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Long-term migratory shorebird monitoring program for the Mardie Project

Prepared for Mardie Minerals Pty Ltd

October 2021

Final

Long-term migratory shorebird monitoring program for the Mardie Project

Prepared for Mardie Minerals Pty Ltd

Version history

Author/s	Reviewer/s	Version	Version number	Date submitted	Submitted to
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1 INTRODUCTION

Mardie Minerals Pty Ltd (Mardie Minerals) is developing the Mardie Project (the Project), 100 km west of Karratha in the Pilbara region of Western Australia (Map 1-1). Mardie Minerals is a wholly-owned subsidiary of BCI Minerals Ltd (BCI). The Project is a proposed solar salt operation that will make use of seawater and evaporation to produce a concentrated salt product and other associated products. This will involve the creation of a series of evaporation and crystallisation ponds to produce Sodium Chloride (NaCl) salt, as well as Sulphate of Potash. The waste bitterns will be discharged through a diffuser offshore.

Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned to develop a migratory shorebird monitoring program for the Project, which follows an initial desktop study and reconnaissance survey in 2017 (Phoenix 2017), a Level 2 targeted terrestrial fauna survey over 2017-2018 (Phoenix 2020) and supplementary survey work in 2019 and 2020 (Phoenix 2021).

Globally, shorebird populations are in decline, and a major contributing factor to these declines is habitat loss (Clemens *et al.* 2009). This presents a considerable conservation challenge as their movement patterns take them across international boundaries that span much of the globe (Bamford *et al.* 2008). The identification and management of important sites for migratory species is therefore a complicated task that is managed with considerable scrutiny. There are 37 migratory shorebird species listed under the Environment Protection and Biodiversity Conservation (EPBC) Act Policy Statement 3.21 (DoEE 2017), which are also protected under the following international agreements;

- the Convention on Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention),
- bilateral agreements for the conservation of migratory birds between the Government of Japan (JAMBA), the Government of China (CAMBA), and the Government of the Republic of Korea (ROKAMBA), and
- the Convention on Wetlands of International Importance (also known as the Ramsar Convention).

Of the 37 species of migratory shorebirds listed under the EPBC Act, 20 were recorded during the surveys completed by Phoenix during the baseline surveys. While the vast majority (93.1%) of the birds recorded during the baseline surveys were outside the proposed development areas, compliance with Commonwealth and State legislation as well as the agreements listed above, requires that the proposed works do not negatively impact any of the EPBC listed species. As such, it is necessary to adequately monitor the population in the vicinity of the proposed Project. If a decline is detected, which is attributable to the Project, mitigation procedures will need to be implemented to reverse any negative effects the Project has had on said species.

In developing this management plan, a focus has been made through discussions with Birdlife Australia to maximise the value of the data gathered for improving our understanding of the migratory shorebird population that uses the Pilbara coast each year. Filling knowledge gaps in the migratory shorebird ecology in Australia is objective 4a of the Wildlife Conservation Plan for Migratory Shorebirds (DoEE 2015). This large area of the Australian coast is not currently being surveyed by any other monitoring programs, and so presents an opportunity to fill a knowledge gap through partnership with Mardie Minerals as they complete their monitoring program obligations. All migratory shorebird data gathered through the implementation of this monitoring program will be made available to the Department of Agriculture, Water and the Environment (DAWE), the Department of Biodiversity, Conservation and Attractions (DBCA), and Birdlife Australia's National Shorebird Monitoring Program ('Shorebird 2020').

The Wildlife Conservation Plan for Migratory Shorebirds lists coastal development in Australia, anthropogenic disturbance, and altered hydrological regimes as threats that are to be mitigated (DoEE 2015). While the Project has the potential to impact shorebirds through such mechanisms, there is however also considerable evidence that saltworks in the region and other comparable regions provide valuable feeding habitat for a range of migratory shorebird species (e.g. Johnstone *et al.* (2013), Clemens *et al.* (2009), Bennelongia (2011), Houston *et al.* (2012), Bertzeletos *et al.* (2012), Estrella *et al.* (2016). The saltworks at Lake MacLeod and Port Hedland have both been shown to provide internationally important feeding habitat for migratory shorebirds (Bertzeletos *et al.* 2012; Estrella *et al.* 2016; Johnstone *et al.* 2013). Given the evidence of the value these land uses have for migratory species (specifically the initial intake ponds where invertebrate density is very high), it is likely that this project will have a net positive outcome on migratory shorebirds, with the creation of new foraging habitat.

This report outlines the results of the baseline work completed by Phoenix associated with the Project and details the proposed monitoring program. The aim of the program is to ensure that a robust dataset is collected and can be analysed to provide evidence of changes to the migratory shorebird population at the Project site.

