedule 3(5iii) MS 769, Schedule 3(2iii) EPBC 2003/1294 and 2008/4178, Schedule 3(4iii)	6.2

1 No Material or Serious Environmental Harm caused by fire was recorded during the Reporting Period.

6.1 Event data

Incidences of fire caused by the Gorgon Gas Development, or fires that impacted on Project facilities during the Reporting Period, including details of cause, lessons learnt, and recommended actions, are provided in the following tables.

Event data: Fires
Results
• No fire events occurred during the Reporting Period that caused Material or Serious Environmental Harm outside the TDF. • No fire events impacted the Gorgon Gas Development facilities.

6.2 Changes to the Fire Management Plan

No changes or revisions were made to the Gorgon Gas Development Fire Management Plan (Ref. 13) during the Reporting Period.

In accordance with the variation to EPBC 2003/1294 and 2008/4178 conditions issued 7 August 2023, the Fire Management Plan will be revised and resubmitted to DCCEEW by 30 June 2024, and subsequently to DWER.

7 Carbon Dioxide Injection Project

The Gorgon Carbon Dioxide Injection Project is the largest of its kind in the world and the largest GHG abatement project undertaken by industry to date.

As at the date of this EPR, the Gorgon Joint Venture Participants remain committed to safely reducing the Gorgon Gas Development's GHG emissions and have:

- injected or offset more than 16 million tonnes of GHG (including more than 8.5 million tonnes of actual abatement and more than 7.5 million credible offsets acquired and surrendered)

- invested more than AU$3.2 billion in the Carbon Dioxide Injection System with further investment planned in the coming years to improve system performance and increase injection rates
- committed to invest AU$40 million in future lower-carbon projects in WA.

Table 7-1 lists the matters related to the Carbon Dioxide Injection Project to be reported on in this EPR.

Table 7-1: EPR requirements for the Carbon Dioxide Injection Project

Item	Source[1]	Section in this EPR
Volume of reservoir carbon dioxide and other acid gases removed from the incoming natural gas stream and available for injection	EPBC 2003/1294 and 2008/4178, Schedule 3(5i)	7.1
Volume of reservoir carbon dioxide and other acid gases injected	EPBC 2003/1294 and 2008/4178, Schedule 3(5ii)	7.2
Results of environmental monitoring and identified Material or Serious Environmental Harm, if any, resulting from the seepage of injected carbon dioxide to the surface or near-surface environments including those which may support subterranean fauna (including the Blind Gudgeon [*Milyeringa veritas*])	EPBC 2003/1294 and 2008/4178, Schedule 3(5iii)	N/A[2]
Reasons for shortfall between the volume of reservoir carbon dioxide extracted and injected	EPBC 2003/1294 and 2008/4178, Schedule 3(5iv)	7.3
If the amount of carbon dioxide injected falls significantly below the target levels, CAPL must report on: • measures that could be implemented that would ensure the target level is met or, if injection is not considered feasible for all or some of the gas, measures to otherwise offset • which if any of these measures the Proponent intends to implement	EPBC 2003/1294 and 2008/4178, Schedule 3(5v)	7.4
If monitoring shows there is an elevated risk of Material or Serious Environmental Harm and/or risk to human health associated with the injection of reservoir carbon dioxide, the Proponent must report to the Minister on the efficacy of continuing to geosequester and alternative offsets considered instead of continuing injection of reservoir carbon dioxide	EPBC 2003/1294 and 2008/4178, Schedule 3(5vi)	N/A[2]

1 *Reporting of this aspect was no longer required under MS 800 as amended by MS 1198, published 20 October 2022.*

2 *Environmental monitoring was not required during the Reporting Period as seepage of injected CO_2 to the surface or near-surface environments was not detected. Therefore, no elevated risk of Material or Serious Environmental Harm and/or risk to human health was identified.*

7.1 Volume of reservoir carbon dioxide removed

The Commonwealth *National Greenhouse and Energy Reporting Act 2007* (NGER Act) contains provisions for reporting emissions from transporting and injecting GHGs, and storing them underground. To comply with NGER Act reporting requirements, CAPL is required to determine the volume of reservoir CO_2 removed from the incoming natural gas stream that is available for injection. This EPR includes data on the volumes of reservoir CO_2 extracted for the most recent financial year (1 July to 30 June), which aligns with CAPL's NGER Act reporting obligations. This enables the processes and procedures (including quality assurance, audit, and sign-off checks) developed for NGER Act compliance to be applied to these data.

Volume of reservoir carbon dioxide removed
2,561,538 × 10^3 standard cubic metres of reservoir CO_2 was removed from the incoming natural gas stream during the 2022–2023 financial year. This equates to 5,049,189 tonnes of carbon dioxide equivalent (tCO_2e).

7.2 Volume of reservoir carbon dioxide injected

This EPR includes data on the volumes of reservoir CO_2 injected for the most recent financial year, which aligns with CAPL's NGER Act reporting obligations.

Volume of reservoir carbon dioxide injected
862,375 × 10^3 standard cubic metres of reservoir CO_2 was injected during the 2022–2023 financial year. This equates to 1,717,841 tCO_2e.

7.3 Reasons for shortfall between volume extracted and injected

The key reason for the shortfall between the volume of reservoir CO_2 extracted and injected for the 2022–2023 financial year is the careful management of reservoir CO_2 injection rates. This ensures reservoir pressure in the Dupuy Formation remains within an acceptable range while the pressure management capacity of the CO_2 injection system is constrained.

In accordance with Condition 26.4 of Ministerial Statement 1198, CAPL will offset the quantity of Reservoir Carbon Dioxide that was not injected underground and will report on these offsets in the consolidated report required under Condition 27.3.

7.4 Measures being implemented

Early reservoir performance and modelling indicates that additional pressure management capacity is required to manage reservoir pressures in the Dupuy Formation.

CAPL is progressing measures to optimise the current pressure management system to increase water production rates. Implementation of these measures is expected to result in a significant increase in injection rates over the life of the Gorgon Gas Development.

While these measures are being implemented CAPL will continue to inject as much reservoir CO_2 as practicable.

8 Air quality

Table 8-1: EPR requirements for air quality

Item	Source	Section in this EPR
Air quality monitoring results, with a discussion on the success (or otherwise) in meeting emissions targets	MS 800, Schedule 3(7i)	8.1

8.1 Monitoring results

The objectives of the Gorgon Gas Development Air Quality Management Plan (AQMP) (Ref. 14), as defined by Ministerial Conditions, are to:

- ensure air quality meets the appropriate standards for human health in the workplace
- ensure air emissions from GTP operations do not pose a risk of Material or Serious Environmental Harm to the flora, vegetation communities, terrestrial fauna, and subterranean fauna of Barrow Island.

The ambient air quality monitoring program measures air quality for selected atmospheric pollutants and air toxics emissions associated with operating the GTP, and then compares these data against the applicable assessment criteria defined in the AQMP (Ref. 14). The occupational hygiene monitoring plan is implemented within the GTP to evaluate workplace exposure standards for airborne contaminants (Ref. 15).

The AQMP also specifies emission targets for selected atmospheric pollutants and air toxics emitted from major GTP emission sources (Frame 9 Gas Turbine Generators [GTGs] and Frame 7 Liquefaction Compressor Gas Turbines [LCGTs]) (Ref. 14). Emissions from these major sources are monitored via sampling at the point of discharge (the stacks) to the environment.

The tables below summarise the 2022–2023 air quality monitoring results, including exceedance assessments.

Monitoring program: Ambient air quality
Results
The ambient air quality monitoring program recorded no exceedances of the relevant National Environmental Protection Measure (NEPM) (Table 8-2) and National Occupational Health Exposure Standards (NOHES) guidelines for nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), carbon monoxide (CO), hydrogen sulfide (H_2S), or aromatic hydrocarbons (BTEX). The annual occupational hygiene monitoring plan was implemented within the GTP including evaluating mercury (Hg), H_2S, and aromatic hydrocarbons (BTEX) against relevant workplace exposure standards for airborne contaminants. Results met appropriate standards for human health in the workplace. • In total, nine exceedances of the NEPM guideline for particulate matter (PM_{10}) occurred at the Communications Tower (CT) location and six exceedances at Butler Park (BP) during the Reporting Period (Table 8-2). – At the CT, the number of recorded PM_{10} exceedances was fewer than in previous Reporting Periods. The CT monitoring station is immediately adjacent to an unsealed road, with the potential for resuspended road dust (a potential localised particulate source) caused by vehicle movements. – The number of exceedances recorded at BP over the Reporting Period has increased since the previous Reporting Period; however, this number was still significantly lower when compared to historic exceedance totals. Four of the six exceedances recorded at BP correlated with elevated measurements at the CT. The other two exceedances, which occurred on 23 and 24 July 2023 were due to the area adjacent to BP being temporarily used for laydown/construction. At BP, there are potential localised particulate sources including resuspended road dust and vehicular emissions from

Monitoring program: Ambient air quality
transporting personnel to and from BP and operating the GTP. However, to date, no exceedances have been directly attributable to this. – No NEPM 1-year exceedance occurred for either location. Note: The NEPM 1-year guideline is based on calendar year reporting. For this EPR, the Reporting Period is deemed to be equivalent to a calendar year. • Detections of H_2S above 'nuisance' World Health Organization guideline levels occurred at the CT, but these were three orders of magnitude below NOHES guidelines. During periods of elevated H_2S, winds were typically light (<5 m/s) and south-westerly to westerly. Under light winds, sources are most likely localised. The acid gas removal vents continue to be the most likely source of H_2S, based on the prevailing wind direction and that H_2S is known to be present in the acid gas being vented. • Measured ambient air quality results were evaluated against modelling predictions relevant for current operating conditions involving higher venting rates and generally were found to be within modelled predictions for atmospheric pollutants and air toxics. • Measured ambient air quality results and modelled predictions were compared against the applicable assessment criteria. Measured results did not exceed the applicable assessment criteria, and modelled predictions also indicated these criteria were met for areas outside the specific monitoring locations described in the ambient air quality monitoring program.
Conclusions
• Except for PM_{10}, no other exceedances were recorded for parameters against NEPM and NOHES guidelines associated with the ambient air quality monitoring program. Results from the occupational hygiene monitoring plan met relevant workplace exposure standards for human health in the workplace. • Exceedances for PM_{10} were inferred to have originated from localised unsealed road dust lift-off and localised events. These exceedances are not considered attributable to GTP emission sources. • Measured ambient air quality results were within model predictions—neither the modelled nor the measured results exceed applicable assessment criteria outlined in the AQMP. • Overall, results of the ambient air quality monitoring program demonstrated that air quality was below the relevant NEPM and NOHES guidelines during the Reporting Period. Consequently, during the Reporting Period the air quality was assessed to have met appropriate standards for human health in the workplace, and GTP operations did not pose a risk of Material or Serious Environmental Harm to the flora, vegetation communities, terrestrial fauna, and subterranean fauna of Barrow Island.

Table 8-2: Summary of exceedances against guideline values during the Reporting Period

Guideline Value			No. of Exceedances	
Parameter[1]	Concentration	Averaging Period	CT	Butler Park
PM_{10}	50 µg/m^3	1 day	9	6
	25 µg/m^3	1 year[1]	0	0
NO_2	0.12 ppm	1 hour	0	0
	0.03 ppm	1 year[1]	0	0
O_3	0.10 ppm	1 hour	0	0
	0.08 ppm	4 hours	0	0
SO_2	0.20 ppm	1 hour	0	0
	0.08 ppm	1 day	0	0
	0.02 ppm	1 year[1]	0	0
CO	9.0 ppm	8 hours	0	0
Benzene	0.003 ppm	1 year[1]	0	0
Toluene	1 ppm	1 day[2]	0	0
	0.1 ppm	1 year[1]	0	0

Guideline Value			No. of Exceedances	
Parameter[1]	**Concentration**	**Averaging Period**	**CT**	**Butler Park**
Xylene	0.25 ppm	1 day[2]	0	0
	0.2 ppm	1 year[1]	0	0

1 *In NEPM, the annual averaging period is based on a calendar year. For this EPR, the period 10 August 2022 to 9 August 2023 is used as the yearly averaging period.*

2 *This is based on a conservative estimate where it is assumed that the pollutant concentration measured over the sampling period (nominally 14 days) was due to a single event lasting one day.*

Monitoring program: Stack air quality (major emission sources)
Results
All air quality parameters, except nitrogen oxides (NO_X), were below the relevant emission targets in the Reporting Period for the emission sources considered (Table 8-3) (Ref. 16).
Conclusions
• Overall, results of the stack air quality monitoring demonstrated that all measured parameters remained within emission targets for the GTGs and LCGTs during the Reporting Period, except for two exceedances for NO_X. • The two NO_X exceedances of emission targets occurred at GTG 2 and GTG 3 during periods when the GTGs were operating under low loads. The NO_X target (of 70 mg/m^3) only applies when the GTGs are running at >55% load (Ref. 17). Optimisation of GTGs is ongoing to improve performance.

Table 8-3: Summary of exceedances against stationary source emissions targets during the Reporting Period

Emission Source	Emission Targets[1]		No. of Exceedances[2]
	Parameter	**Concentration (mg/m^3)**	
GTG 1	NO_x	70	0
	CO	125	0
GTG 2	NO_x	70	1
	CO	125	0
GTG 3	NO_x	70	1
	CO	125	0
GTG 4	NO_x	70	0
	CO	125	0
GTG 5	NO_x	70	0
	CO	125	0
LCGTs	NO_x	70	0
	CO	125	0

1 *Emission targets apply at the point of discharge to the environment.*

2 *Target does not apply when GTGs are operating under low loads (<55% capacity).*

9 Coastal stability

Table 9-1: EPR requirements for coastal stability

Item	Source	Section in this EPR
Results of beach and sediment monitoring	MS 800, Schedule 3(8i) EPBC 2003/1294 and 2008/4178, Schedule 3(6i)	9.1, 9.2
Any mitigation measures applied in response to action-related impacts of beach profile	MS 800, Schedule 3(8ii) EPBC 2003/1294 and 2008/4178, Schedule 3(6ii)	N/A[1]
All exceedances of management triggers	Approval letter from the former WA Department of Environment and Conservation to CAPL (Ref. 18)	9.1, 9.2

1 No mitigation measures as required under Condition 25.6(iii) of MS 800 and Condition 18.6(iii) of EPBC 2003/1294 and 2008/4178 were implemented during the Reporting Period; therefore, reporting is not applicable at this time.

9.1 Monitoring results

The objectives of the Gorgon Gas Development Coastal Stability Management and Monitoring Plan (CSMMP) (Ref. 19), as defined by Ministerial Conditions, are to:

- ensure that the MOF and LNG Jetty do not cause significant adverse impacts to the beaches adjacent to those facilities
- establish a monitoring program to detect adverse changes to the beach structure and beach sediments that could have implications for marine turtles nesting on the beaches adjacent to the MOF and LNG Jetty.

The monitoring program detects changes to the beach morphology (beach structure and beach sediments) that could have potential implications for coastal stability and/or marine turtle nesting (Ref. 19). Monitoring is carried out on two Potential Impact beaches (Terminal and Bivalve) and three Reference beaches (Inga, YCN, and YCS).

