Environmental Approval & Compliance Solutions

Shorebird Monitoring Study for the Townsville Port Expansion Project October 2020 to February 2021

Port of Townsville Limited

Document Control Summary

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Report Summary	
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Abstract	Port of Townsville Limited (Port) has commenced Stage 1 of the Port of Townsville Expansion Project (PEP). This report presents the results of the second annual shorebird monitoring study conducted coincidental with the construction phase of Stage 1 of the PEP. The monitoring study is a requirement of the PEP Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 approval.

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1. Introduction

On 5 February 2018, Port of Townsville Limited (Port) received approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) for the Townsville Port Expansion Project (PEP). Condition 12 of the EPBC Act approval (EPBC 2011/5979) requires the implementation of '*a program to monitor the potential impacts to shorebirds before and during construction activities in the marine environment*'. In response to this requirement, Port has developed and commenced a Shorebird Monitoring Program to achieve the following objectives.

- **Objective One**: develop a Shorebird Monitoring Program to monitor potential impacts to shorebirds before and during construction activities.
- **Objective Two**: conduct a survey of shorebirds in the PEP area and on the nearby Ross River sand spit prior to construction to identify and record the abundance of each bird species.
- **Objective Three**: monitor and report on changes to shorebird roosting and foraging, beyond natural spatial and temporal variation, during the project construction activities in the marine environment, to identify any impacts from the project on shorebirds.
- **Objective Four**: provide recommendations on key areas of actual impact and potential mitigation measures should impacts be detected.
- **Objective Five**: contribute to improving public awareness on local avifauna biodiversity and species richness in the vicinity of the project area.

A shorebird survey was completed in early 2019 (NRA 2019) prior to construction works, fulfilling Objectives One and Two. Pre-construction works for Stage 1 of the PEP, the Channel Upgrade (CU) project, commenced soon after the completion of the NRA (2019) study. NRA (2020a) documented the results of the first annual monitoring event coincident with the CU project. The CU project involves the following works (locations as per mapping in **Appendix A**):

- supply and haulage of marine-grade armour rock required for rock walls and revetments
- creation of a new reclamation area (approximately 62 ha), via the construction of rock walls and revetments, to receive capital dredge material from channel widening works
- capital dredging to widen the Platypus Channel
- capital dredging to widen the Sea Channel.

1.1 Scope

NRA Environmental Consultants (NRA) was commissioned by Port to continue works to address Objectives Three and Four. The Shorebird Monitoring Program will operate for the duration of construction, which is estimated as three years. The scope relevant to the 2020/21 monitoring season is as follows.

- Five shorebird monitoring events will be implemented.
  - Surveys will nominally occur once per month between October 2020 and February 2021 (the period of peak shorebird abundance at the site).
  - The surveys will be designed to permit comparison with previous work (NRA 2012, 2019, 2020a), be repeatable during and following construction, and address the PEP EPBC Act approval requirement for monitoring.
- Annual reporting following the shorebird monitoring surveys will:
  - describe study context, scope and methods

- describe shorebird habitat within the study area
- describe shorebird species composition (*ie* a species list) present in the study area
- identify shorebird species listed as Endangered, Vulnerable, Near Threatened and/or Migratory under the EPBC Act and/or the Queensland *Nature Conservation Act* 1992 (NC Act) occurring in the study area, and their abundance
- assess the significance of observed species, abundances and habitats with reference to EPBC Act policy
- compare the results of surveys before (NRA 2019) and during CU project construction activities (NRA 2020a), and previous surveys reported in NRA (2012), noting any changes in the significance of identified values to shorebirds and potential CU project-related impacts
- include recommendations if any adverse impacts to shorebirds are detected.

The study area will, to the extent that is practical given safety and logistical matters associated with the CU project, replicate that assessed by NRA (2012, 2019, 2020a) and will comprise:

- Port of Townsville land (PoT):
  - Eastern Reclaim Area between the Marine Precinct and the proposed reclamation area
  - the vacant area of the Marine Precinct (southern area)
  - rock walls along the Eastern Reclaim Area and Marine Precinct
  - intertidal area between the Marine Precinct and Benwell Road (an undeveloped section of Lot 773 on SP223346)
- sand spit area at the mouth of Ross River (**Figure 1**).

1.2 Terms

Shorebirds, also known as waders, refer to a subset of bird families, notably Charadriidae (*eg* plovers and dotterels) and Scolopacidae (*eg* curlews, godwits and sandpipers), belonging to the order Charadriiformes. These birds commonly feed by wading in shallow water or saturated substrate along the shores of lakes, rivers and the sea (Geering *et al*. 2007). They include a large group of species that migrates annually along the East Asian-Australasian flyway (EAA flyway) between Australia and areas as far north as the Arctic Circle, and a smaller group of species that permanently resides in Australia. Many of these migratory and resident species are listed as Migratory under the EPBC Act.