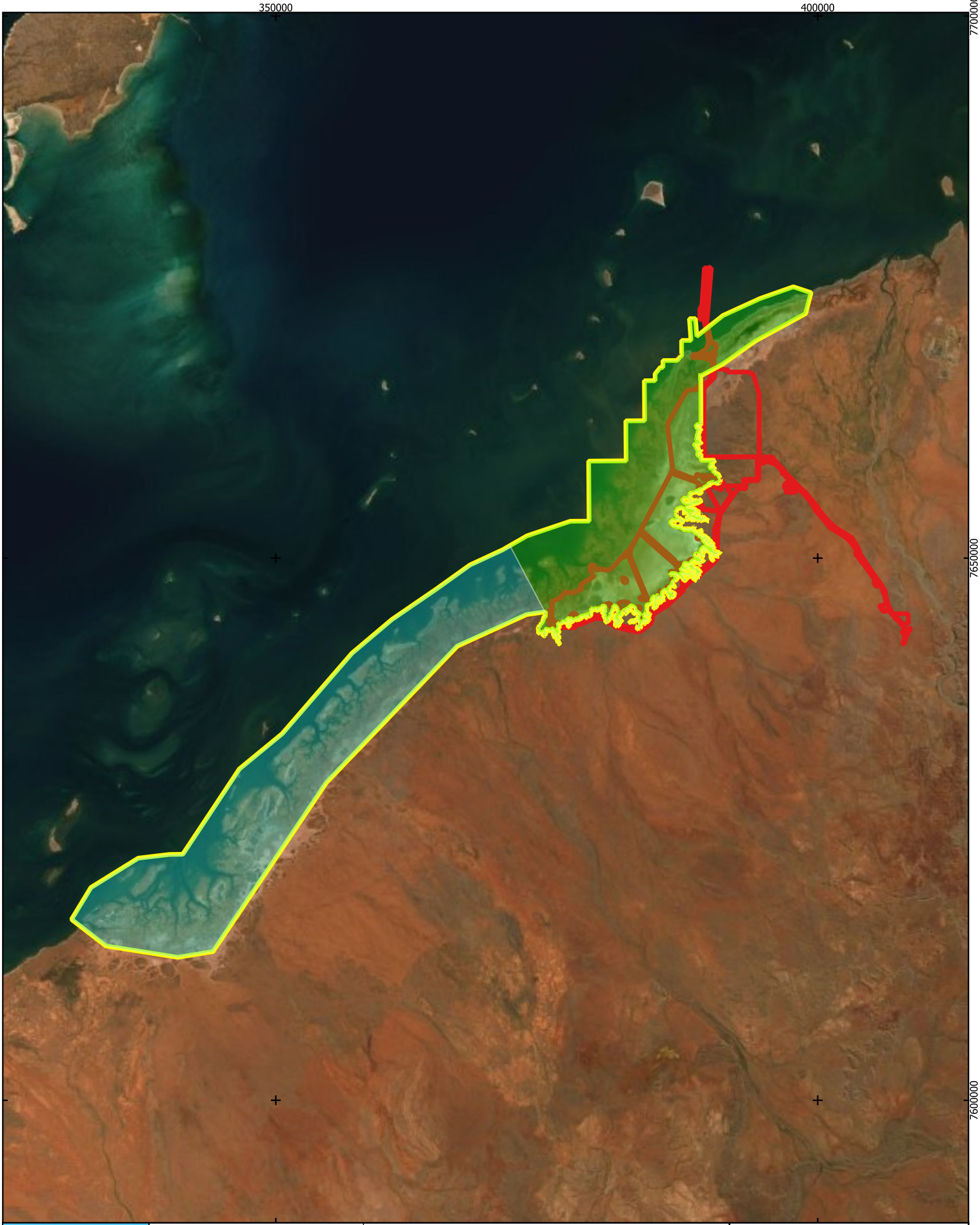
1.1 BASELINE SURVEYS

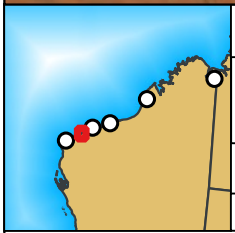
Phoenix undertook a desktop study and site reconnaissance to inform the Pre-Feasibility Study (PFS) for the Project in 2017 (Phoenix 2017). The key findings of the desktop study and site reconnaissance with respect to migratory shorebirds was that migratory shorebirds are certain to occur and therefore needed to be assessed in terms of individual and collective numbers with respect to Important Bird Areas (IBA's) and East Asian-Australasian Flyway (EAAF) population criteria.

Based on the desktop and reconnaissance findings, as well as the requirements of the Project Environmental Scoping Document (ESD) (BCI Minerals & Preston Consulting 2018) Phoenix undertook a targeted Level 2 survey for vertebrate fauna, including migratory shorebirds. The surveys took place over the period 2017-2019 (Phoenix 2020), with the local shorebird surveys occurring over the summer of 2018-2019 and winter 2019.

The shorebird sampling took place within the Migratory Shorebird Study Area (MSSA) associated with the coast and coastal habitats (Map 1-1). The sampling comprised of a 'local program' and a 'regional program' where the local program was adjacent to the Project Development Envelope (DE) and the regional program was south of the DE within the MSSA (Map 1-1). Similar habitats were sampled in the local and regional programs; these habitats (described in (Phoenix 2020) (Figure 1-1)) included;

- samphire wetland
- coastal mudflat and sandbar
- mangal forest stand
- mangal forest fringing tidal creeks
- non-vegetated inland mudflat, and
- beach.





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Project No	1189.MSP.BCI
Date	22-Sep-2021
Drawn by	Floyd Holmes
Map author	Phoenix Env. Sci.

0 4 8 12 km

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Legend

Phoenix spatial data

Polygons

- Migratory Shorebird Study Area (MSSA)
- Development Envelope (DE)
- MSSA 'Local Program'
- MSSA 'Regional Program'

Map 1-1

Migratory shorebird baseline study area (Phoenix 2020)