Coastal stability management triggers have been established for beach volume, beach slope, and sediment particle size at Potential Impact beaches, and data from each monitoring event are compared against these management triggers. The actions required if a management trigger exceedance occurs are set out in the CSMMP Supplement: Management Triggers (Ref. 20) and include assessing defined Performance Standards. Interim management triggers specific to changes in turtle nesting habitat, based on the quantifying marine turtle nesting areas through habitat mapping, have been defined in the approved CSMMP Supplement: Management Triggers (Ref. 20). These marine turtle nesting habitat interim management triggers apply to the Potential Impact beaches (i.e. Terminal and Bivalve, immediately adjacent to the MOF), and to data collected at the end of dry season monitoring event (Ref. 19; Ref. 20).

The 2022–2023 monitoring results, including any detected exceedances and major event monitoring[1], are summarised in the following tables.

[1] Major event: a sustained period (4 days or more) of winds with an easterly component (NNE to SSE), during which the total duration of winds >18 knots is ≥96 hours recorded at Barrow Island. (Ref. 16)

Monitoring program: Beach structure
Objective
Detect changes to the beaches adjacent to the Causeway, MOF and LNG Jetty (marine infrastructure) that may affect the stability of those beaches by measuring beach profile, beach volume, and quantifying the extent of any erosion or accretion of sediment over time.
Methodology
• Remote sensing surveys are completed twice each year (at the end of the dry and wet seasons where practicable, typically October and April). These surveys capture horizontal (x-,y-plane) and vertical (z-plane) data to generate digital surface elevation models over the entire beach (landward of the primary dune to the waterline) at Potential Impact beaches (Terminal and Bivalve) and Reference beaches (Inga, YCN, and YCS). • Topographic surveys (using remote sensing or real-time kinematic GPS methods) to record beach morphology are also undertaken, where practicable, after a major weather event.
Survey timing
• End of dry season routine monitoring event: – on-ground survey 11–13 October 2022 – topographic survey 30 October 2022 – aerial image capture 5 December 2022 • End of wet season routine monitoring event: – on-ground survey 19–21 May 2023 – topographic survey 20 April 2023.
Results
Surface elevation – Patterns of erosion and accretion • Measurements of surface elevation are presented in the context of change since baseline condition (October 2009 to May 2023), and most recent annual (May 2022 to May 2023) and seasonal change (October 2022 to May 2023). Changes to each beach are described with reference to the 2009 sparse vegetation line (SVL), which separated the foredune area (FA) (landward of the SVL) from the active zone of the beach (seaward of the SVL) in October 2009. *Terminal Beach* • Between October 2009 and May 2023, Terminal Beach (immediately north of the marine infrastructure) eroded at the northern end of the beach and accreted at the southern end of the beach, with some accretion also evident in the creek bed at the centre of the beach (Figure 9-1). Changes were greatest in the active zone of the beach; however, changes have also occurred at the FA, which includes building out the foredune at the southern end of the beach and eroding the edge of the FA at the northern end of the beach, leading to some minor loss of sparse foredune vegetation (Ref. 21). • Between May 2022 and May 2023, changes to surface elevation were minimal, with some further accretion at the southern end of the beach and minor erosion in the creek bed (Figure 9-1). • Between October 2022 and May 2023 further accretion occurred at the southern end of the beach, with changes typically within the limit of detection (±0.25 m) elsewhere (Figure 9-1). *Bivalve Beach* • Between October 2009 and May 2023, Bivalve Beach (immediately south of the marine infrastructure) exhibited the opposite trend to Terminal Beach, eroding at the southern end of the beach and accreting at the northern end (Figure 9-2). Erosion is also evident in the creek bed at the southern end of the beach. Erosion has encroached on the seaward edge of the FA, along approximately two-thirds of the beach, which has resulted in some minor loss of sparse foredune vegetation (Ref. 21). • Changes occurring between May 2022 and May 2023 were minimal, with a strip of accretion evident at the current sparse vegetation line over the northern third of the beach (Figure 9-2). • Between October 2022 and May 2023, patches of accretion occurred over the active zone of the northern third of the beach, with minimal changes elsewhere (Figure 9-2). *Inga Beach* • Between October 2009 and May 2023, Inga Beach exhibited a similar trend to Bivalve Beach, accreting at the northern end and eroding along southern sections (Figure 9-3). Changes occurred predominantly over the active zone of the beach, with some erosion encroaching onto the seaward edge of the FA along the central third of the beach. Erosion at Inga Beach has resulted in the progressive exposure of bedrock and

Monitoring program: Beach structure
a veneer of loose pebbles and cobbles at the northern extent of bedrock exposure. Accretion at the northern end of the beach has resulted in sparse coastal vegetation establishing in areas that were previously bare (i.e. before marine infrastructure was constructed). There is evidence of sediments in the area of accretion being transported around the rock headland at the northern end of the beach (Ref. 21). • Very little change occurred from May 2022 to May 2023 at Inga Beach (Figure 9-3), with a small patch of accretion occurring at the northern end of the beach. • Between October 2022 and May 2023, a small patch of accretion occurred at the northern end of the beach (Figure 9-3). *YCN Beach* • Between October 2009 and May 2023, YCN Beach accreted at the beach face over the northern third of the beach, and at the base on the FA along the length of the beach (Figure 9-4). Beach face erosion has occurred over the southern half of the beach, and in a localised area on the lower beach face at the very northern extent. Changes at YCN Beach are strongly linked to changes occurring at YCS Beach to the south and to the mouth area of Terminal Creek to the north, which periodically changes due to creek flow events. • Between May 2022 and May 2023, and October 2022 to May 2023, changes to surface elevation were minimal, with changes typically occurring within the limit of detection (±0.25 m; Figure 9-4). *YCS Beach* • Between October 2009 and May 2023, erosion occurred at the beach face along the length of YCS Beach, which is an extension of the erosion over the southern half of YCN Beach (Figure 9-5). Similar to YCN Beach, accretion was detected at the base of the FA along the length of the beach. • Between May 2022 and May 2023, small patches of both accretion and erosion were evident over the active zone of the beach, particularly in the centre of the beach, where sand is frequently redistributed around a persistent rock outcrop (Figure 9-5). • Between October 2022 and May 2023, patches of both erosion and accretion were detected near the persistent rock outcrop in the centre of the beach (Figure 9-5).