Shorebirds often share their habitats with a range of other waterbirds, notably seabirds of the family Laridae (terns and gulls) and various wetland species in the families Accipitridae (kites, osprey and sea eagle), Ardeidae (herons and egrets), Threskiornithidae (spoonbills and ibis) and Anatidae (ducks, geese and swans). Some species in the Laridae family are listed as Migratory under the EPBC Act. The coastal Migratory seabird populations around Townsville undertake seasonal movements, sometimes into and out of the region, though most do not undertake transcontinental migrations.

Some of the above bird species are listed as Threatened under the EPBC Act and NC Act. Threatened species categories under the EPBC Act comprise Critically Endangered, Endangered or Vulnerable. Under the NC Act, Threatened is limited to the Endangered or Vulnerable categories. Migratory species under the EPBC Act that are not Threatened are recognised as Special Least Concern under the NC Act.

Figure 1: Shorebird monitoring study area

Project: Shorebird Monitoring Study for the Townsville Port Expansion Project October 2020 to February 2021

- CU project reclamation area
- Lot 773 on plan SP223346
- Rock wall
- Eastern reclamation area
- Marine precinct
- Ross River mouth sand spit
- Intertidal flats

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Kilometres

Source:
Google Earth, Port of Townsville Limited

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2. Background

2.1 Study area

The PEP area occurs near the mouth of Ross River in Townsville (**Figure 1**). The Ross River mouth area contains terrestrial, intertidal and inshore marine habitats that are used by a diverse range of bird species. Of particular significance in this area is the sand spit near the river mouth and intertidal banks (or flats) that extend from the river mouth south-east along Cleveland Bay. The intertidal areas and sand spit provide ideal foraging and roosting habitat for a variety of shorebirds and other waterbirds. Previous studies have found that the area supports Migratory shorebird populations that are of national and international significance with respect to species richness and abundance (NRA 2005, 2008, 2012, 2019, 2020a, 2020b, Driscoll 2009), with the majority of this population being transient. While the sand spit is outside the PEP area, it plays an important role in the dynamics of the local shorebird population; therefore, it is included in the study area.

PoT is on the northern bank of the Ross River mouth. The developed areas are predominantly built on reclaimed land and contain administration buildings, ship loading facilities, and storage facilities. PoT also contains recently reclaimed areas (currently undeveloped) where future development is planned. Areas undergoing land reclamation transition from aquatic to terrestrial environments. The process is gradual, and during the latter stages, the reclamation areas resemble wetland habitats. NRA (2012) recorded Migratory shorebirds foraging in, and roosting on, sections of reclaimed land; certain species were sometimes present in nationally significant numbers. As the land reclamation progresses, the way in which Migratory shorebirds use these areas is changing (NRA 2020a).

The PoT's northern and eastern boundaries are protected by constructed rock walls. The seaward edge of the rock walls is subject to tidal inundation and spray from wave action. The wet and dry cycles experienced along the seaward edge vary with tides, sea state and rainfall. These conditions are favourable for many species of mollusc and crustacean, which are a food source for a variety of waterbirds. Rock walls may be used by waterbirds as perches for hunting, feeding and resting. These man-made structures provide similar habitats to naturally occurring rocky headlands and foreshores, such as those found nearby at Kissing Point and Magnetic Island (approximately 4 km and 8 km from the study area respectively). NRA (2012, 2019, 2020a) recorded small numbers of Migratory shorebirds around the Marine Precinct rock walls, but very little bird activity around the Eastern Reclamation Area rock walls.

2.2 General bird use patterns of the Ross River mouth and surrounds

Based on work by NRA (2005, 2008, 2012, 2019, 2020a, 2020b) and Driscoll (2009), during high tide, most shorebirds and seabirds from the local population and various other waterbirds move to the sand spit in the Ross River mouth to roost. This site is an ideal roost because it is near suitable foraging habitat, provides unobstructed visibility of potential predators and is relatively isolated from the mainland at high tide. Isolation at high tide is important because it affords roosting birds a degree of protection from land-based predators and human disturbance. Such areas are uncommon along the Queensland coastline and very uncommon in the Townsville region. Driscoll (1997, 2009) assessed the Ross River site as being the most significant in the region and ranking within the top 40 sites for shorebirds along the east coast of Queensland.