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a) Samphire wetland

b) Coastal mudflat and sandbar

c) Mangal forest stand

d) Mangal forest fringing tidal creeks

e) Non-vegetated inland mudflat

f) Beach

Figure 1-1 Typical migratory shorebird habitats in the area

1.2 BASELINE SURVEY RESULTS

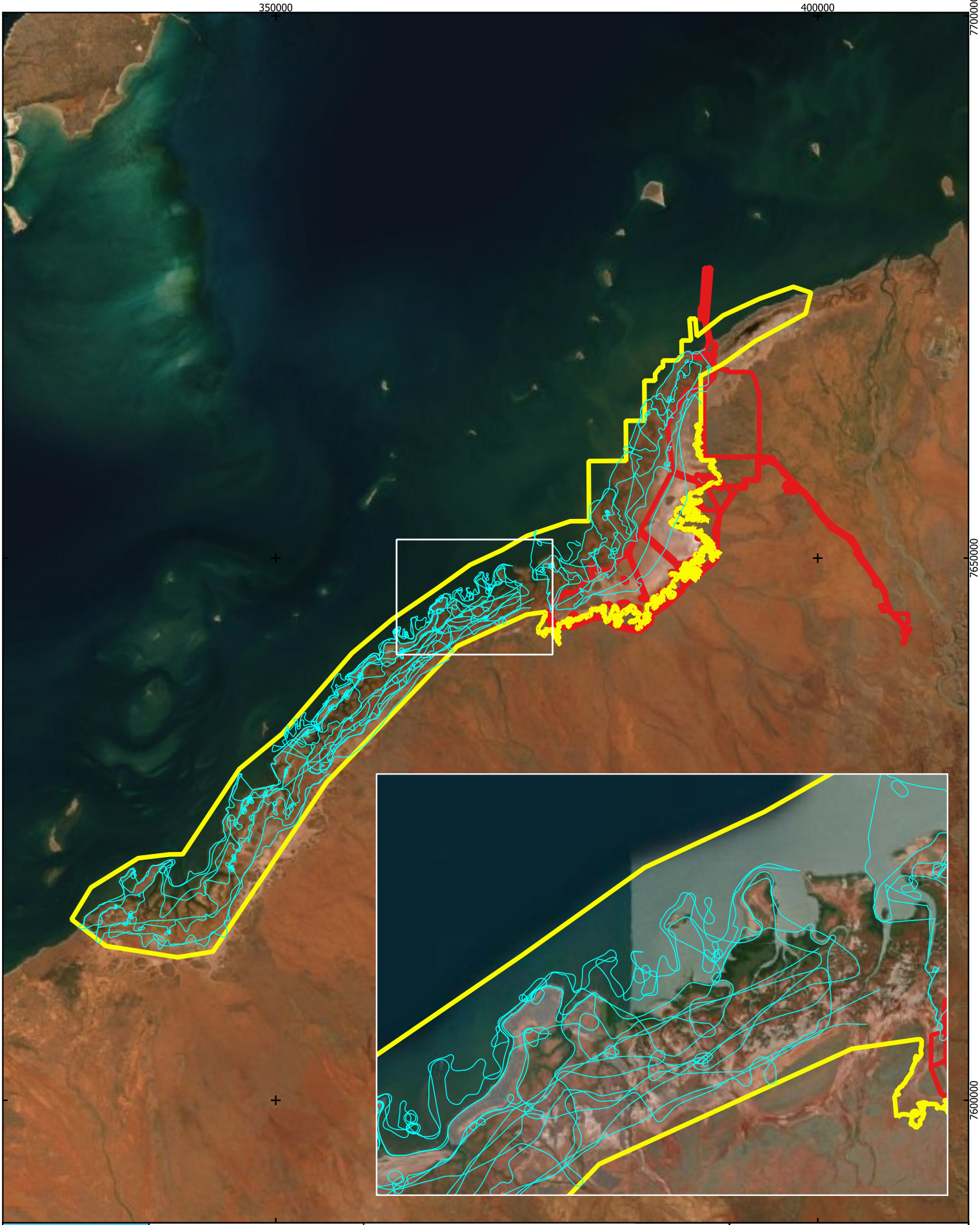
Phoenix completed the baseline migratory shorebird surveys over four phases. These surveys were conducted aerially with the use of a helicopter. The dates those phases were carried out over are presented in Table 1-1, and the flightpath transects for one phase of the survey as an example of the coverage achieved by each phase are presented in Map 1-2.

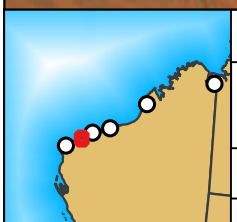
The highest numbers of migratory shorebirds were recorded during Phases 2 and Phase 4 which occurred during January and February. A total of 20 of the 37 species listed under EPBC Act Policy Statement 3.21 (DoEE 2017) were recorded during the surveys, 19 of which were also recorded exclusively in the local program (see Map 1-1). All 20 species were recorded in the summer sample events, and 18 were recorded overwintering; no species were confined to the overwintering survey (Phase 3).

The highest densities of birds were detected along the coast directly to the west of the DE and at the southern extent of the MSSA. Full details of the baseline survey results and extrapolations of populations across the survey areas is provided in the final survey report (Phoenix 2020).

Table 1-1 Baseline survey details and results

Phase	Survey Dates	Number of replicates	Median number of migratory shorebirds recorded	Total number of migratory shorebird species s
Phase 1	5-7/12/2017	6	322	18
Phase 2	13-15/01/2018	6	737	17
Phase 3	24-26/07/2018	10	436	18
Phase 4	21-25/02/2019	4	731	20





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Legend

- Migratory Shorebird Study Area (MSSA)
- Development Envelope (DE)
- HelicopterTracks