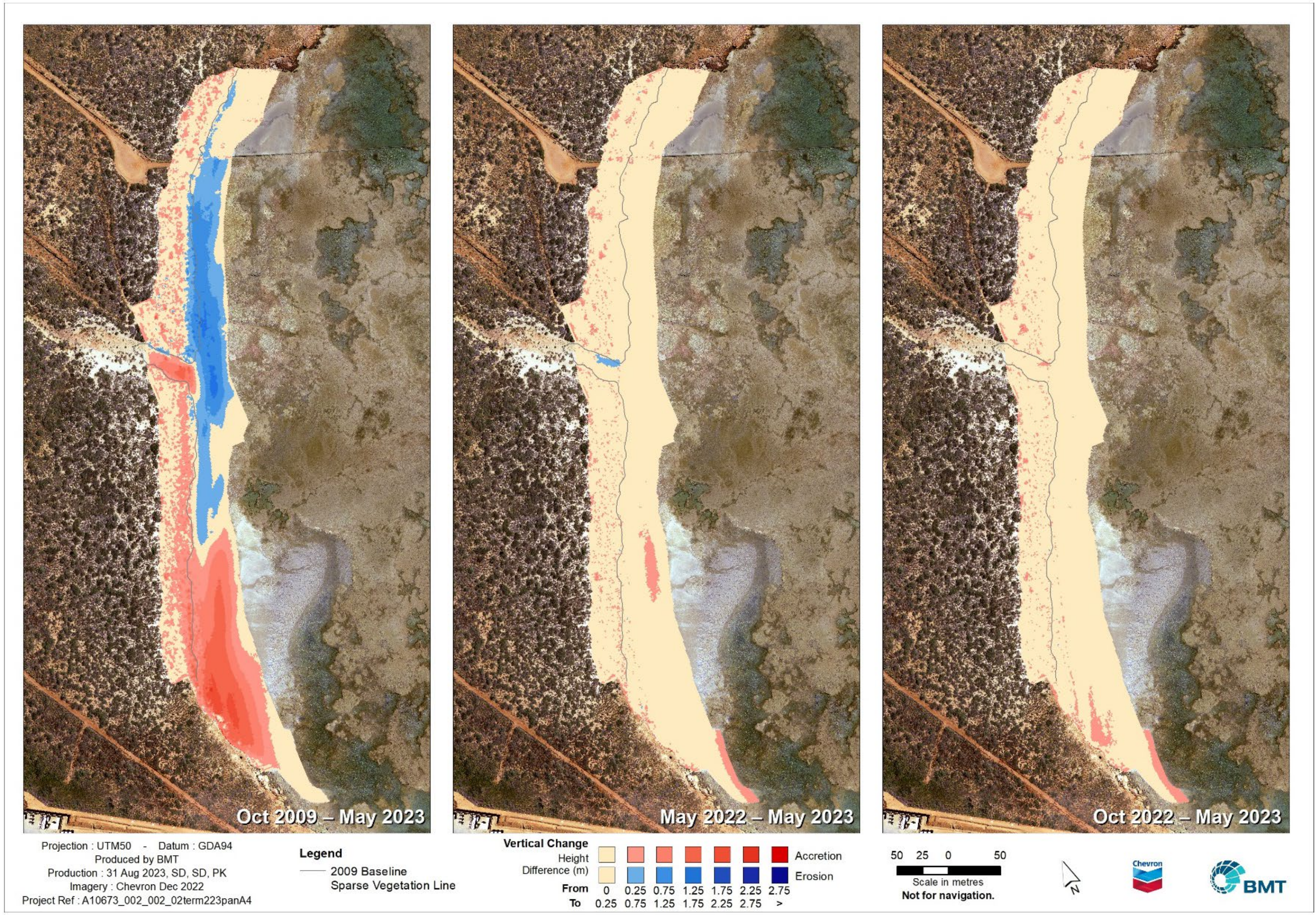


Figure 9-1: Surface elevation changes at Terminal Beach

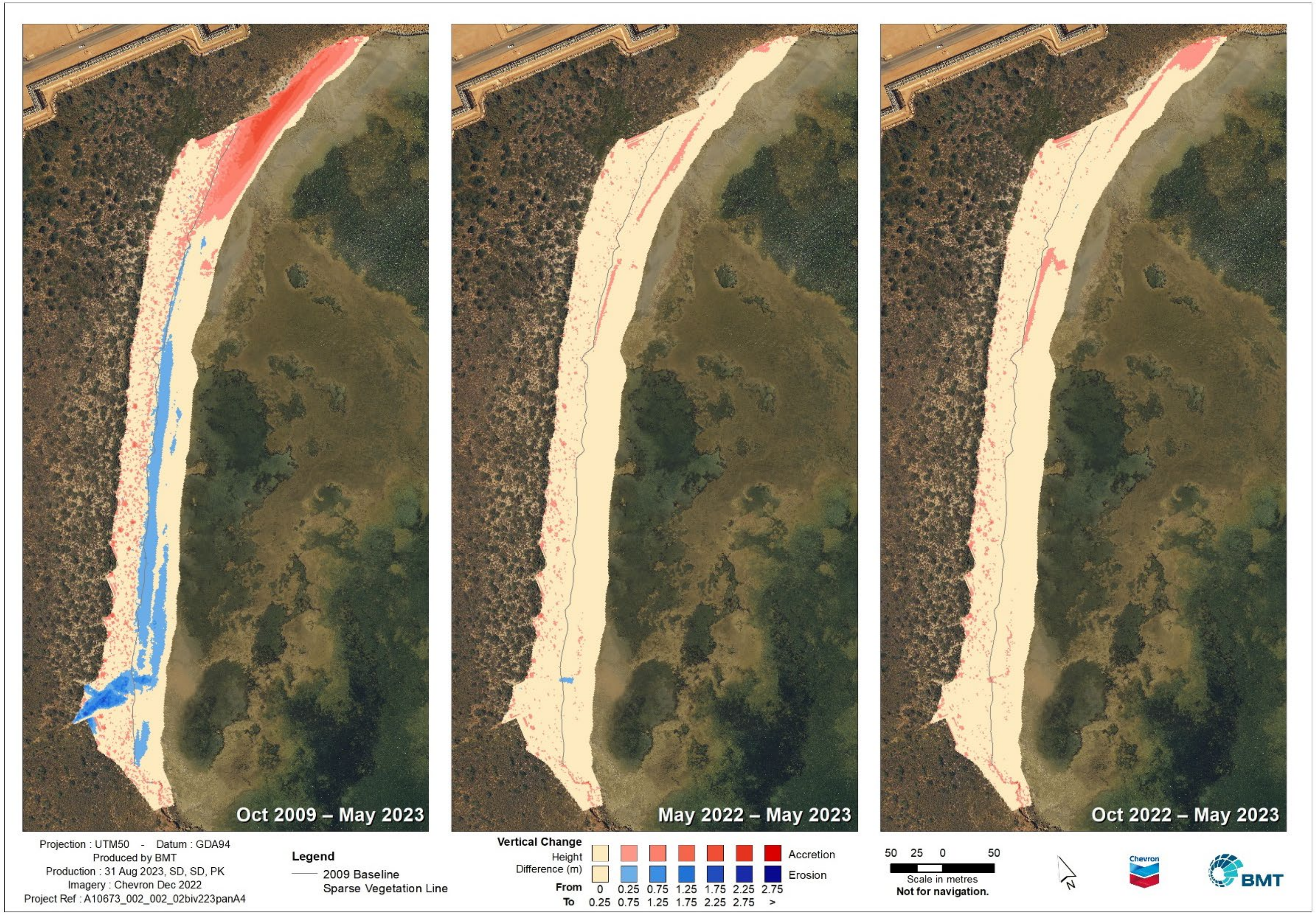


Figure 9-2: Surface elevation changes at Bivalve Beach

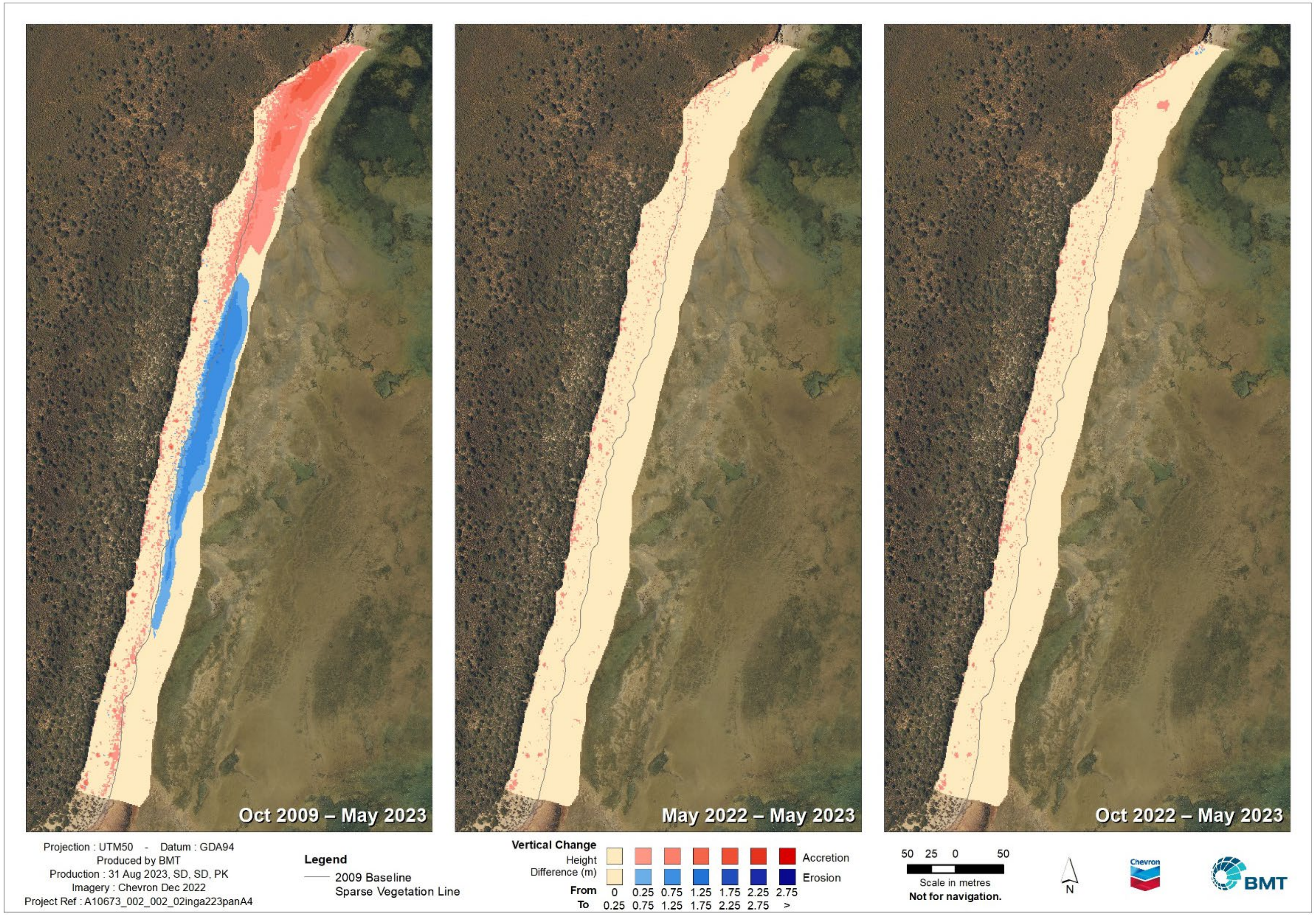


Figure 9-3: Surface elevation changes at Inga Beach

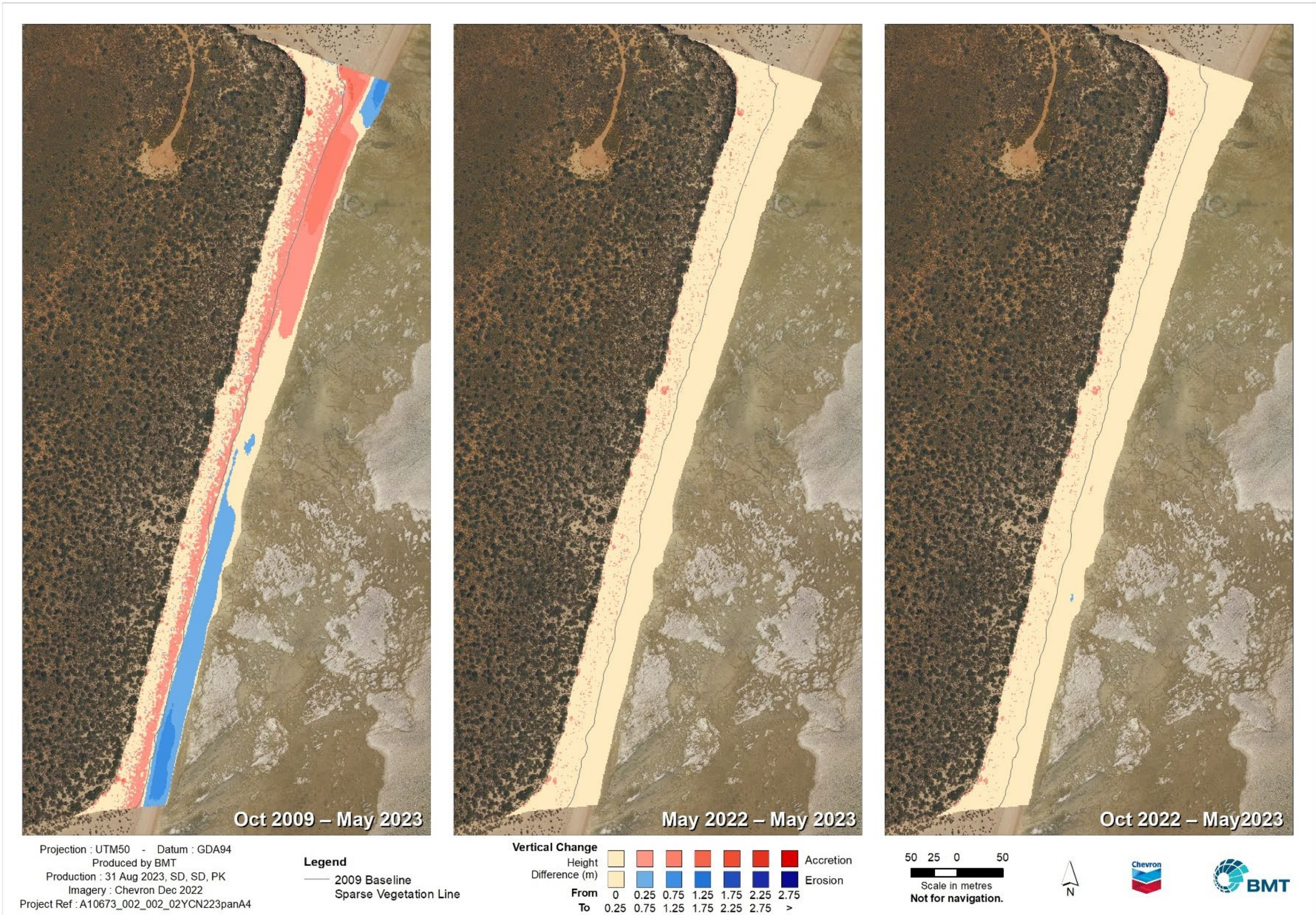


Figure 9-4: Surface elevation changes at Yacht Club North Beach

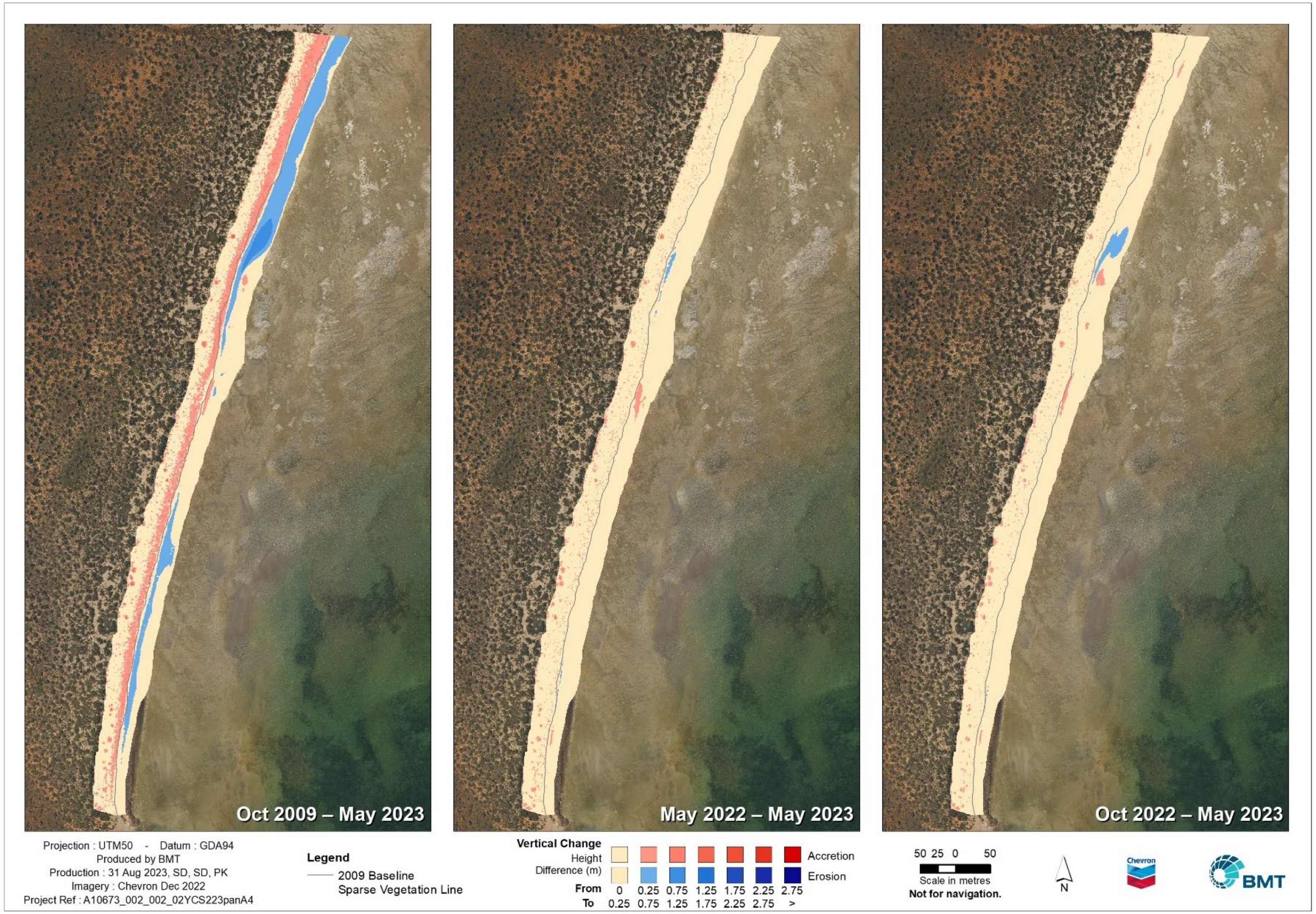


Figure 9-5: Surface elevation changes at Yacht Club South Beach

Monitoring program: Beach structure
Results (continued)
Net volume change • Net sand volume on the beaches fluctuates as a result of seasonal and regional interannual cycles, or specific events such as tropical cyclones (Figure 9-6). Seasonal changes are linked to wind patterns and the resulting incident wave climate. Interannual changes can be linked to regional influences, such as water level fluctuations (e.g. caused by the El Niño Southern Oscillation) and other metocean variability or anomalies. • Since baseline (i.e. October 2009 to May 2023), a net reduction of sediment from the beach face has occurred on YCS Beach (−5,556 m^3), and a net gain has occurred on Terminal (+5,184 m^3), Bivalve (+3,577 m^3), Inga (+1,177 m^3) and YCN (+631 m^3) beaches (Figure 9-2). • Over the dry season (May to October 2022), a net reduction of sediment occurred on all monitored beaches except YCN Beach. In contrast, a net gain occurred on all beaches over the wet season (October 2022 to May 2023), which was greater than the magnitude of net loss at all but YCS Beach (Table 9-2, Figure 9-7). Therefore, a net sediment gain for the annual period May 2022 to May 2023 was recorded for all beaches except YCS Beach, with the greatest gains occurring on Terminal and Bivalve beaches (Table 9-2). **Major event monitoring** • During the Reporting Period, no weather events exceeded the CSMMP post-major event monitoring trigger at Barrow Island. Similarly, no storms or tropical cyclones generated conditions warranting further investigation. Therefore, no major event monitoring was undertaken during the Reporting Period.
Management trigger exceedances
• Management trigger exceedances were recorded for these sites and parameters during the Reporting Period: – Terminal Beach: beach volume and slope at the crest of beach face (CBF) and FA at Transects 11 and 22 – Bivalve Beach: beach volume and slope at the CBF and FA at Transects 11 and 22 (Table 9-3). • Exceedances of management triggers at Terminal and Bivalve beaches have been detected since post-construction monitoring began in July 2010. The cause of these exceedances has been attributed both to natural variability and to the presence of the marine infrastructure, which has caused the realignment of Terminal and Bivalve beaches. Because most FA sites on Terminal and Bivalve beaches have accreted or remained the same, with the changes typically restricted to the area seaward of the CBF, investigations conclude that the shoreline changes occurring on Terminal and Bivalve beaches are not having significant adverse impacts on the stability of these beaches.

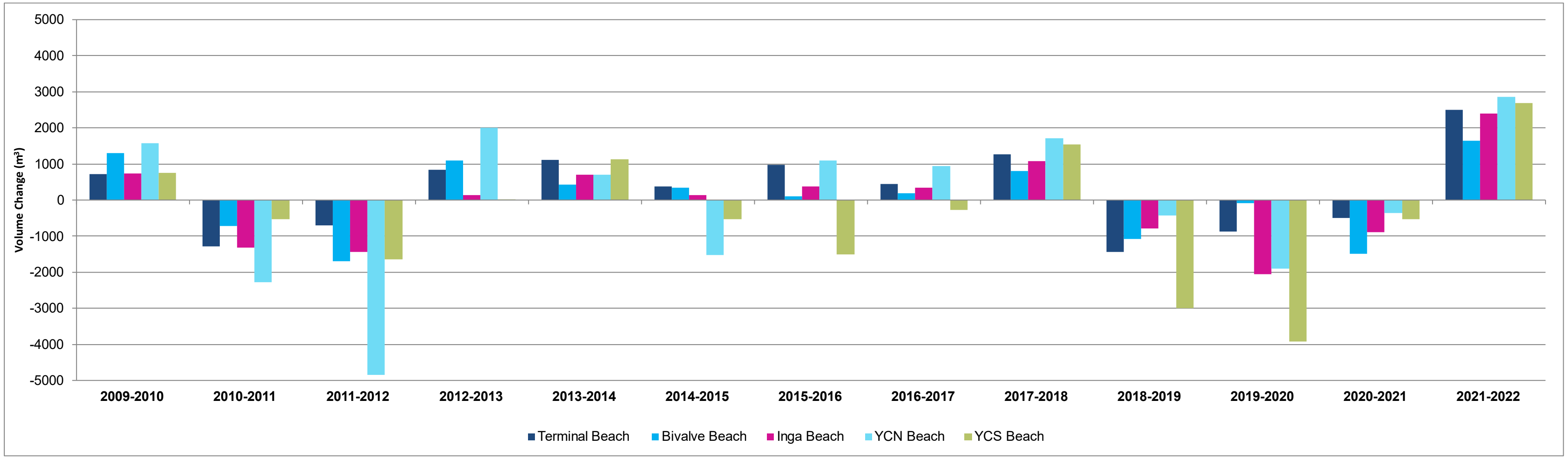


Figure 9-6: Annual net volume change of the active zone of the beach (below the SVL) at monitored beaches, October to October, 2009–2022

Table 9-2: Net volume changes (m^3) across the active zone[1] of the beach at monitored beaches