As the tide recedes, the majority of shorebirds move off the sand spit to forage on the flats south-east of the river mouth (*ie* Cleveland Bay), notably the area near Sandfly Creek (approximately 2.3 km south-east of sand spit), with smaller numbers venturing farther south into Cleveland Bay or along the banks of Ross River (NRA 2005, 2008, 2011, 2012a–d, 2019, 2020a, 2020b, Driscoll 2009). The historical preference of shorebirds for the Sandfly Creek area could be related to the nutrient rich outfall from the Cleveland Bay Sewage Treatment Plant (Pell & Lawler 1996). The Sewage Treatment Plant was recently upgraded, and the impacts of the upgrade on this foraging area have not been reported.

Seabirds move off the sand spit to forage in the surrounding open water, though the timing of their movements relative to the tide is less defined (*cf* shorebirds). The exception is the Little Tern (*Sternula albifrons*; Migratory, EPBC Act), which breeds on the sand spit in spring and summer (NRA 2005, 2008, 2011, 2012a–d, 2019, 2020a, 2020b) and maintains a regular presence on the sand spit when caring for eggs or young.

While the majority of local Migratory shorebirds roost on the sand spit and forage on nearby intertidal banks, NRA (2012, 2019, 2020a) found that some birds from this population used habitats on PoT. This included 18 Migratory bird species and six Threatened (EPBC Act and/or NC Act) species[1]. Of the Migratory birds using PoT, the Lesser Sand Plover (*Charadrius mongolus*), Greater Sand Plover (*Charadrius leschenaultii*), Sharp-tailed Sandpiper (*Calidris acuminata*) and Red-necked Stint (*Calidris ruficollis*) were the most abundant and sometimes observed in nationally significant numbers[2].

Low levels of bird activity occur along and near the northern and eastern rock walls (*eg* breakwaters) around PoT. NRA (2012, 2019, 2020a) recorded small numbers of Grey-tailed Tattler (*Tringa brevipes*), Common Sandpiper (*Actitis hypoleucos*), Whimbrel (*Numenius phaeopus*)[3], Sooty Oystercatcher (*Haematopus fuliginosus*) and/or Striated Heron (*Butorides striata*) using these areas, particularly the rock walls around the Marine Precinct. The Migratory-listed Caspian Tern (*Hydroprogne caspia*), Crested Tern (*Thalasseus bergii*) and Little Tern occasionally forage in waters adjacent to the rock walls.

2.3 Assessing significance

Under the EPBC Act, 'important habitat' is a key concept for assessing the significance of an area to Migratory shorebirds (DoEE 2017). EPBC Act Policy Statement 3.21 '*Industry Guidelines for Avoiding, Assessing and Mitigating Impacts on EPBC Act Listed Migratory Shorebird Species*' (DoEE 2017) states that sites contain important habitat when they support 2,000 or more Migratory shorebirds, 15 or more Migratory shorebird species[4] or individual Migratory shorebird species abundance above thresholds for national significance. The threshold for national significance is 0.1% of the EAA flyway population for a given species. The most recent EAA flyway population estimates are available in Hansen *et al.* (2016). Sites supporting 20,000 or more shorebirds or ≥1% of the EAA flyway species population are considered to be of international significance.

[1] The legislative status for some species has changed since NRA (2012).

[2] Lesser Sand Plover and Greater Sand Plover are also Threatened species under the EPBC Act and/or NC Act.

[3] Grey-tailed Tattler, Common Sandpiper and Whimbrel are Migratory species under the EPBC Act.

[4] Referring to species richness.

2.4 Species status

The legislative status of some species under the EPBC Act and NC Act changed in the period between NRA (2012) and NRA (2019); these are documented in NRA (2019). No further changes in legislative status relevant to the monitoring program have occurred since NRA (2019). Species status is current as at 1 March 2021.

3. Methods

3.1 Overview

3.1.1 General methods

The surveys were conducted between October 2020 and February 2021 on the dates shown in **Table 1**. The survey period was primarily chosen because overall shorebird abundance in the Ross River mouth (*ie* sand spit and adjacent intertidal areas) is highest during spring and summer (Driscoll 2009, NRA 2020b). The survey area comprised developed (Marine Precinct, Eastern Reclamation Area and rock walls along the Marine Precinct and eastern side of the Eastern Reclamation Area) and undeveloped (intertidal area between the Marine Precinct and Benwell Road) sections of PoT, and the Ross River mouth sand spit (**Figures 1** and **2**).

The surveys were undertaken using binoculars (10 x 42) and, when necessary, a spotting scope (Swarovski ATS 65 mm).