Map 1-2

Example flightpaths from baseline surveys

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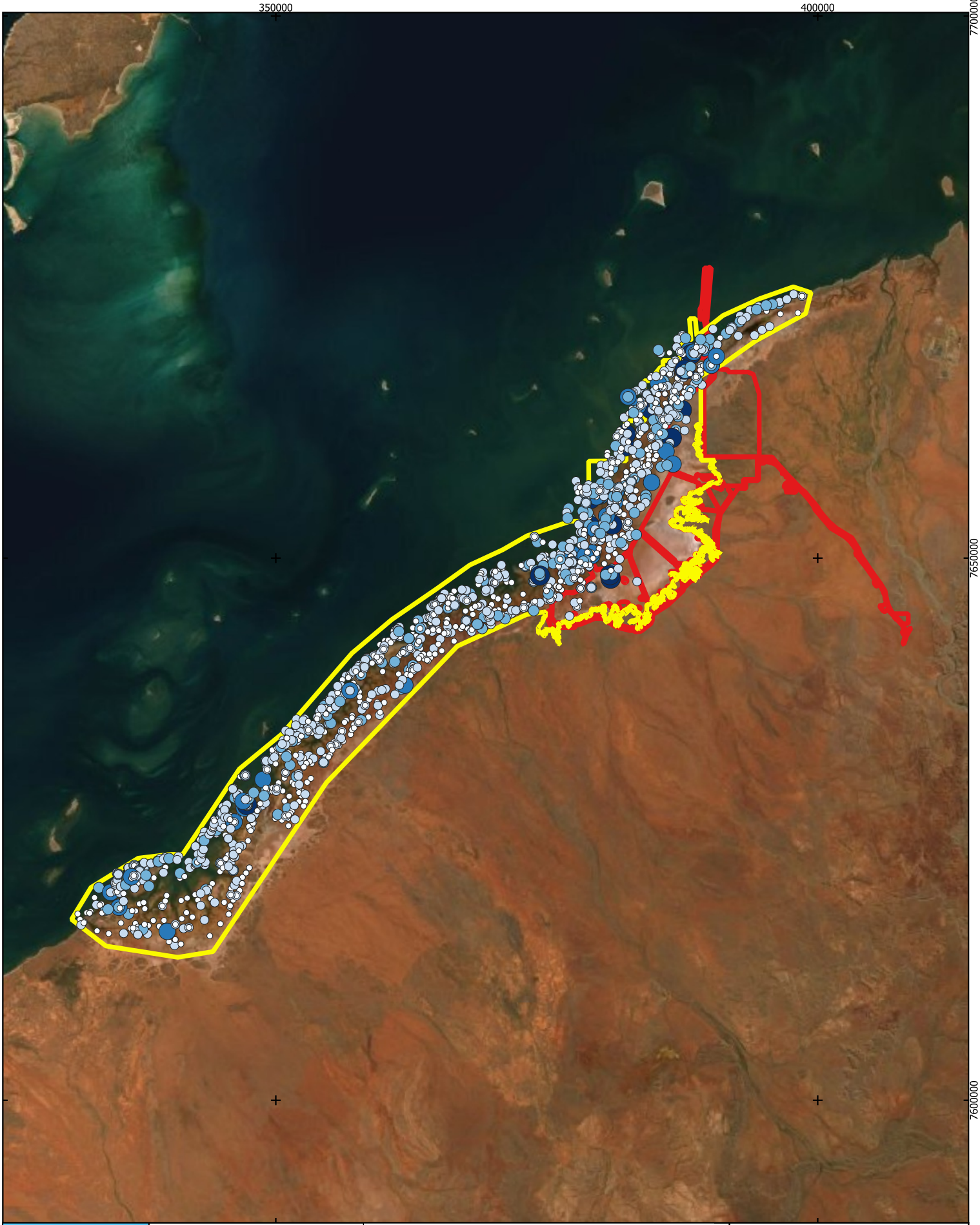

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Legend

- Migratory Shorebird Study Area (MSSA)
- Development Envelope (DE)

Migratory shorebirds (No. individuals recorded)

- 1 - 1
- 1 - 10
- 10 - 50
- 50 - 100
- 100 - 300

Map 1-3

Location of all migratory shorebird records from baseline surveys

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1.3 SIGNIFICANCE OF THE MARDIE AREA TO MIGRATORY SHOREBIRDS

The EPBC Act provides protection for 105 Migratory species (not including sub-species) listed under numerous international agreements that Australia is a signatory to (section 2.1). Of these, 37 Migratory shorebird species (Table 3-3) are given special consideration through the *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed Migratory shorebird species* (DoEE 2017).

Australia is geographically and ecologically an important location for Migratory shorebirds within the EAAF ('the flyway'). A total of 36 of the 37 Australian Migratory shorebird species breed in the northern hemisphere and migrate annually to southern non-breeding areas including Australia. Double-banded plovers migrate between Australia and breeding grounds in New Zealand, rather than north–south through the flyway. The flyway stretches from Siberia and Alaska, southwards through east and south-east Asia, to Australia and New Zealand.

Under the EPBC Act, 'important habitat' is a key concept for Migratory species (DoEE 2013; 2017). Important habitats in Australia for Migratory shorebirds under the EPBC Act include those recognised as nationally or internationally important. The accepted and applied approach to identifying internationally important shorebird habitat has been through the use of criteria adopted under the Ramsar Convention on Wetlands (DoEE 2017).

According to that approach:

1. Internationally important habitat regularly supports
    a. 1% of the individuals in a population of one species or sub-species of waterbird or
    b. a total abundance of at least 20,000 waterbirds
2. Nationally important habitat regularly supports:
    a. 0.1% of the flyway population of a single species of Migratory shorebird or
    b. a total abundance of at least 2,000 Migratory shorebirds or
    c. at least 15 Migratory shorebird species.

The MSSA met the criteria for 1a, 2a, 2b and 2c. Within the regional program area, the area is likely to also meet criteria 1b. The Level 2 migratory shorebird survey recorded 20 of the 37 species listed under *EPBC Act Policy Statement 3.21* (DoEE 2017) and therefore the MSSA meets the diversity criterion for 'nationally important shorebird habitat' as it supports at least 15 migratory shorebird species (during the summer months) (Phoenix 2020).

The results indicated the MSSA is likely to regularly support at least 2,000 birds and therefore is likely to meet the threshold criterion of 'total abundance of at least 2,000 Migratory shorebirds' for nationally significant shorebird habitat.

Six species were recorded in nationally significant numbers (i.e. >0.1% of the EAAF population estimates) in any one sample event:

- Bar-tailed Godwit
- Eastern Curlew (CR)
- Grey-tailed Tattler (P4)
- Ruddy Turnstone
- Sanderling
- Whimbrel.

Accordingly, the MSSA appears to meet the individual species abundance criterion for nationally important habitat, i.e. regularly supports >0.1% of the flyway population of a single species of

Migratory shorebird. An additional eight species (Common Greenshank, Curlew Sandpiper (CR), Greater Sand Plover (VU), Oriental Plover, Pacific Golden Plover, Red Knot (EN), Red-necked Stint and Terek Sandpiper) were deemed to be likely to also occur in nationally significant numbers in the MSSA.

Based on extrapolated data, a further three species are likely to occur in internationally significant numbers (i.e. >1% of the EAAF population) in the MSSA – Grey-tailed Tattler (P4), Ruddy Turnstone and Whimbrel (all of which were evenly distributed across the MSSA).