Beach	Length (m)	Change since Baseline		Annual change		Seasonal change	
		Oct 09–Oct 22	Oct 09–May 23	Oct 21–Oct 22	May 22–May 23	May 22–Oct 22	Oct 22–May 23
Terminal	700	3,091	5,184	2,505	1,520	−573	2,093
Bivalve	785	919	3,677	1,647	1,975	−783	2,758
Inga	818	−532	1,177	−2,401	958	−750	1,708
YCN	832	−446	631	2,854	1,124	46	1,078
YCS	1,175	−5,783	−5,556	2,691	-398	−625	227

1 Active Zone = the beach face, defined as the area below the 2009 SVL.

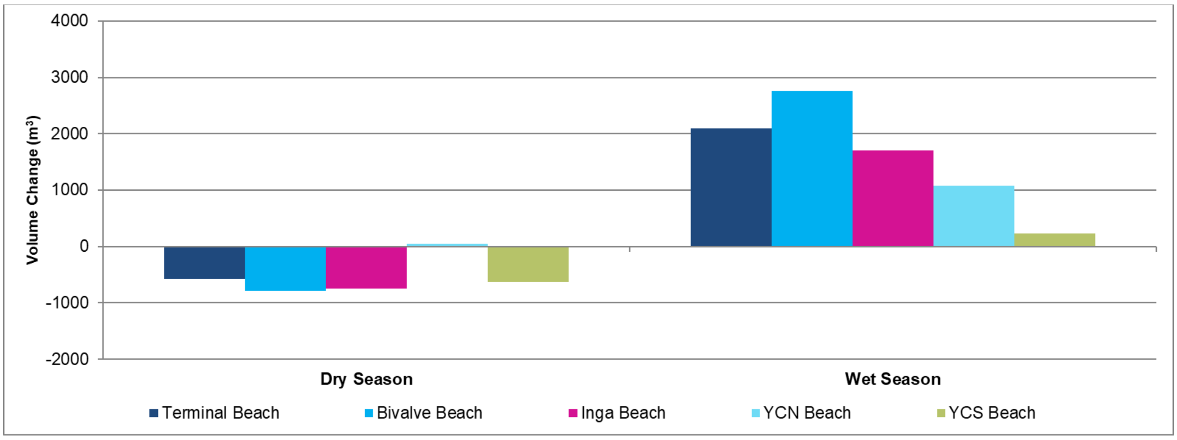


Figure 9-7: Seasonal net volume change of the active zone of the beach (below the SVL) at monitored beaches

Note: Dry season: May–October 2022; Wet season: October 2022–May 2023

Table 9-3: Management trigger exceedances at Terminal and Bivalve beaches during the Reporting Period

Location	Transect	Survey Date	Volume Trigger[1,2]				Slope Trigger[1,2]				Change from Baseline Mean
			1	2	3	4	1	2	3	4	
Terminal (CBF)	11	Oct 2022	x	x	x	x	-	-	-	-	Increase volume, no change slope
		May 2023	x	x	x	x	x	-	-	-	Increase volume, increase slope
	22	Oct 2022	x	x	x	x	-	-	-	-	Decrease volume no change slope
		May 2023	x	x	x	x	-	-	-	-	Decrease volume, no change slope
Bivalve (CBF)	11	Oct 2022	x	x	x	x	-	-	-	-	Increase volume, no change slope
		May 2023	x	x	x	x	x	-	-	-	Increase volume, increase slope
	22	Oct 2022	x	x	x	x	-	-	-	x	Decrease volume, increase slope
		May 2023	x	x	x	x	-	-	-	-	Decrease volume, no change slope
Terminal (FA)	11	Oct 2022	x	x	x	x	x	x	x	x	Increase volume, decrease slope
		May 2023	x	x	x	x	x	x	x	x	Increase volume, decrease slope
	22	Oct 2022	-	-	-	x	x	x	x	x	Increase volume, increase slope
		May 2023	x	-	-	x	-	x	x	-	Increase volume, increase slope

Location	Transect	Survey Date	Volume Trigger[1,2]				Slope Trigger[1,2]				Change from Baseline Mean
			1	2	3	4	1	2	3	4	
Bivalve (FA)	11	Oct 2022	-	-	-	-	x	x	x	-	No change volume, decrease slope
		May 2023	-	-	-	-	x	x	x	-	No change volume, decrease slope
	22	Oct 2022	-	-	-	-	x	x	x	x	No change volume, increase slope
		May 2023	-	-	-	-	x	x	x	x	No change volume, increase slope

1 *Trigger 1 = single point ±3 SD from the baseline mean; Trigger 2 = 2 out of 3 consecutive points ±2 SD from the baseline mean; Trigger 3 = 4 out of 5 consecutive points ±1 SD from the baseline mean; Trigger 4 = 8 consecutive points on the same side of the baseline mean.*

2 *'x' = exceedance; '-' = no exceedance.*

Monitoring program: Beach sediments

Objective

Detect changes to beach sediments as a result of the presence of the MOF and LNG Jetty.

Methodology

- Sediment sampling is completed once a year, at the end of the dry season (typically October), where practicable. Sediments are sampled at 2 locations (CBF and FA), and up to 3 depths (0.0 m, 0.3 m, 0.6 m) along selected transects (7 on Terminal; 6 on Bivalve; and 2 each on Inga, YCN, and YCS beaches) and then analysed to measure changes in particle size distribution (PSD) over time.
- Beach sediment sampling is also undertaken after a major (weather) event, where practicable.

Results

Terminal and Bivalve beaches

- At Terminal Beach, sediment coverage has decreased and sediment size has coarsened within CBF sediments at the northern end of the beach since the baseline survey. In October 2022, CBF sediment samples were not collected from transects T19, T21, or T22 due to insufficient sediment at these sites. At the southern end of the beach, a greater proportion of fine sediments has been observed at the CBF compared with baseline, while the northern end of the beach has a greater proportion of gravel. Changes in sediments at the FA have been less pronounced; however, there is an increased component of fine sediments across most sites (Ref. 22).
- At Bivalve Beach, sediment coverage has decreased since the baseline survey at the southern end of the beach at both CBF and FA sites, noting some interannual variation (Ref. 21). In October 2022, CBF samples were not collected from transect B24 due to insufficient sediment coverage. At the northern end of the beach, there has been a decrease in the gravel fraction in CBF sediments since baseline and at the southern end of the beach, there has been an increase in the gravel fraction in CBF sediments (Ref. 22).

Inga, YCN, and YCS beaches

- Sediments sampled at Inga, YCN, and YCS beaches in 2022 generally comprised similar PSDs to samples from the previous sampling event (October 2021) and from baseline (Ref. 22).

Management trigger exceedances

- The beach sediment management trigger is qualitative and based on a change from baseline sediment characteristics. At some sites, the management trigger can no longer be assessed due to erosion. Due to this, and the qualitative nature of the management trigger, no exceedances of management triggers for sediment PSD were identified during the Reporting Period.

Monitoring program: Marine turtle nesting habitat
Objective
Detect adverse changes to the beach structure and beach sediments (as a result of the presence of the MOF and LNG Jetty) that could have implications for marine turtle nesting on the beaches adjacent to these marine facilities.
Methodology
• Multiple physical characteristics of the beaches are used to categorise and map the suitability of areas on each beach for marine turtle nesting. Areas were categorised as one of three zones, based on the characteristics of the measured physical parameters within the study area: – Optimal Nesting Zone: considered ideal for marine turtle nesting – Suboptimal Nesting Zone: considered less than ideal but may still allow successful marine turtle nesting – Unsuitable Nesting Zone: unlikely to allow successful marine turtle nesting. • Physical characteristics used to classify the nesting habitat zones include: landward and seaward boundaries, presence of rock (e.g. intertidal rock, subaerial rock), sediment composition, sand depth, and other (e.g. presence of infrastructure, discontinuous nesting areas within otherwise unsuitable area). • Typically, data are collected in October each year. In 2022, data were collected in October and December; therefore, the timing is referred to as 'late-2022'.
Results
• The total available (i.e. optimal + suboptimal) Flatback Turtle nesting area for the mapped Barrow Island beaches in October 2009 was 14.7 ha, with 89% of this area defined as optimal nesting habitat. In late-2022, the total available nesting area was 11.5 ha, with 76% defined as optimal nesting habitat (Figure 9-8). • Changes in the size of nesting areas since baseline (October 2009) have varied between individual beaches, with the greatest changes observed on beaches closest to the marine infrastructure (Terminal, Bivalve, and Inga). Changes are primarily attributable to increases in the amount of intertidal rock exposed on the beach face over time, resulting in optimal nesting habitat being reclassified as either suboptimal or unsuitable as sandy access pathways to the FA are eroded. • Progressive exposure of intertidal rock since baseline is due to the ongoing realignment of Terminal, Bivalve, and Inga beaches towards the marine infrastructure via longshore sediment redistribution. Realignment has resulted in a gain in optimal nesting area on each beach at the end closest to the MOF (northern end for Bivalve and Inga beaches, southern end for Terminal Beach), and a reduction in optimal nesting area at the end furthest from the MOF. *Terminal Beach* • The area of mapped optimal nesting habitat at Terminal Beach progressively reduced between 2009 and 2012, from 2.25 ha in October 2009 to 0.81 ha in October 2012. Since 2012, optimal nesting habitat has stabilised and averaged 0.85 ha (0.91 ha in late-2022). The greatest change has occurred in the northern two-thirds of the beach, where intertidal rock has been exposed. In the southern third of the beach, optimal habitat has been created further south of the baseline nesting area on the accreted sections of beach (Figure 9-8, Figure 9-9). • In late-2022, the southern third of Terminal Beach was classified as optimal nesting habitat (with some small areas classified as unsuitable and suboptimal due to shallow sand), the middle third was classified as suboptimal, and the northern third was classified as unsuitable (Figure 9-9). • Between October 2021 and late-2022, the area of optimal nesting habitat increased from 14.3% (0.87 ha) to 14.9% (0.91 ha) of the study area. The area of suboptimal nesting habitat increased from 0.5% (0.03 ha) to 12.0% (0.7 ha) (Figure 9-8). The optimal area increased as a result of continued accretion in the lee of the southern rock headland, which increased the sand depth in this area. Changes in the exposure of bedrock in the central third of the beach led to the increase in suboptimal nesting area, with rock that was exposed marginally above the mean high water springs (MHWS) tide mark in 2021, now recovered due to natural sand redistribution (Figure 9-9). *Bivalve Beach* • At Bivalve Beach, the area of optimal nesting habitat progressively reduced between 2009 and 2015, from 2.10 ha in October 2009 to 0.779 ha in October 2015. Since 2015, optimal nesting habitat has stabilised and averaged 0.79 ha (0.90 ha in late-2022). Optimal nesting habitat has been reclassified to suboptimal or unsuitable along the southern two-thirds of the beach where intertidal rock has been

Monitoring program: Marine turtle nesting habitat

exposed. In the northern third of the beach, optimal habitat has been created further north of the baseline nesting area on the accreted section of beach (Figure 9-8, Figure 9-10).

- In late-2022, the southern two-thirds of Bivalve Beach were predominantly classified as unsuitable habitat, with small areas of suboptimal habitat. The northern third was largely classified as optimal habitat, with some unsuitable areas of shallow sand adjacent to the rock headland (Figure 9-10).
- Between October 2021 and late-2022, the optimal nesting area increased, from 14.3% (0.79 ha) to 16.3% (0.90 ha) of the study area. The area of suboptimal nesting habitat decreased, from 7.14% (0.39 ha) to 3.10% (0.17 ha). Changes in the suboptimal nesting zone were predominantly associated with changes in sediment distribution, which increased the exposure of intertidal rock above the MHWS tide line in the middle section of the beach (Figure 9-10).

Inga Beach

- Optimal nesting area at Inga Beach has decreased over time from 1.86 ha in October 2009 to 0.24 ha in late-2022. Optimal nesting habitat has been replaced with either suboptimal or unsuitable habitat along the southern two-thirds of the beach, due to the exposure of intertidal rock or loose rock pebbles and cobbles. At the northern end of the beach, optimal habitat has been created further north of the baseline nesting area on the accreted section of beach (Figure 9-11).
- In late-2022, the northern quarter of Inga Beach was classified as optimal nesting habitat, with the remainder being suboptimal in the middle section and unsuitable in the southern half.
- Between October 2021 and late-2022, optimal nesting area on Inga Beach decreased from 4.1% (0.26 ha) to 3.8% (0.24 ha) of the study area. This was accompanied by a decrease in suboptimal nesting area, from 15.5% (0.99 ha) to 14.3% (0.92 ha). These changes correspond to an increase in exposure of rock, cobbles, and pebbles, encroaching north over the lower beach face.

YCN Beach

- YCN Beach has undergone minor changes in turtle nesting habitat since baseline, with changes relating to the annual position of the MHWS line, which is influenced by patterns of erosion and accretion. No intertidal rock has been exposed at YCN Beach since baseline, and no areas of suboptimal or unsuitable nesting habitat have occurred since baseline (Figure 9-12). In October 2009, 3.49 ha of optimal nesting area was recorded; this had increased to 3.60 ha in late-2022.
- Between October 2021 and late-2022, optimal nesting area on YCN Beach decreased slightly, from 56.9% (3.68 ha) to 55.7% (3.60 ha) of the study area (Figure 9-8).

YCS Beach

- YCS Beach has seen a small decrease in optimal nesting area and a small increase in suboptimal nesting area since baseline. In October 2009, 3.44 ha of optimal nesting area was recorded, which had reduced to 3.08 ha by late-2022. Changes in the size of nesting areas relate to exposure of intertidal rock, particularly in the central section of beach (Figure 9-13).
- Between October 2021 and late-2022, optimal nesting area on YCS Beach increased slightly, from 32.2% (3.04 ha) to 32.7% (3.08 ha) of the study area (Figure 9-8).

Management trigger exceedances

No exceedances of the interim marine turtle nesting habitat management triggers occurred during the Reporting Period at Terminal or Bivalve beaches.