2 SCOPE OF WORK

The scope of work for the Mardie Salt Project: Migratory Bird Monitoring Program is to develop and implement a long-term migratory shorebird monitoring program that principally aims to:

1. monitor and track any changes in the migratory shorebird population at the impact sites (inside and adjacent to the development footprint), as well as at both the control and regional sites (described in 2.1).
2. determine whether the trends in number of migratory species detected each year at the impact sites are consistent with those at the control and regional sites.
3. record any threats to shorebirds in impact and control areas (e.g. feral or native predators, human influences).
4. in the event that there is:
    a. a decline in numbers of any migratory bird species is detected, or
    b. an increase in threats to migratory birds, such as presence of predators or human influences.

   Then additional works will be actioned to identify the threatening process and reverse or mitigate the declines or threatening processes. This will require an adaptive management approach, as the nature of the disturbance will need to be identified before a management plan can be implemented.

2.1 STUDY AREA

The three study areas are defined as follows Map 2-1;

- Impact Area (IA) – areas inside and adjacent to the DE. These areas include the evaporation ponds and the trestle jetty, and are a maximum of 5 km from the DE
- Control Area (CA) – areas to the southwest of the impact areas away from the development envelope that are of similar habitat to those found in the IA. These sites fall within a distance of 10 km to 40 km from the DE
- Regional Area (RA) – areas within the Pilbara of similar habitat that are more than 40 km from the DE

2.2 METHODS

2.2.1 Overview

Accurately measuring changes in migratory shorebird communities between years is a complicated task. The methods outlined below were developed in consultation with BirdLife Australia with consideration for the following factors:

- tidal variation – birds use different habitats at different times of day in accordance with the tides
- seasonality – number of birds present varies dramatically throughout the year
- annual variability – number of birds varies between years depending on weather events and other factors, including international events and development
- remote/difficult to access areas – birds occur in areas with poor access and use a range of habitats where they can be difficult to observe
- detectability – many migratory species can be difficult to identify/detect.

The goal of the methods outlined below is to provide a robust, spatially explicit dataset that will show whether a change in the migratory shorebird population occurs inside the IA, and identify whether that change is attributable to the developments associated with the Project. Consideration has been made to assess changes in the numbers of migratory shorebird species at the local scale (comparing trends involving the IA and CA), the regional scale (trends involving the CA and RA) and national scale (trends involved in national count data collated by Birdlife Australia (Birdata). If a decline measured at the IA is greater than the trend measured at the CA, or RA, then it will be considered a decline attributable to the Project and the threatening process will need to be identified and managed. If declines measured at the IA are less than those measured at the CA or RA, then they will be considered a reflection of changes in the migratory bird species populations caused by factors other than the Project.

The monitoring program incorporates both aerial (helicopter) and ground based bird counts (Table 2-1). Aerial surveys were used in the baseline survey as they provide the greatest area of cover and can be used to survey a range of habitat types that are otherwise inaccessible. Ground surveys are a cost-effective way of providing additional data at key sites and can also provide a more accurate count of species that occur in mixed flocks of birds that can be difficult to accurately identify.

By using a combination of the two survey methods, and surveying at various spatial scales, it will be possible to assess whether the diversity and number of birds at the IA is increasing, decreasing, or static. In the event that a change is detected, the annual habitat monitoring assessments (BCI and Phoenix 2021) and finer scale location data will be useful in identifying the cause(s). These methods were developed using the baseline data (Phoenix 2020), the *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (DoEE 2017), and consultation with Dr. J. Ringma, the WA shorebird project coordinator at Birdlife Australia.

2.2.2 Aerial surveys

The baseline surveys for the Project that Phoenix completed between 2017-2020 all used an aerial survey technique. Aerial surveys, using a helicopter, are the recommended method for surveying migratory shorebirds in large remote regions where access is a limiting factor (DoEE 2017). Aerial surveys provide a cost effective and efficient method for sampling large numbers of birds quickly (Kingsford *et al.* 2020). The survey method used for the monitoring program will be a modified version of the method used during the baseline survey. Adjustments were made to maximise the repeatability of the survey between years, which will aid in the statistical analysis of changes in migratory shorebird occurrence at the IA and CA.

A series of 15 transects across the MSSA have been selected to be sampled systematically each year. The transects are made up of 1x10 grids that are 500 m by 500 m squares. Sites were placed so that six are located in the IA and nine are in the CA. The transects are aligned along paths flown during the baseline surveys and thus target the range of potential shorebird habitats, taking into account the habitat-tidal sequence, rom ocean mud/sand flats, through beaches, mangrove stands, samphire wetlands and finally bare mudflats that are barely inundated at the limit of the tide.

Each transect will be surveyed systematically by flying slowly at a low height through the middle of the grid, and recording all birds observed. A team of two people will be used to complete these surveys with at least one member being an ornithologist with experience conducting aerial surveys of shorebirds. These surveys will be repeated at both high and low tide over four consecutive days in late January or early February when shorebird numbers are at their highest.

2.2.3 Ground-surveys

The baseline surveys recorded 6.94% of the total number of migratory shorebirds birds recorded in the MSSA inside the DE, despite the DE being 32% of the size of the MSSA. This is largely due to the habitat inside the DE being less suitable habitat than the adjacent tidal areas where most of the birds were detected.