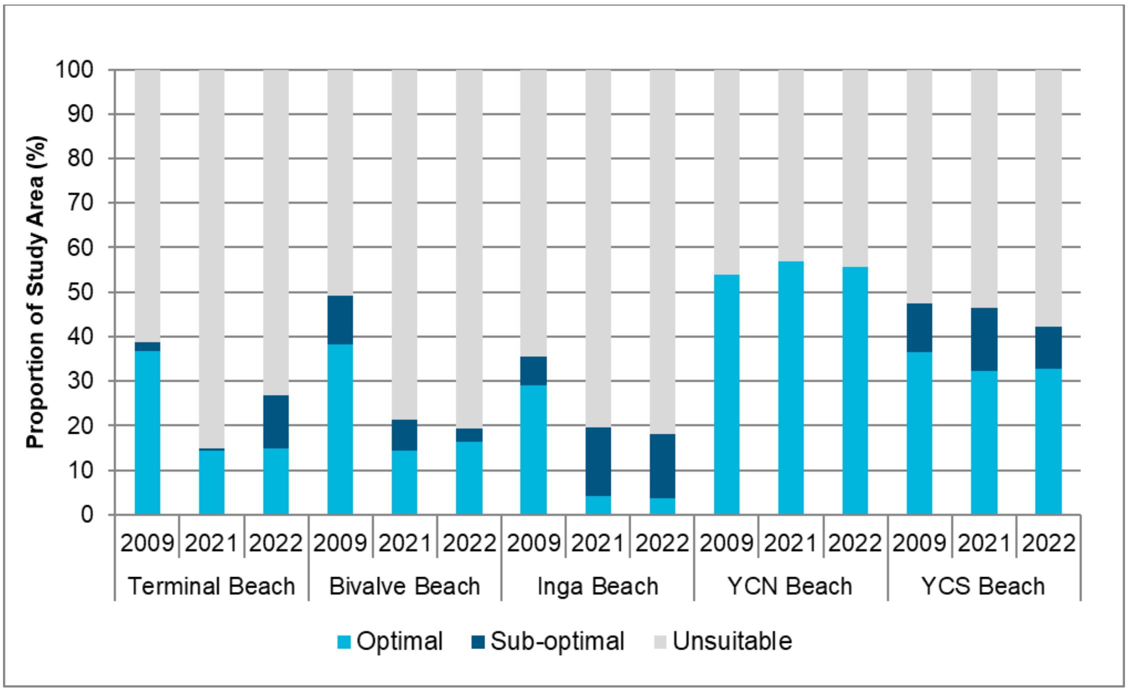


Figure 9-8: Proportions (%) of marine turtle nesting habitat zones for monitored beaches in 2009 (baseline), 2021, and 2022