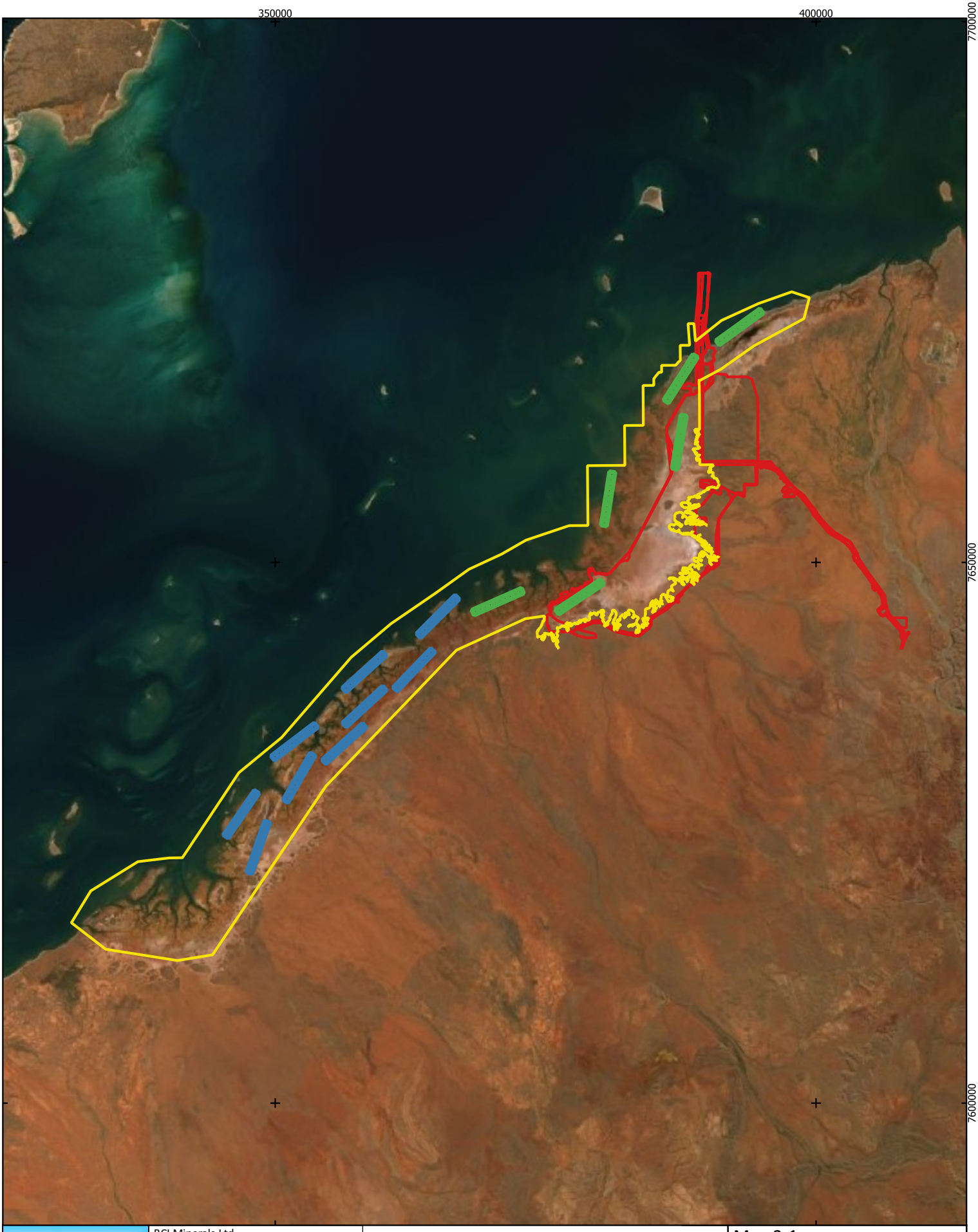
The purpose of the ground-surveys at the ponds is to provide information on any changes to habitat use by migratory birds in response to the development. Numerous studies have shown that salt works such as this one along the north western and north eastern coasts can provide suitable foraging habitat for migratory shorebirds (e.g. (Storr 1984), (Clemens *et al.* 2009), (Bennelongia 2011), (Houston *et al.* 2012), (Bertzeletos *et al.* 2012),(Estrella *et al.* 2016) As such, it is likely that the first few stages of the evaporation ponds will see an increase in usage once the development has been completed. This may result in an apparent decline in some species in the surrounding area, as they move into the newly created foraging habitat. To account for this, the birds inside the areas expected to see the greatest increase in numbers will be monitored.

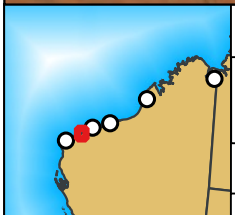
Systematic counts across the first two evaporation ponds will be carried out by the same team that complete the aerial surveys, and either during the days leading up to or after the aerial surveys have been completed. This survey will be done using a car to move around the site and with a spotting scope to locate and identify birds. These counts will only be done once at high tide and once at low tide as tidal variation in the surrounding area will likely influence the birds. While completing these surveys, any evidence of predation pressure from cats and/or dogs or disturbances caused by humans will also be recorded.

Additional ground-based surveys may also be completed around Karratha, approximately 100 km east of the DE, to provide regional data to be used to calibrate for annual variation in migratory shorebird numbers. Alternatively, a data-sharing agreement may be made with other salt projects in the region that can be used to provide regional context for annual variation in migratory shorebird numbers.

Table 2-1 Summary of long-term monitoring program coverage

Method	Location	No. of replicates	Total area of coverage (ha)
Aerial Survey	Impact Area	6	1500
	Control Area	9	2250
Ground Survey	Evaporation ponds 1 and 2	1	2953
	Total	**16**	**9**





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Legend

- Migratory Shorebird Study Area (MSSA)
- Development Envelope (DE)

Aerial transects

- Control Sites
- Impact Sites

Map 2-1

Aerial survey transects

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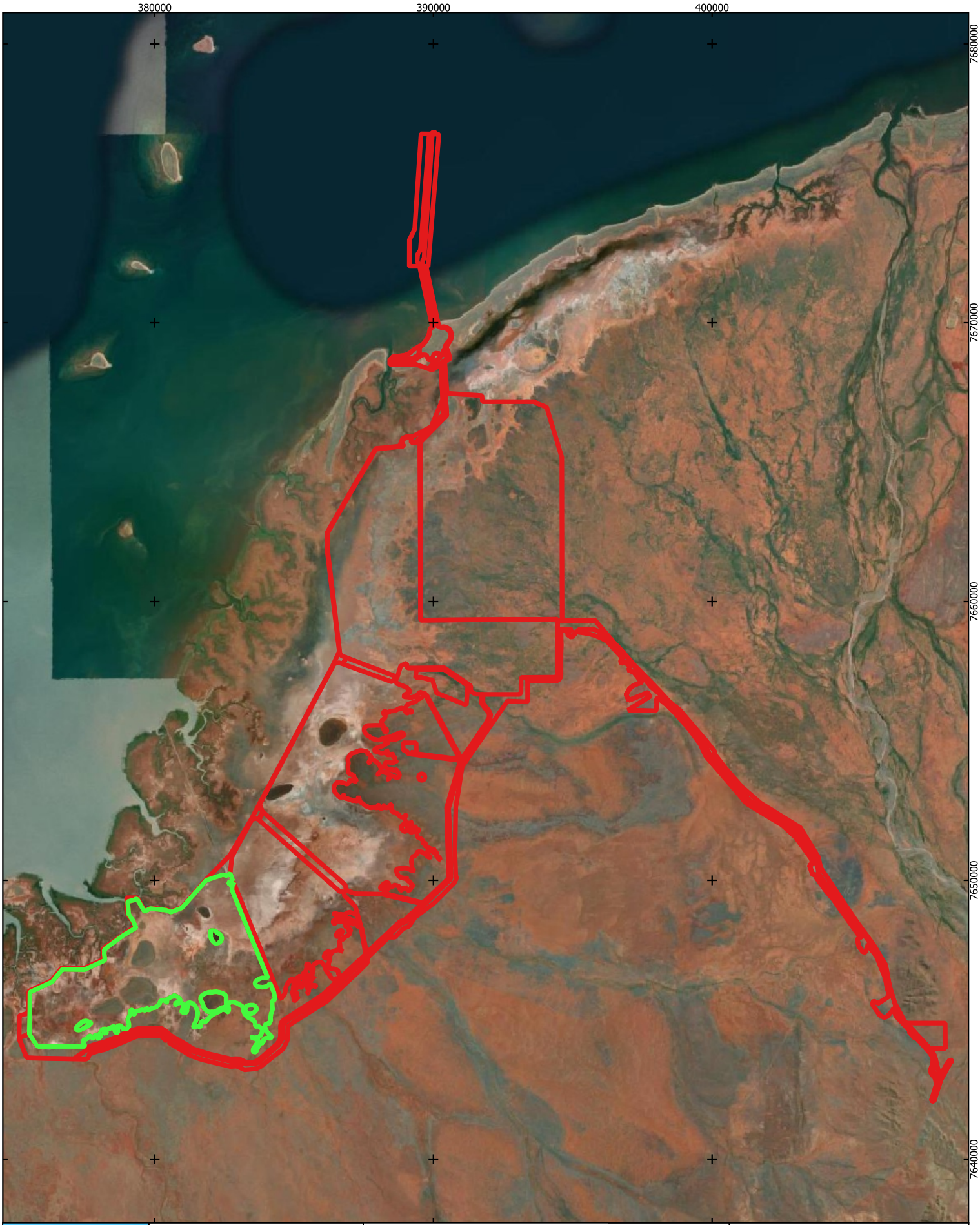

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Map author	Phoenix Env. Sci.

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Legend

- Evaporation ponds 1 and 2
- Development Envelope (DE) with indicative disturbance

Map 2-2

Ground survey site (evaporation ponds 1 and 2)

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2.2.4 Data analysis

Changes in the migratory shorebird population over time will be estimated using General Linear Modelling techniques. Model type and fit will be assessed for each species with specific model formats used for each taxon to best fit population trends, for example, logistic regressions for species undergoing regional decline or zero inflated models for species only encountered periodically. By modelling populations, we can better estimate how improbable unusually high or low counts are with respect to previous counts which allows for greater confidence when accounting for the high level of variability expected between counts.

For any species where data is insufficient (encounter rates too low), suitable surrogate species will be selected. This will be done by pairing up rare and common birds of similar size that occupy similar habitats and employ similar feeding methods. The trend of the commonly detected bird can be considered a surrogate indication for the rarely detected bird. An example of this is the Godwits. Only One Black-tailed Godwit was encountered during the four baseline phases, but almost 4400 Bar-tailed Godwits were recorded. As such, the trend of the Bar-tailed Godwit will be used to assess the trend for the Black-tailed Godwit.

Data will need to be collected annually; however, it will take some time before a trend can be determined with any confidence as the number of birds is likely to continue to fluctuate. We are anticipating that it will take at least five years before we can begin to properly evaluate whether a change is occurring. The longer the monitoring program runs, the greater our confidence in the data will become. However, habitat monitoring of Mangrove, Tecticornia/samphire shrublands and algal mat communities conducted annually will provide an 'early warning system' regarding habitat changes that would be expected to impact shorebird usage.

Maximum count was used for the analysis of baseline data in the Phoenix 2020 report as it is used a as a measure of the importance of the area, however, it is more susceptible to outliers which is problematic for monitoring over longer time frames. Hence, we will be moving to a modelled average (using general linear modelling) as it is a better measure of trend.

Shorebird populations are under a state of decline due to numerous threats throughout the flyway. Hence, populations trends at the assessment site may be affected by external influences, potentially misrepresenting the impacts of at a local scale due to flyway wide declines or vice versa. In order to distinguish between site level and flyway levels changes in population, monitoring must take place at both a local scale (between IA and CA) and at the regional scale. Regional data will consist of annual counts during the same time period at 3-5 sites (using either data collected at Karratha by the Phoenix team or data from Rio Tinto Karratha saltworks and Port Hedland, assuming we can organise a data sharing agreement). We will also factor in global changes in the population size in the event that a change in the total population size of the flyway occurs. By comparing trends at the local scale to the larger scales it will be possible to gauge whether any changes are attributable to the Project.

The baseline data (Phoenix 2020) will be incorporated into the model as the sites selected for the aerial surveys all intersect helicopter transect lines. The detection rate of species across the whole of the MSSA and the proposed transect sites are displayed in Table 2-2. For species with a low chance of being suitable for trend analysis, surrogate species may provide an indication of whether a change is likely to have occurred.

An example generalised logistical model fitted to changes in numbers of a shorebird species (Curlew Sandpiper) in a different region (Rottnest Island) is presented in Figure 2-1. The blue dots depict individual counts, the redline is the averaged trend, and the pinkish fill is one standard deviation from the mean. Similar trends will be generated for all species where sufficient data is available for this monitoring program.