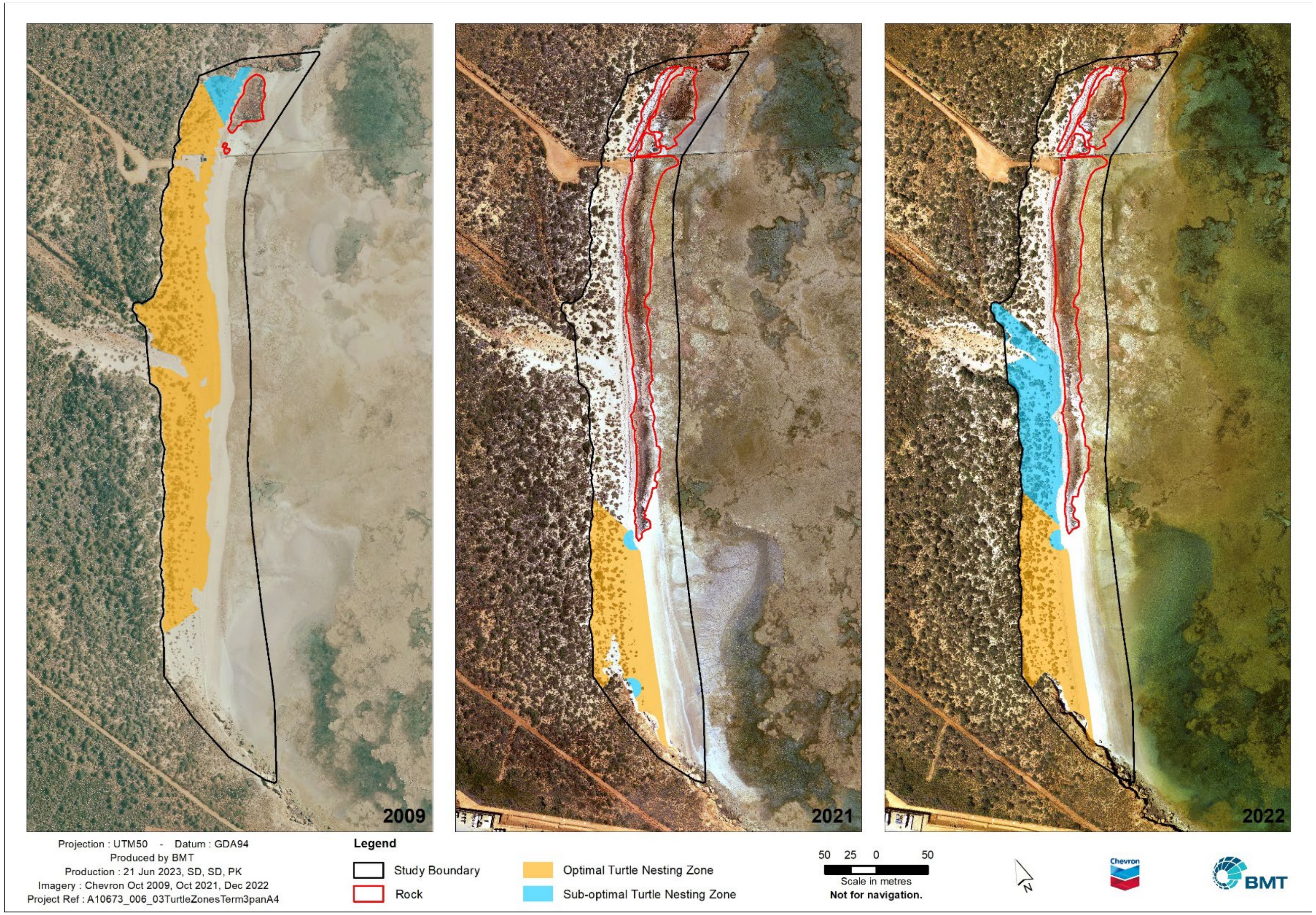


Figure 9-9: Marine turtle nesting habitat zones for Terminal Beach

Figure 9-10: Marine turtle nesting habitat zones for Bivalve Beach

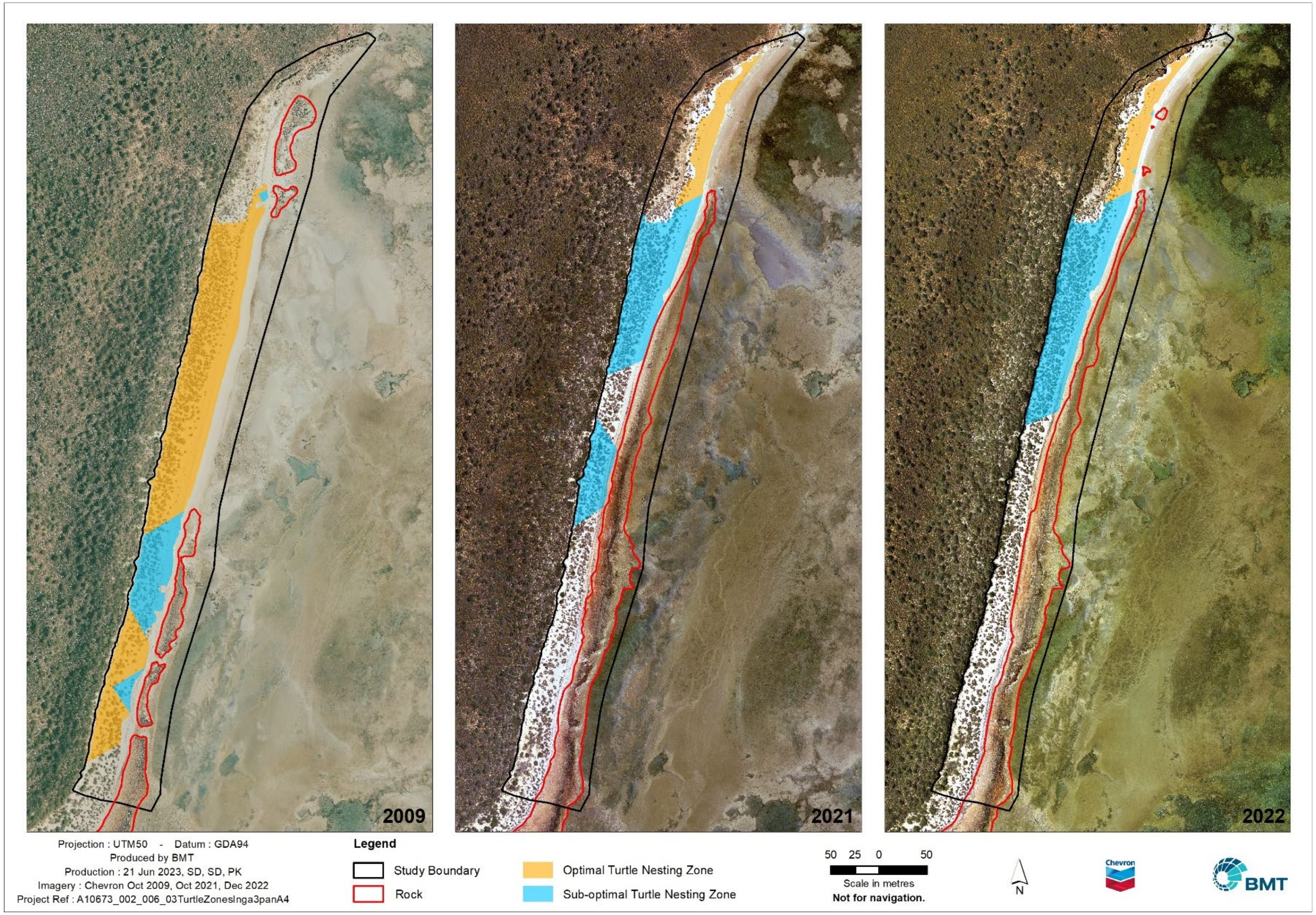


Figure 9-11: Marine turtle nesting habitat zones for Inga Beach

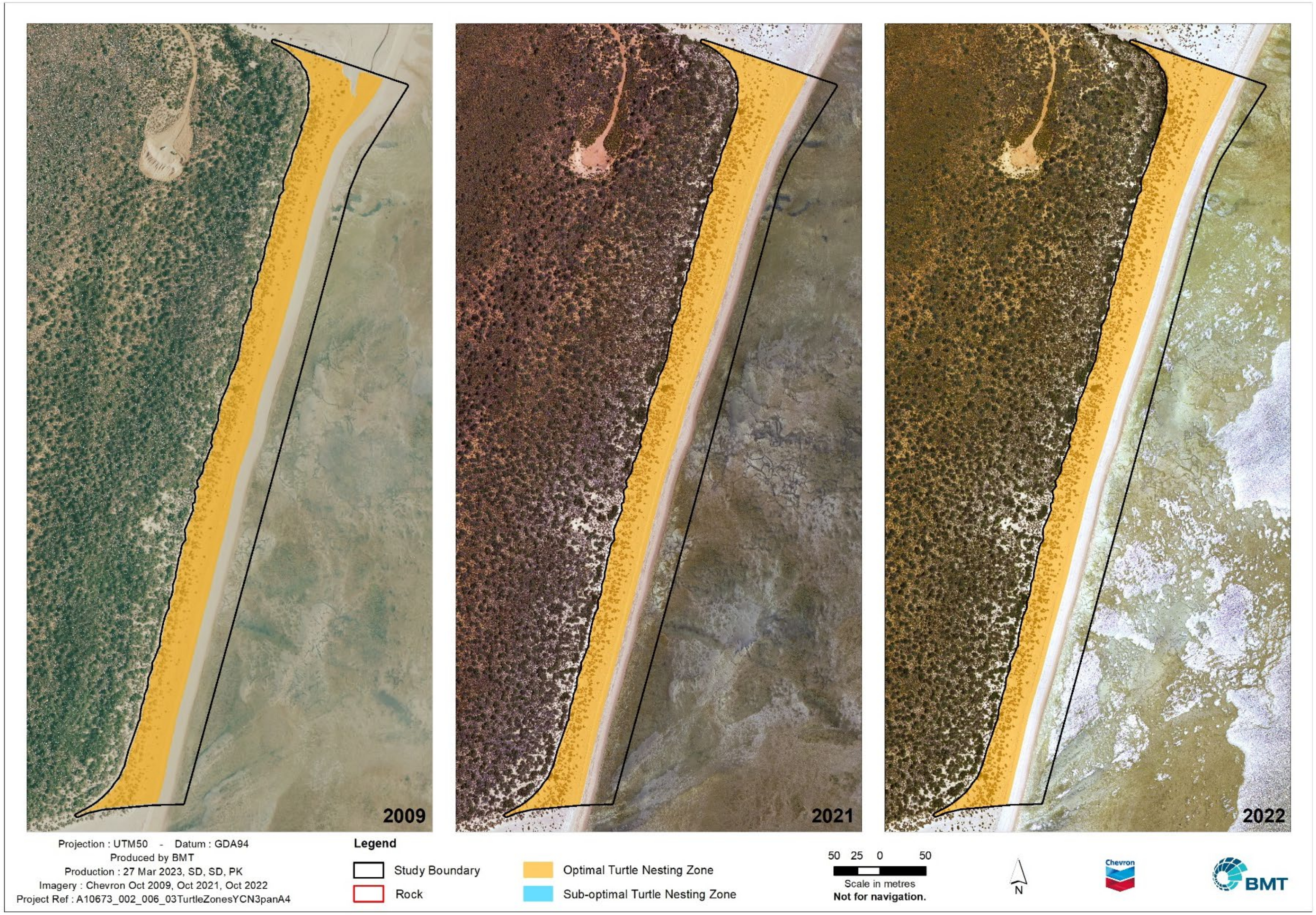


Figure 9-12: Marine turtle nesting habitat zones for YCN Beach

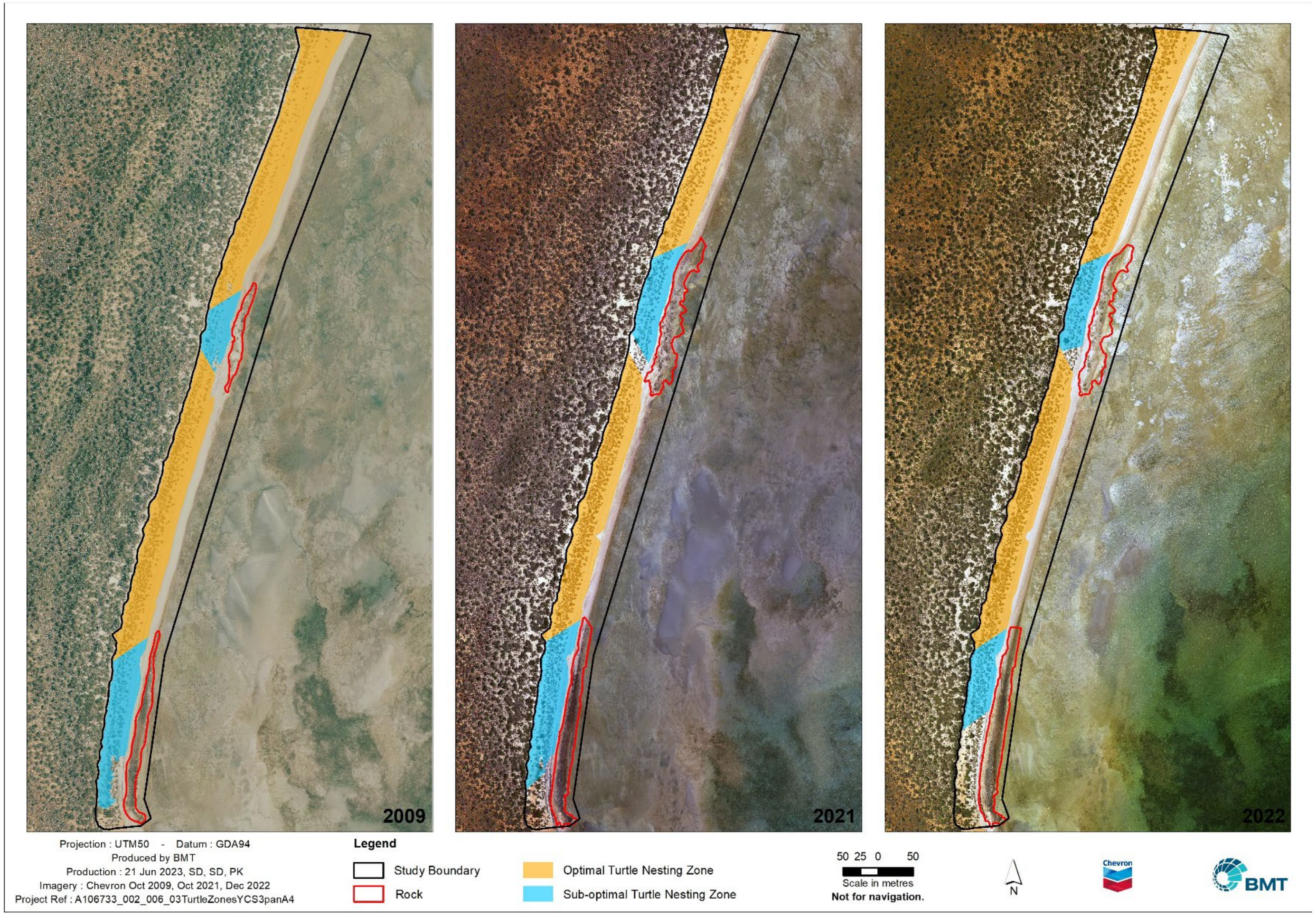


Figure 9-13: Marine turtle nesting habitat zones for YCS Beach

9.2 Changes to the Coastal Stability Management and Monitoring Plan

Results of the CSMMP monitoring program since installation of the marine infrastructure have indicated that changes to Terminal, Bivalve, and Inga beaches have been greater than predicted. In response to these findings, a new revision (Revision 0.3) of the CSMMP was developed and submitted to DWER and the former Commonwealth Department of Agriculture, Water and the Environment (DAWE; now DCCEEW) in March 2019. The revision proposed new management triggers for coastal stability and marine turtle nesting habitat. Further improvements were proposed in Revisions 0.4 and 0.5, submitted to DWER and DAWE/DCCEEW in June 2020 and September 2023 respectively. As at the date of this annual EPR, these CSMMP revisions are still awaiting approval.

In accordance with the variation to EPBC 2003/1294 and 2008/4178 conditions, issued 7 August 2023, the CSMMP will also be revised and resubmitted to DCCEEW by 30 June 2024, and subsequently to DWER.

9.3 Discussion and conclusion

During the Reporting Period, exceedances of volume management triggers were detected for all CBF sites at monitoring transects on Terminal and Bivalve beaches, and for FA sites on Terminal Beach. Slope exceedances were detected at one Terminal Beach and two Bivalve Beach CBF sites, and at all FA sites. These exceedances correspond to a trend of sand redistribution towards the marine infrastructure on Terminal and Bivalve beaches since baseline (October 2009). Terminal Beach has eroded in the north and accreted in the south, while Bivalve Beach has eroded in the south and accreted in the north. Changes on these beaches have predominantly occurred over the active beach face; however, erosion has encroached onto the seaward edge of the FA at some locations on Potential Impact beaches, resulting in some vegetation loss.

Coastal instability is caused by erosion of the beach face and berm, allowing wave action to influence the backshore and sand dunes. Typically, a stable beach changes in the active zone (i.e. the beach face) but should remain relatively static in the backshore and sand dunes.

Terminal and Bivalve beaches are inherently stable through geological control, i.e. they are underpinned by rock and bounded at each end by rock headlands. Although erosion has occurred over the beach face since baseline, the presence of rock in the active zone may help prevent further encroachment of waves into the foredune and primary dune areas. Therefore, Terminal and Bivalve beaches are currently considered relatively stable—it is unlikely the marine infrastructure has had a significant adverse impact on coastal stability and Performance Standards have not been exceeded. However, changes occurring on these beaches may increase the vulnerability of the FA and primary dunes to extreme metocean conditions, and the presence of the marine infrastructure will restrict the capacity for natural recovery after such events.

Inga, YCN, and YCS beaches are bounded by rock headlands (northern end of Inga Beach and southern end of YCS Beach) and are intersected by subaerial and intertidal rock outcrops and creeks. The latter features have a greater capacity for sediment exchange into and out of the study area boundaries, which results in lower capacity for trapping sediments than on Terminal and Bivalve beaches. Since baseline, Inga Beach has exhibited a similar trend to Bivalve Beach—i.e. eroding in the south and accreting in the north. YCN and YCS beaches, when examined as a single sediment transport cell, have also exhibited this trend.

Large sections of the underlying rock platform on Terminal, Bivalve, and Inga beaches have been gradually exposed as a result of sand redistribution at the beach face, predominantly in the direction of marine infrastructure, since construction. Rock exposure has reduced the availability of sandy access pathways preferred by Flatback Turtles to access nesting habitat in the FA of each beach. Therefore, the largest reductions in optimal nesting habitat have occurred on these beaches, and this habitat has been replaced by suboptimal and unsuitable nesting habitat. In general, decreases in optimal nesting habitat have occurred on sections of beach furthest from the marine infrastructure (southern ends of Bivalve and Inga, northern end of Terminal) and increases have occurred closest to the marine infrastructure. No interim management triggers for marine turtle nesting habitat (which apply to Terminal and Bivalve beaches only) were exceeded during the Reporting Period.

However, the reduction in optimal nesting habitat may represent an adverse change that could have implications for marine turtles. In response to monitored changes to beaches, CAPL is evaluating a range of mitigation options and continue to engage with DWER and DCCEEW on this matter.

As required by the CSMMP, CAPL will continue to monitor changes in beach morphology to detect and evaluate potential implications for marine turtle nesting and coastal stability. If exceedances of the CSMMP management triggers or Performance Standards are detected, they will be assessed in accordance with the requirements identified in the current approved CSMMP and relevant Ministerial Conditions.

10 Terrestrial rehabilitation

Table 10-1: EPR requirements for terrestrial rehabilitation

Item	Source	Section in this EPR
A description of any rehabilitation activities undertaken	MS 800, Schedule 3(9i)	10.1
Results of the rehabilitation monitoring program including performance against completion criteria targets	MS 800, Schedule 3(9ii)	10.2
Results of any studies to address knowledge gaps as referenced in Condition 32.5(x) and proposals for further studies (if any)	MS 800, Schedule 3(9iii)	N/A[1]
Recommended changes, if any, to the Gorgon Gas Development Post-Construction Rehabilitation Plan (PCRP) (Ref. 23)	MS 800, Schedule 3(9iv)	10.5
A figure identifying areas rehabilitated, areas planned to be rehabilitated, and disturbed areas to be retained for ongoing construction and operational needs	PCRP (Ref. 23), Section 7.2.2	10.1
Topsoil usage and topsoil balances	Gorgon Gas Development Topsoil Management Plan (TMP) (Ref. 24), Section 3.3	10.3
Changes to volume of soil stockpiled as a result of rehabilitation or clearing activities	TMP (Ref. 24), Section 3.3	10.3
Results of the topsoil monitoring program, topsoil performance reviews, and topsoil volume reconciliation	TMP (Ref. 24), Section 5.0	10.4
Progress against rehabilitation objectives in Table 5-2 of the PCRP (Ref. 23)	PCRP (Ref. 23), Table 5-2	10.1, 10.2, 10.3, 10.4

1 No studies to address knowledge gaps were undertaken during the Reporting Period; therefore, reporting is not applicable at this time.

10.1 Rehabilitation activities

Rehabilitation activities undertaken during the Reporting Period are summarised in the following table.

Rehabilitation activities
• No new rehabilitation scopes were completed during the Reporting Period. • Areas rehabilitated for the Gorgon Gas Development are shown in Figure 10-1.

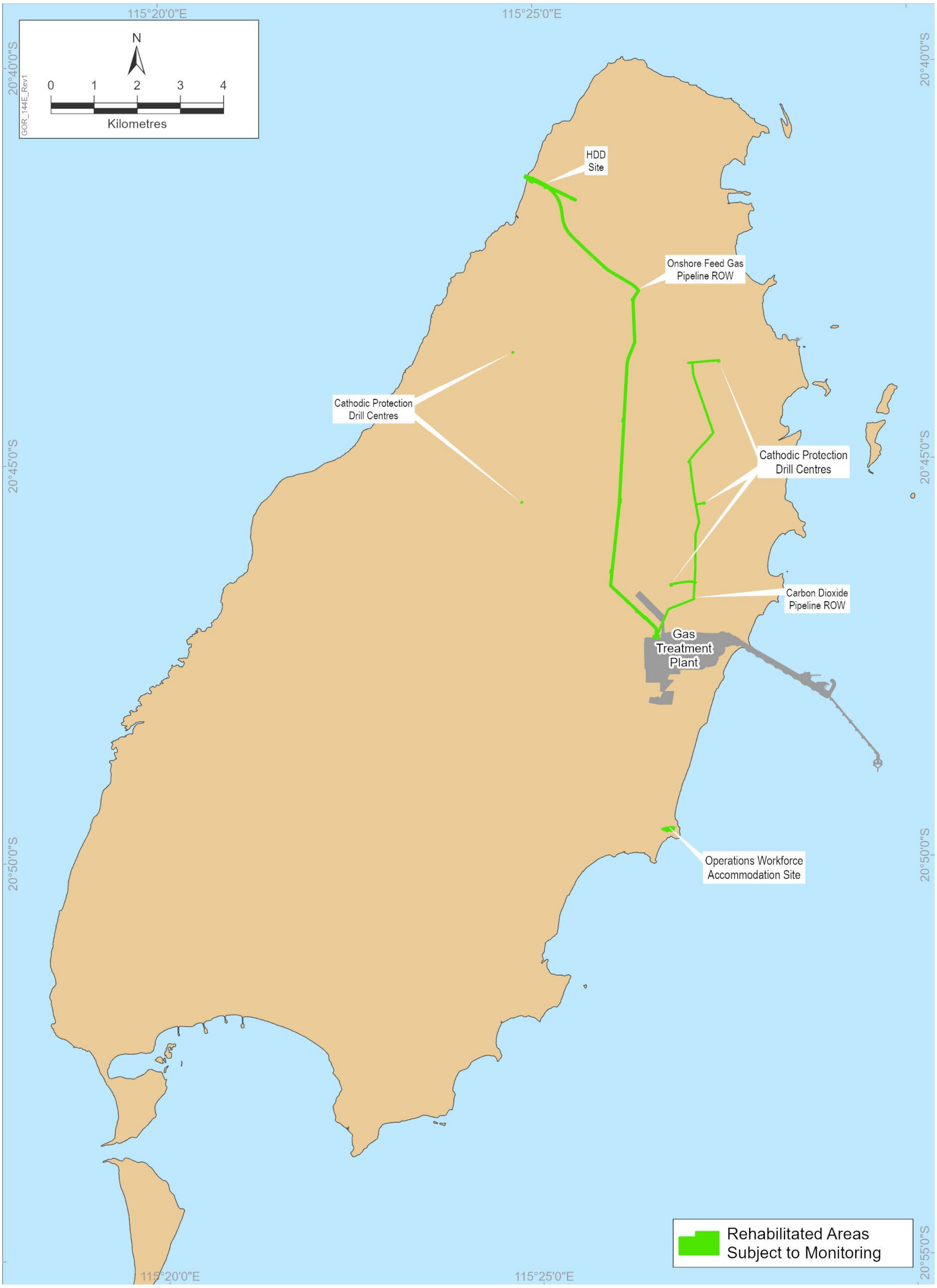


Figure 10-1: Areas rehabilitated for the Gorgon Gas Development

10.2 Rehabilitation monitoring results

The PCRP (Ref. 23) details the rehabilitation methodology and completion criteria for rehabilitating lands temporarily disturbed by the Gorgon Gas Development. The rehabilitation monitoring methodology is ecosystem function analysis (EFA), a method that has been used on Barrow Island since 2004.

The rehabilitation monitoring methodology and results (Ref. 25) are summarised in the following table.

Monitoring program: Rehabilitation
Objectives
To meet the intent of the Ministerial objectives for rehabilitated areas, the PCRP (Table 5-2 in Ref. 23) further defines specific objectives for rehabilitating temporarily disturbed areas: • The rehabilitated land surface and soil properties are appropriate to support the target ecosystem. • Vegetation in rehabilitated areas will have equivalent values as surrounding natural ecosystems. • The rehabilitated ecosystem has equivalent functions and resilience as the target ecosystem. • Rehabilitated sites provide appropriate habitat for fauna and fauna recruitment including EPBC Act listed species. • The rehabilitated site should be able to be managed in the same way as surrounding land.
Methodology
• EFA is based on a methodology developed by the CSIRO, originally described as landscape function analysis (LFA), which uses indicators that assess and determine functional status of the landscape. EFA differs from LFA in that ecosystem components such as vegetation composition, cover, and habitat complexity are also recorded and assessed to provide a quantitative measure of the ecological function of the site. LFA is a core component of EFA, and primarily focuses on stability, water infiltration, and nutrient indices. For arid environments, permanent EFA transects are set up to follow a line of resource flow, typically up to 50 m long. • In total 23 rehabilitation sites were monitored—22 sites in the CO_2 and feed gas pipeline corridors, and one non-pipeline transect. • Two Reference quadrats adjacent to the horizontal directional drilling (HDD) site were also monitored. Eight Reference sites (corresponding to limestone, drainage, or plain habitats) were also monitored to allow assessment against the completion criteria in the PCRP. Broadly, the monitoring gathered data on: – landscape function (stability, infiltration, and nutrient cycling) – vegetation (*Triodia* cover, species diversity, density, cover and height, floristic composition, and functional structure) – erosion and visual amenity.
Results
• None of the monitored rehabilitation sites met all the completion criteria in the PCRP, but this outcome was expected at this relatively early stage of vegetation re-establishment. Criteria that were consistently not met for all sites were *Triodia* cover, floristic composition, functional structure (only two sites met criteria) and total plant cover/height—these criteria require time to reach completion. • Criteria that were frequently met were erosion, species diversity and landform consistency with surrounding areas (Ref. 25), indicating that the rehabilitation sites are fundamentally sound. • Overall in 2022, eight of the limestone rehabilitation transects and two of the drainage/flats rehabilitation transects were within the analogue range for all landscape function indices. This is an improvement from 2021 when only one transect was within the analogue range of all landscape function indices. • Compared to 2021, an overall improvement in rehabilitation performance was shown with more transects also achieving targets for the stability index (14 vs two transects), infiltration index (17 vs six transects), nutrient cycling index (11 vs five transects), total plant cover (six vs five transects) and total plant density (11 vs four transects) in 2022. • The findings of the 2022 monitoring of the feed gas pipeline rehabilitated sites and Reference sites showed that the rehabilitated sites hosted comparable levels of arthropod diversity (abundance and richness) to the Reference sites. The rehabilitation sites recorded a marginally higher abundance, but a marginally lower richness of arthropods and parasitic hymenopterans compared to Reference sites, although the difference was not statistically significant.