Table 2-2 Detection rates of species during baseline surveys inside the MSSA and proposed transects

Species	Detection rate over whole MSSA (%)	Detection rate over proposed transects (%)	Likelihood to be suitable for trend analysis
Bar-tailed Godwit	92	38	High
Black-tailed Godwit	4	0	Low
Common Greenshank	100	58	High
Common Sandpiper	85	35	High
Curlew Sandpiper	23	4	Low
Eastern Curlew	88	38	High
Great Knot	23	4	Low
Greater Sand Plover	58	8	Medium
Grey Plover	15	0	Low
Grey-tailed Tattler	100	54	High
Lesser Sand Plover	12	0	Low
Oriental Plover	31	12	Medium
Oriental Pratincole	27	8	Medium
Pacific Golden Plover	19	0	Low
Red Knot	38	4	Low
Red-necked Stint	96	42	High
Ruddy Turnstone	81	38	High
Sanderling	15	4	Low
Terek Sandpiper	73	19	Medium
Whimbrel	88	65	High

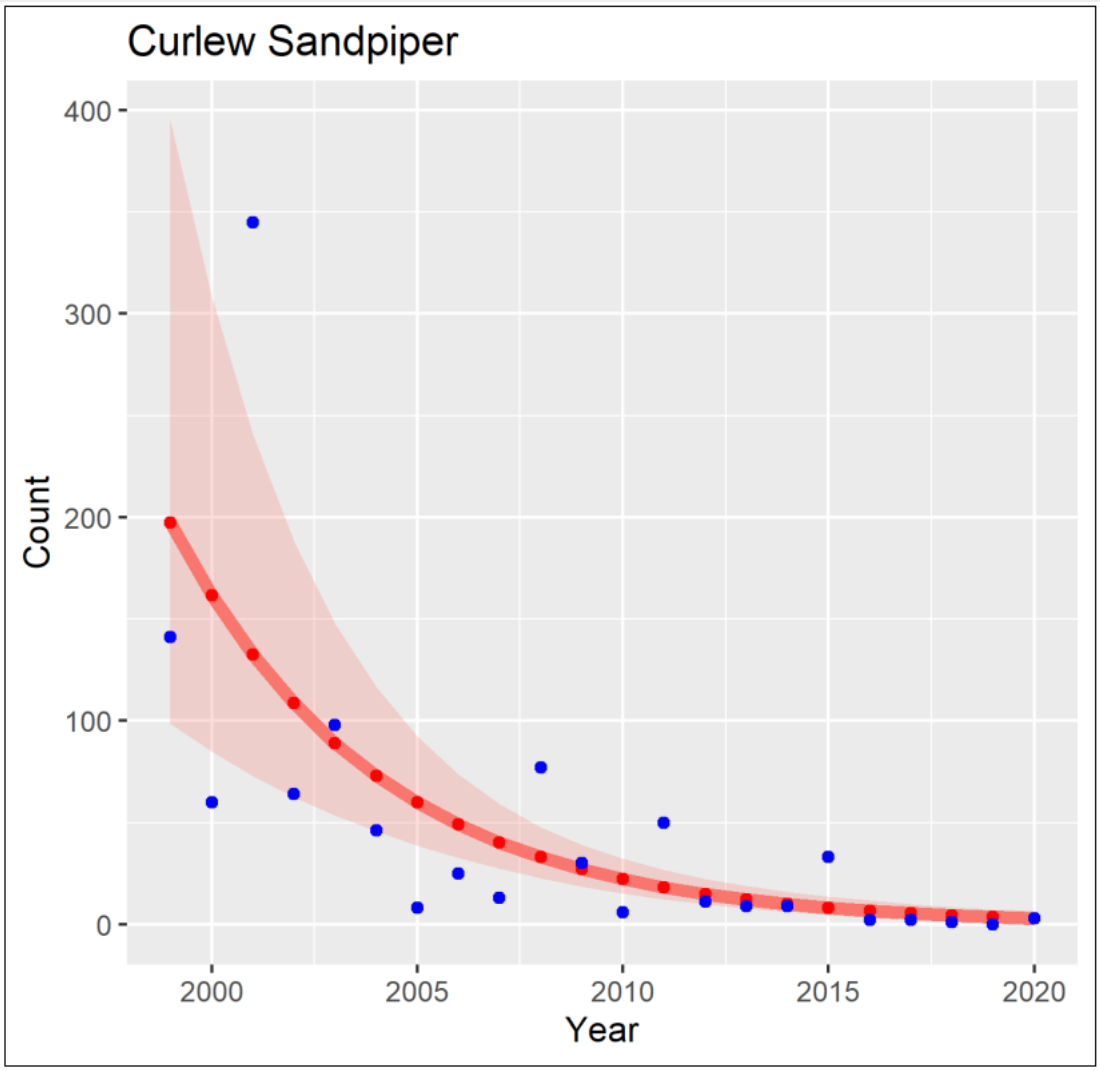

Figure 2-1 **Example generalised logistic model fitted to changes in Curlew Sandpiper numbers from Rottnest Island.**

2.3 REVIEW AND REPORTING

The results of the long-term migratory shorebird monitoring program will be reviewed every five years by a consultant with suitable expertise in migratory shorebirds. This review will also consider the program efficacy and recommend changes, if suitable.

3 UTILISATION OF RESULTS

In addition to making results available to DAWE, DBCA, the Birdlife Shorebird2020 program, and any other relevant community stakeholders, Mardie Minerals will use the outputs of the long-term monitoring program to:

- compare to the outputs of the Mardie Benthic Communities & Habitats Monitoring and Management Plan
- inform regular reviews of its environmental risk profile, specifically in relation to migratory shorebirds, and adjust if necessary
- initiate specific research if declining utilisation of the area by migratory shorebirds is observed
- review its operational and environmental management controls relevant to migratory shorebirds, if necessary.

The long-term monitoring program will also provide valuable information for closure planning, ensuring that closure impacts to migratory shorebirds are minimised.

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