Monitoring program: Rehabilitation
• The HDD area was stable. Foliar cover improved at the HDD analogue quadrats while plant density remained consistent between 2021 and 2022. Observations at the HDD rehabilitation area noted that plant cover was sparse.
Conclusions
• During the Reporting Period, the rehabilitation monitoring program was completed in accordance with the requirements of the PCRP (Ref. 23). • Completion criteria addressing key rehabilitation aspects such as erosion and landform consistency were met at all rehabilitation sites, indicating that the rehabilitation sites are fundamentally sound. • Compared to 2021, there was a general increase in completion criteria targets achieved, likely due to above average rainfall prior to monitoring. • Overall, rehabilitation performance indicates the rehabilitation sites becoming more resilient.

10.3 Topsoil activities

Topsoil activities undertaken during the Reporting Period and topsoil stockpile volumes are summarised in Table 10-2.

Table 10-2: Monitored topsoil stockpile volume summary (2022–2023)

Topsoil stockpile	Original topsoil source location	Changes to volume stockpiled during the Reporting Period (m^3)	Total volume stockpiled (m^3)
A28	GTP Site	None	7,483
Q31	GTP Site	None	7,984
X62J	GTP Site	None	17,655[1]
R Station	GTP Site	None	3,481
P13	CO_2 pipeline right-of-way	None	9,453[1]
ASA Stage 3	ASA Stages 3 and 4	None	2,272
ASA Stage 2	ASA Stages 1 and 2	None	3,550
Perentie II	GTP Site and ASA	None	8,884

1 *The total volume stockpiled for X62J was updated after the stockpile survey was completed in November 2015. The total volume stockpiled for P13 was updated to include topsoil activities conducted after the stockpile survey was completed in October 2017.*

10.4 Topsoil monitoring results

The TMP (Ref. 24) complements the PCRP (Ref. 23), and describes the stripping, transport, and re-use of recovered topsoil. The TMP also includes a monitoring program to measure topsoil viability. The monitoring program was amended in 2020 to accommodate assessment using object-based image analysis (OBIA), with performance criteria developed that aligned with current criteria for Gorgon rehabilitation areas. The assessment used 2020 aerial imagery.

The topsoil monitoring results are summarised in the following table (Ref. 26).

Monitoring program: Topsoil
Objectives
• Measure and record the physical, chemical, and biological attributes, and the overall integrity, of the stored topsoil from the Gorgon Gas Development. • Provide assurance that the topsoil remains viable and stable.

Monitoring program: Topsoil
Results
• An on-ground integrity assessment found: – vegetation on the topsoil stockpiles were in excellent condition – no major erosion issues – no weed populations were observed. These findings were consistent with topsoil stockpile observations made in previous integrity assessments. • OBIA of October 2021 aerial imagery was conducted for 16 stockpiles. The dominant vegetation cover classes on the stockpiles were *Triodia* and shrubs. Vegetative cover increased at all but three stockpiles (A28, X62.1 and X62.4). Decreases in vegetative cover at the three topsoil stockpiles ranged from 1.8% to 11.2%. • *Triodia* flowered on Barrow Island for the second successive year, but this did not result in large numbers of germinable seed on the soil, with numbers of *Triodia* germinants only being about 10% of that recorded in 2021, despite very similar rainfall patterns. *Triodia* germinants were recorded in soil from three of the five Reference sites sampled. • The number of monocot germinants in stockpiled topsoil, comprising predominantly *Triodia*, had increased around 20-fold, to the equivalent of ~400 seedlings/m^2 (at 2 cm soil depth). • Dicot germinant numbers were about one-third of that of monocots. Successful flowering and seed production by *Triodia* in 2021 supports observations that substantial favourable rainfall events are critical for continued vegetation establishment.
Conclusion
Topsoil stockpiles are stable. The number of soil-stored germinable seed in stockpiled soils has generally been similar or greater than Reference sites for several years. It is reasonable to expect that seed production from the standing vegetation on the stockpiled soils will be maintained, as long as the stockpiles remain undisturbed.

10.5 Changes to the Post-Construction Rehabilitation Plan

No changes were made to the to the PCRP (Ref. 23) during the Reporting Period.

11 Spill management

Table 11-1: EPR requirements for spill management

Item	Source	Section in this EPR
Incidence of spills caused by the Proposal, and spills that impact on the Proponent's facilities including details of cause and recommended actions	MS 769, Schedule 3(3i)	11.1

11.1 Event data

No spills caused by the Jansz Feed Gas Pipeline, or spills that impacted on Jansz Feed Gas Pipeline facilities, occurred during the Reporting Period.

12 Terminology

Table 12-1 defines the acronyms, abbreviations, and terminology used in this document.

Table 12-1: Terminology

Term	Definition
~	Approximately
°C	Degrees Celsius
µg	Microgram
ABU	Australian Business Unit
Adult female breeding omission probability	Annual probability estimate of skipped breeding for adult female marine turtle nesters in a nesting population
Adult female survival probability	Annual estimated survival rate for adult female marine turtle nesters in a nesting population
AGL	Above ground level
Alert trigger	Measured parameter deviates towards (but remains within) 1 SD for 2 consecutive years, or deviates outside a 1 SD limit
Annual nester abundance	Estimate of total female marine turtle nesters per season at a rookery
AQMP	Air Quality Management Plan
ASA	Additional Support Area
At Risk	Being at risk of Material Environmental Harm or Serious Environmental Harm and/or, for the purposes of the EPBC Act relevant listed threatened species, threatened ecological communities, and listed migratory species, at risk of Material Environmental Harm or Serious Environmental Harm
At Risk zone/site/island	An area where potential impacts are predicted to occur
AU$	Australian dollar
Backshore	An upper shore zone above high tide
Baseline	The original status of the environment in the area before the development work of the project is started
BC Act	Western Australian *Biodiversity Conservation Act 2016*
BP	*See* Butler Park
BTEX	Benzene, toluene, ethylbenzene, and xylene compounds
Butler Park	Barrow Island accommodation village
CAPL	Chevron Australia Pty Ltd
CBF	Crest of Beach Face; sampling site located at the change in slope at the transition between the beach face and foredune area
CI	Confidence Interval; an interval that is likely to contain the true value of a population parameter, but reflects the inherent uncertainty in estimating this parameter from a sample. The level of confidence reflects the likelihood that the constructed interval contains the true parameter value, so a 95% Confidence Interval is an interval that will include the true parameter value 95% of the time. By convention, 95% Confidence Intervals are usually used to define reasonably upper and lower bounds for parameter estimates.
Civil Twilight hours	The beginning of morning civil twilight is defined as the instant in the morning, when the centre of the Sun is at a depression angle of six degrees (6°) below an ideal horizon.

Term	Definition
Clutch fate	The recorded fate of a Flatback Turtle nest. Fate is determined based on set criteria including discrepancies between egg counts at laying versus egg counts at excavation, and evidence of disturbance from other nesting turtles or predation.
Clutch frequency	The mean number of clutches laid per female marine turtle nester per season
Clutch size	The mean number of eggs in a Flatback Turtle nest
cm	Centimetre
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSMMP	Coastal Stability Management and Monitoring Plan
CT	Communications Tower
DAWE	Former Commonwealth Department of Agriculture, Water and the Environment (dates: 1 Feb 2020 to 30 Jun 2022; split into Department of Climate Change, Energy, the Environment and Water and Department of Agriculture, Fisheries and Forestry on 1 Jul 2022)
DBCA	Western Australian Department of Biodiversity, Conservation and Attractions
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water (from 1 Jul 2022)
DNA	Deoxyribonucleic Acid
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DomGas	Domestic Gas
DWER	Western Australian Department of Water and Environmental Regulation
e.g.	For example
eDNA	Environmental DNA; DNA that can be extracted from environmental samples
EFA	Ecosystem Function Analysis
Egg hatching probability	The median hatching success of eggs within complete clutches. Complete clutches refer to clutches not disturbed by other turtles, predated or lost.
EMP	Environmental Management Plan
Environmental Harm	Has the meaning given by Part 3A of the *Environmental Protection Act 1986* (WA)
EPBC 2003/1294	Commonwealth Ministerial Approval (for the Gorgon Gas Development) as amended or replaced from time to time
EPBC 2008/4178	Commonwealth Ministerial Approval (for the Revised Gorgon Gas Development) as amended or replaced from time to time
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPR	Environmental Performance Report
EWMA	Exponentially Weighted Moving Average
$F_{1,12}$	In linear regression, the F-statistic is the test statistic for the analysis of variance (ANOVA) approach to test the significance of the model or the components in the model.
F3	Total Recoverable Hydrocarbons Fraction 3, which corresponds the carbon number range C_{16}–C_{34} as specified in the National Environmental Protection Measure guidelines

Term	Definition
FA	Foredune Area; area between the beach face and the primary dune, which is populated by scattered vegetative hummocks and marine turtle body holes
First Response	Quarantine activities that occur immediately after the detection of a suspect NIS or Marine Pest. The aim is to contain, control, and eliminate.
GHG	Greenhouse Gas
GME	Groundwater Monitoring Event
Gorgon Gas Development	Gorgon Gas Development and Jansz Feed Gas Pipeline
GPS	Global Positioning System
GTG	Gas Turbine Generator
GTP	Gas Treatment Plant
H_2S	Hydrogen sulfide
ha	Hectare
Hatchling	Newly hatched marine turtle
Hatchling disorientation	The range of dispersion (nest fan spread angle) of marine turtle hatchling tracks from the emergence point
Hatchling emergence probability	The median emergence success of hatchlings from clutches
Hatchling misorientation	The degree of deflection (nest fan offset angle) of marine turtle hatchling tracks from the most direct line to the ocean
HDD	Horizontal Directional Drilling
Hg	Mercury
HSE	Health, Safety, and Environment
i.e.	That is
Incubation duration	The mean incubation time period of a Flatback Turtle nest
Incubation temperature	The mean incubation temperature of a Flatback Turtle nest
ind/ha	Individuals per hectare
Internesting interval	Period between a successful nest and subsequent nest or nesting attempt in a single breeding season. The females move to offshore internesting grounds while they form the next clutch of eggs. Internesting grounds may be close to or remote from the nesting beach.
km	Kilometre
L	Litre
LCGT	Liquefaction Compressor Gas Turbine
LFA	Landscape Function Analysis
LNG	Liquefied Natural Gas
LOR	Limit of Reporting (also known as the detection limit)
LTMTMP	Long-term Marine Turtle Management Plan
m	Metre
m/s	Metres per second
m^2	Square metre
m^3	Cubic metre

Term	Definition
MAD	Median Absolute Deviation
MAH	Monocyclic Aromatic Hydrocarbon
Management trigger	Quantitative, or where this is demonstrated to be not practicable, qualitative matters above or below which relevant additional management measures must be considered
Marine Pest	Species other than the native species known or those likely to occur in the waters of the Indo–West Pacific region and the Pilbara Offshore marine bioregion
Material Environmental Harm	Environmental Harm that is neither trivial nor negligible
MDEA	methyldiethanolamine
MEG	Monoethylene glycol; used as a hydrate inhibitor
mg	Milligram
MHWS	Mean High Water Springs (tide)
mm	Millimetre
MOF	Materials Offloading Facility
MS	(Western Australian) Ministerial Statement
MS 1198	Western Australian Ministerial Statement 1198, (for the Gorgon Gas Development), as amended from time to time
MS 769	Western Australian Ministerial Statement 769 (for the Jansz Feed Gas Pipeline) as amended from time to time
MS 800	Western Australian Ministerial Statement 800 (for the Gorgon Gas Development) as amended from time to time
MS 965	Western Australian Ministerial Statement 965, issued for the Additional Support Area, as amended from time to time
MSORD	Multi-state open robust design
N	Nitrogen
N/A	Not Applicable
NEPM	National Environmental Protection Measure
Nesting activity	The spatial and temporal nesting distribution of adult female Flatback Turtles
NGER Act	Commonwealth *National Greenhouse and Energy Reporting Act 2007*
NIS	Non-indigenous Terrestrial Species; any species of plant, animal, or microorganism not native to Barrow Island
NNE	North-north-east (compass direction)
NO_2	Nitrogen dioxide
NOHES	National Occupational Health Exposure Standards
NO_x	Nitrogen oxides (NO and NO_2)
O_3	Ozone
OBIA	Object-based Image Analysis
ORP	Oxidation-reduction Potential (also known as redox)
P	The p-value is a number between 0 and 1 representing the probability that this data would have arisen if the null hypothesis were true.
PAH	Polycyclic Aromatic Hydrocarbon
PAR	Parakeelya Island

Term	Definition
PCRP	Post-Construction Rehabilitation Plan
Performance Standards	Developed for assessing performance, not compliance, and are quantitative targets or if that is demonstrated to be not practicable, qualitative targets, against which progress towards achievement of the objectives of conditions can be measured.
PFC	Percentage foliage cover
pH	Measure of acidity or basicity of a solution
PM_{10}	Airborne particulate matter, less than 10 microns
Potential Impact beaches	Those beaches on the east coast of Barrow Island, adjacent to the marine infrastructure, that modelling predicted most likely to be impacted as a consequence of the presence of the marine infrastructure.
Project	Gorgon Gas Development
Proliferation	Increase of a species, attributable to the Gorgon Gas Development, by frequent and repeated reproduction: • NIS plant (excluding those considered to be naturalised) proliferation: an increase in the distribution of NIS plants producing propagules outside existing Weed Hygiene Zones. • NIS animal proliferation: an increase in reproductively capable offspring dispersing outside the known distribution. • Marine Pest proliferation: an increase in reproductively capable offspring dispersing outside the known distribution in the waters surrounding Barrow Island.
Proposal	Gorgon Gas Development, as expanded and revised by the Revised and Expanded Gorgon Gas Development
PSD	Particle Size Distribution
PWD	Permanent Wastewater Disposal (well)
QEP	Quarantine Expert Panel
QMS	Quarantine Management System
Quadrat	A rectangular or square measuring area used to sample living things in a given site; can vary in size
Quarantine Incident	A quarantine incident is declared (declaration is subject to positive identification*) by the CAPL Quarantine Manager following: • a detection of NIS or Marine Pest on Barrow Island after Final Quarantine Clearance, or • the proliferation of a NIS population on Barrow Island or Marine Pest in the waters surrounding Barrow Island. **Level 1 Quarantine Incident** • A confirmed detection of NIS on Barrow Island, after Final Quarantine Clearance, where the risk of the species to the biodiversity of Barrow Island is considered by CAPL, on advice of the QEP, to be low, or • A proliferation of existing NIS on Barrow Island as a consequence of Gorgon Gas Development activities. **Level 2 Quarantine Incident** A confirmed detection of NIS on Barrow Island, after Final Quarantine Clearance, where: • uncertainty exists (as determined by CAPL on advice of the QEP) as to the risk of the species to the biodiversity of Barrow Island due to a range

Term	Definition
	of factors (e.g. the ability of the species to survive on Barrow Island, availability of suitable habitats), or • the risk to the biodiversity of Barrow Island is considered to be high (as determined by CAPL, on advice of the QEP), but the ability to detect and eradicate is considered readily achievable (due to factors such as visibility, fecundity, slow dispersal etc.). **Level 3 Quarantine Incident** **Terrestrial NIS**: A confirmed detection of NIS on Barrow Island, after Final Quarantine Clearance, where: • the risk to the biodiversity of Barrow Island is considered to be high and the ability to detect and eradicate is difficult (as determined by CAPL, on advice of the QEP), and/or • the consequence of eradication/control actions on the biodiversity of Barrow Island is considered to be high (as determined by CAPL, on advice of the QEP). **Marine Pests**: A confirmed detection of a Marine Pest on marine infrastructure or in the waters surrounding Barrow Island. Note: A Marine Pest that has only been detected on the wetsides of a vessel and not on marine infrastructure and/or in the waters surrounding Barrow Island is not considered an incident (see Quarantine Intercept). ** Positive identification is taxonomic (morphologic or molecular) confirmation in every instance except where there is high certainty of species identification in the expert judgement of the CAPL Quarantine Manager.* **Note**: An introduction of a Marine Pest is classified as a Level 3 Incident only.
Quarantine Intercept	**Terrestrial NIS**: The detection, containment, and removal of suspected NIS prior to Final Clearance. **Marine Pest**: The detection, containment, and removal of a Marine Pest on a vessel's (including barges etc.) wetsides after Final Quarantine Clearance is granted and when the vessel is within the limited access zone or controlled access zone.
Quarantine Introduction	The presence of viable NIS on Barrow Island, or of a Marine Pest in the waters surrounding Barrow Island (excluding on vessel wetsides—see Quarantine Intercept). In both instances, the species will be considered introduced if the species has survived First Response and Incursion Response.
Quarantine Procedural Breach	Any case where a quarantine observation, inspection, or audit detects a failure to comply with Barrow Island quarantine procedures, standards, or concessions. **Level 1 Quarantine Procedural Deviation** • Upon arrival of a vessel or material at Barrow Island, it is determined that a quarantine procedure, or part thereof, has not been followed and the potential impact of the deviation has low risk to the biodiversity of Barrow Island and surrounding waters. **Level 2 Quarantine Procedural Deviation** • Upon arrival of a vessel or material at Barrow Island, it is determined that a quarantine procedure, or part thereof, has not been followed and the potential impact of the deviation has high risk to the biodiversity of Barrow Island and surrounding waters.
R^2	The coefficient of determination, or R^2, is a measure that provides information about the goodness of fit of a model. In the context of regression it is a statistical measure of how well the regression line approximates the actual data.
Redox	*See* ORP

Term	Definition
Reference zone/site/island	Specific areas of the environment that are not at risk of being affected by the Project or existing developments, that can be used to determine the natural state, including natural variability, of environmental attributes
Remigrant turtle	A tagged Flatback Turtle returning and 'recaptured', as opposed to a new (untagged) turtle that is tagged for the first time.
Reporting Period	The period from 10 August 2022 to 9 August 2023 covered by this EPR
Reservoir Carbon Dioxide	GHG Emissions that are separated (from natural gas or the products produced from extracted hydrocarbons) in the acid gas removal units and expected to be subsequently injected underground (as per MS 1198).
RPA	Remotely Piloted Aircraft
SAQP	Sampling and Analysis Quality Plan
SD	Standard deviation (statistical variation); a measure used to quantify the amount of variation or dispersion of a set of data values
SE	Standard error (statistical variation); a measure used to quantify the accuracy with which a sample mean represents a population mean
Serious Environmental Harm	Environmental harm that is: a) irreversible, of a high impact or on a wide scale; or b) significant or in an area of high conservation value or special significance and is neither trivial nor negligible
SGC	Silica Gel Clean-up
SME	Subject Matter Expert
SO_2	Sulfur dioxide
SO_4	Sulfate ion
SRE	Short-range Endemics; taxonomic group of invertebrates that are unique to an area, found nowhere else, and have naturally small distributions (i.e. <10,000 km^2).
SRESFMP	Short-range Endemics and Subterranean Fauna Monitoring Plan
SSC	Surveillance System Components
SSE	South-south-east (compass direction)
Stressor	An environmental condition or influence that stresses an organism
SVL	Sparse Vegetation Line
tCO_2e	Tonnes of carbon dioxide equivalent
TDF	Terrestrial Disturbance Footprint The area to be disturbed by construction or operations activities associated with the Terrestrial Facilities listed in Condition 6.3 of MS 800, Condition 6.3 of MS 769, and Condition 5.2 of EPBC 2003/1294 and 2008/4178, and set out in the Terrestrial and Subterranean Baseline State and Environmental Impact Report required under Condition 6.1 of MS 800, Condition 6.1 of MS 769, and Condition 5.1 of EPBC 2003/1294 and 2008/4178.
Threatened Species	Species listed as extinct, extinct in the wild, critically endangered, endangered, vulnerable or conservation dependent under section 178 of the Commonwealth EPBC Act
TMP	Topsoil Management Plan
Topsoil	The top layer of soil that stores seed and acts as the growth medium in which vegetation can establish itself
Transect	The path along which a researcher moves, counts, and records observations
TRH	Total Recoverable Hydrocarbons

Term	Definition
TSEMP	Terrestrial and Subterranean Environment Monitoring Program
TTR	Thermal Tolerance Range
TWIP	Temporary Wastewater Injection Plant)
vs	Versus
WA	Western Australia
WAM	Western Australian Museum
Waters surrounding Barrow Island	Refers to the waters of the Barrow Island Marine Park and Barrow Island Marine Management Area (~4,169 ha and 114,693 ha respectively), as well as the Port of Barrow Island representing the Pilbara Offshore Marine Bioregion
Weed	Non-indigenous plant species; a plant that establishes in natural ecosystems, subsequently adversely affecting natural processes and ultimately resulting in the decline of the native vegetation community
Weed Hygiene Zone	An area within which non-indigenous plant species, assessed to be high-risk species, have established populations and/or where a seedbank of a high-risk species is present
YCN	Yacht Club North (beach)
YCS	Yacht Club South (beach)

13 References

Table 13-1 lists the documentation referenced in this EPR.

Table 13-1: References

Ref. No.	Description	Document ID
1.	Chevron Australia. 2020. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Terrestrial and Subterranean Environment Monitoring Program*. Rev. 2.0. Chevron Australia, Australia, Western Australia. Available from: https://Australia.chevron.com/-/media/Australia/our-businesses/documents/gorgon-terrestrial-and-subterranean-environment-monitoring-program.pdf [Accessed 20 Sep 2023]	GOR-COP-01696
2.	Chevron Australia. 2014. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Terrestrial and Subterranean Environment Protection Plan*. Rev. 3. Chevron Australia, Australia, Western Australia. Available from: https://Australia.chevron.com/-/media/Australia/our-businesses/documents/gorgon-emp-terrestrial-and-subterranean-environment-protection-plan.pdf [Accessed 20 Sep 2023]	G1-NT-PLNX0000294
3.	Golder Associates Pty Ltd. 2017. *Gorgon Gas Treatment Plant, Groundwater Monitoring Operational Sampling and Analysis Quality Plan*. Unpublished report for Chevron Australia, Perth, Western Australia.	ABU170700438
4.	Western Australian Museum. 2023. *On the status and distribution of the Barrow Island brush-footed trapdoor spider Idiommata sp. (Araneae, Barychelidae)* Unpublished report for Chevron Australia Pty Ltd, Perth, Western Australia.	ABU231000525
5.	Chevron Australia. 2017. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Terrestrial and Marine Quarantine Management System*. Rev. 1.0. Chevron Australia, Perth, Western Australia. Available from: https://australia.chevron.com/-/media/australia/our-businesses/documents/terrestrial-and-marine-quarantine-management-system.pdf [Accessed 20 Sep 2023]	GOR-COP-01854
6.	Chevron Australia. 2015. *Five-year Environmental Performance Report (August 2010–August 2015)*, Rev. 0, Chevron Australia, Perth, Western Australia, available from: https://australia.chevron.com/-/media/australia/our-businesses/documents/gorgon-and-jansz-feed-gas-pipeline-5-year-environmental-performance-report-2010-2015.pdf [accessed 22 Oct 2023]	G1-NT-REPX0007517
7.	Chevron Australia. 2018. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Long-term Marine Turtle Management Plan*. Rev. 1.0. Chevron Australia, Perth, Western Australia. Available from: https://australia.chevron.com/-/media/australia/our-businesses/documents/gorgon-emp-long-term-marine-turtle-management-plan.PDF [Accessed 20 Sep 2023]	GOR-COP-01728
8.	Pendoley Environmental. 2023. *Gorgon Gas Development: Marine Turtle Monitoring Program 2022/23: Barrow Island and Mundabullangana*. Unpublished report for Chevron Australia, Perth, Western Australia.	ABU220800217
9.	Chevron Australia. 2023. *Gorgon Gas Development and Jansz Feed Gas Pipeline MS800 MS 1136 MS 1198 MS965 and MS769 Compliance Assessment Report 2023,* Chevron Australia, Perth, Western Australia.	ABU230800262
10.	Chevron Australia. 2023. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Lighting Effectiveness Review and Audit Report (2022–2023)*, Chevron Australia, Perth, Western Australia.	ABU230700226
11.	Stantec. 2023. *Flatback Turtle Census and Beach Temperature Assessment.* Unpublished report for Chevron Australia, Perth, Western Australia.	ABU231100086

Ref. No.	Description	Document ID
12.	Chevron Australia. 2019. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Short-Range Endemics and Subterranean Fauna Monitoring Plan*. Rev. 4. Chevron Australia, Perth, Western Australia. Available from: https://australia.chevron.com/-/media/australia/our-businesses/documents/gorgon-emp-short-range-endemics-and-subterranean-fauna-monitoring-plan.pdf [Accessed 20 Sep 2023]	G1-NT-PLNX0000295
13.	Chevron Australia. 2015. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Fire Management Plan*. Rev. 1.0. Chevron Australia, Perth, Western Australia. Available from: https://australia.chevron.com/-/media/australia/our-businesses/documents/gorgon-emp-fire-management-plan.pdf [Accessed 20 Sep 2023]	GOR-COP-01238
14.	Chevron Australia. 2020. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Air Quality Management Plan*. Rev. 3. Chevron Australia, Perth, Western Australia. Available from: https://australia.chevron.com/-/media/australia/our-businesses/documents/gorgon_project_emp_air_quality_management_planrev2amendment1.pdf [Accessed 20 Sep 2023]	G1-NT-PLNX0000301
15.	Chevron Australia. 2020. *ABU Occupational Hygiene Corporate OE Process*, Chevron Australia, Perth, Western Australia.	OE-03.11.02
16.	Compliance Monitoring Pty Ltd. 2023. *Gorgon Air Quality Atmospheric Pollutants: Operations Phase Annual Environmental Performance Report August 2022 to August 2023.* Document Reference RPA088-737. Unpublished report for Chevron Australia, Perth, Western Australia.	ABU231000476
17.	*Licence L9102/2017/1 Decision Report* (File No. DER2017/001839), 16 July 2018.	ABU190901271
18.	Department of Environment and Conservation. 2010. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Coastal Stability Management and Monitoring Plan Supplement: Management Triggers. Approval Letter*. Department of Environment and Conservation, Perth, Western Australia.	G1-CO-LTR-DECWH-CVXPH-0000109
19.	Chevron Australia. 2016. *Gorgon Project: Coastal Stability Management and Monitoring Plan.* Rev. 2. Chevron Australia, Perth, Western Australia. Available from: https://australia.chevron.com/-/media/australia/our-businesses/documents/coastal-stability-management-and-monitoring-plan.pdf [Accessed 20 Sep 2023]	G1-NT-PLNX0000300
20.	Chevron Australia. 2016. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Coastal Stability Management and Monitoring Plan Supplement: Management Triggers*. Rev. 1. Chevron Australia, Perth, Western Australia. Available from: https://australia.chevron.com/-/media/australia/our-businesses/documents/gorgon_project_coastal_stability_management_and_monitoring_plan_supplement.pdf [Accessed 20 Sep 2023]	G1-NT-REPX0002461
21.	BMT Commercial Australia Pty Ltd. 2022. *Gorgon Project Coastal Stability Monitoring—Annual Report 2021/22*. Report No. R-10673_001-2. Unpublished report for Chevron Australia Pty Ltd, Perth, Western Australia.	ABU230100032
22.	BMT Commercial Australia Pty Ltd. In prep. *Gorgon Project Coastal Stability Monitoring—Annual Report 2022/2023*. Report No. R-10673_002-1 Unpublished report for Chevron Australia Pty Ltd, Perth, Western Australia.	ABU231000458
23.	Chevron Australia. 2019. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Post-Construction Rehabilitation Plan*. Rev. 3.0. Chevron Australia, Perth, Western Australia. Available from: https://australia.chevron.com/-/media/australia/our-businesses/documents/gorgon-emp-post-construction-rehabilitation-plan.pdf [Accessed 20 Sep 2023]	G1-NT-PLNX0000303

Ref. No.	Description	Document ID
24.	Chevron Australia. 2014. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Topsoil Management Plan*. Rev. 3. Chevron Australia, Perth, Western Australia. Available from: https://australia.chevron.com/-/media/australia/our-businesses/documents/gorgon-emp-topsoil-management-plan.pdf [Accessed 20 Sep 2023]	G1-NT-PLNX0000769
25.	Stantec Inc. 2023. *Gorgon Rehabilitation Monitoring 2022*. Unpublished report for Chevron Australia, Perth, Western Australia.	ABU201200744
26.	Stantec Inc. 2023. *Gorgon Topsoil Stockpile Monitoring 2022*. Unpublished report for Chevron Australia, Perth, Western Australia.	ABU201200725
27.	Astron Environmental Services Pty Ltd. 2022. *Gorgon Gas Development Barrow Island Terrestrial Vertebrate Fauna Monitoring Program 2022 – Barrow Island Euro*. Unpublished report for Chevron Australia, Perth, Western Australia.	ABU220900486
28.	Astron Environmental Services Pty Ltd. 2022. *Gorgon Gas Development Barrow Island Terrestrial Vertebrate Fauna Monitoring Program 2022 – Spectacled Hare-wallaby*. Unpublished report for Chevron Australia, Perth, Western Australia.	ABU220900491
29.	Astron Environmental Services Pty Ltd. 2022. *Gorgon Gas Development Barrow Island Terrestrial Vertebrate Fauna Monitoring Program 2022 – Burrowing Bettong*. Unpublished report for Chevron Australia, Perth, Western Australia.	ABU220900492
30.	Astron Environmental Services Pty Ltd. 2022. *Gorgon Gas Development Barrow Island Terrestrial Vertebrate Fauna Monitoring Program 2022 – White-winged Fairy-Wren*. Unpublished report for Chevron Australia, Perth, Western Australia.	ABU220900494
31.	Pendoley Environmental Pty Ltd. 2022. *Gorgon Gas Development Seabird Monitoring Program 2022–2023*. Unpublished report for Chevron Australia, Perth, Western Australia.	ABU230900442
32.	Astron Environmental Services Pty Ltd. 2023. *Gorgon Gas Development Barrow Island Biennial Vegetation Monitoring Program 2023*. Unpublished report for Chevron Australia, Perth, Western Australia.	ABU230500226
33.	Bently, B., Stubbs, J., Whiting, S., and Mitchell, N. 2020. Variation in thermal traits describing sex determination and development in Western Australian sea turtle populations. *Functional Ecology*. 34.	