Table 1: Survey dates, locations and corresponding tides during the 2020/21 CU project shorebird monitoring study

Date	Survey area[1]	Tide times	Tide height (m)
28 October 2020	Sand spit	0722 (high)	2.86
29 October 2020	PoT	0749 (high)	2.92
16 November 2020	Sand Spit	0945 (high)	3.63
16 November 2020	PoT	1628 (low)	1.10
17 November 2020	PoT	1037 (high)	3.50
10 December 2020	Sand spit	0558 (high)	2.86
11 December 2020	PoT	0640 (high)	3.19
27 January 2021	Sand spit	0836 (high)	3.49
27 January 2021	PoT	1506 (low)	1.42
29 January 2021	PoT	0939 (high)	3.66
9 February 2021	Sand spit	0800 (high)	3.78
9 February 2021	PoT	1440 (low)	1.07
10 February 2021	PoT	0834 (high)	3.86

[1] The PoT survey areas comprised developed sections (Marine Precinct, Eastern Reclamation Area and rock walls along the Marine Precinct and eastern side of the Eastern Reclamation Area) and undeveloped sections (intertidal area between the Marine Precinct and Benwell Road).
The sand spit extends east of the Ross River mouth.

3.1.2 Variation in methods

While the survey methods generally follow those previously implemented (NRA 2012, 2019, 2020a), the following variations occurred.

- **Survey timing**. The survey regime for the 2020/21 study covered a broader period than previous studies (spanning five months *cf* four months in previous studies). Consistent with previous surveys, this study involved monthly surveys at high tide; however, the number of low tide surveys differed: three surveys for this study, six surveys for NRA (2012), four surveys for NRA (2019) and two surveys for NRA (2020a). The accumulation of site-specific data has provided the opportunity to optimise the survey design and has contributed to the variations described above.
- **Rock wall count areas**. The NRA (2012, 2019) studies had nine fixed count areas along the rock wall (RW1 to RW9). Access to the northern-facing rock wall, and encompassing RW1 to RW5, was impractical during the NRA (2020a) study due to

construction works in the adjacent areas. This restriction extended to RW6 during the 2020/21 study. NRA (2012, 2019) reported very low levels of bird activity along the rock walls, including areas encompassing RW1 to RW6.

3.2 Port of Townsville land

Surveys within the PoT section of the study area involved formal bird counts at fixed locations, informal searches for birds, and habitat assessments. The survey period was approximately 2 hours either side of the high or low tide. Formal counts involved visiting count areas (**Figure 2**) and recording the abundance of each bird species and noting their behaviours. The survey approach is summarised as follows.

- The rock wall was divided into three count areas (RW7 to RW9, **Figure 2**) 250 m apart. Included in the counts were birds perching or foraging along the rock wall and/or foraging within 250 m in the adjacent ocean waters. The overlap between count areas was intentionally done to counteract the obscured visibility caused by the rocks.
- The Marine Precinct (reclaimed land and rock walls) and the adjoining intertidal area were divided into two (MP1 and MP2, **Figure 2**) and three (STB1a to STB1c, **Figure 2**) count areas respectively. Counts were made from vantage points along the western rock wall of the Marine Precinct.
- The Eastern Reclamation Area was divided into six count areas (ER1 to ER6, **Figure 2**). Counts were made from vantage points that offered good visibility without causing birds to flee or change their behaviour. Temporary offices and support facilities were constructed over most of ER2 in early January 2019, rendering the affected areas unsuitable for shorebirds during the 2020/21 surveys.

3.3 Sand spit

A boat was used to access the sand spit and land-based counts were made from vantage points that offered optimal views without disturbing birds. Surveys commenced approximately 1.5 hours prior to high tide and ended when a satisfactory count was achieved, usually within the hour after high tide.

Figure 2: Formal count areas used during the 2020/21 shorebird surveys

Project: Shorebird Monitoring Study for the Townsville Port Expansion Project October 2020 to February 2021

CU project reclamation area

Sand spit

Formal count areas

South Townsville Beach (STB)

Marine Precinct (MP)

Eastern Reclamation Area (ER)

Rock wall (RW)

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0 1

Kilometres

Source:
NRA, Google Earth, Port of Townsville Limited

NRA Ref: 349009
Date: September 2021

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4. Results

4.1 Survey conditions

4.1.1 Changes to Migratory shorebird habitats

The habitats within the study area have changed little to those reported by NRA (2019) during the baseline assessment. As described in NRA (2019), these conditions differ markedly to those reported by NRA (2012) during the impact assessment phase. The main differences are a reduced extent of artificial wetland habitats[5] in the Eastern Reclamation Area and Marine Precinct, and mangrove colonisation of the intertidal flats on the northern river bank (**Figure 1**). These changes reduced the quality of these sites as habitat for shorebirds.

The amount of construction activity associated with the CU project, and in areas used by shorebirds, was higher during the current study relative to the baseline study (NRA 2019), though similar to last season (NRA 2020a). Construction activity during the current study was concentrated in the area west and north of ER1 (**Figure 2**), and involved the haulage and stockpiling of rocks, and the construction of rock walls for the CU project reclamation area.

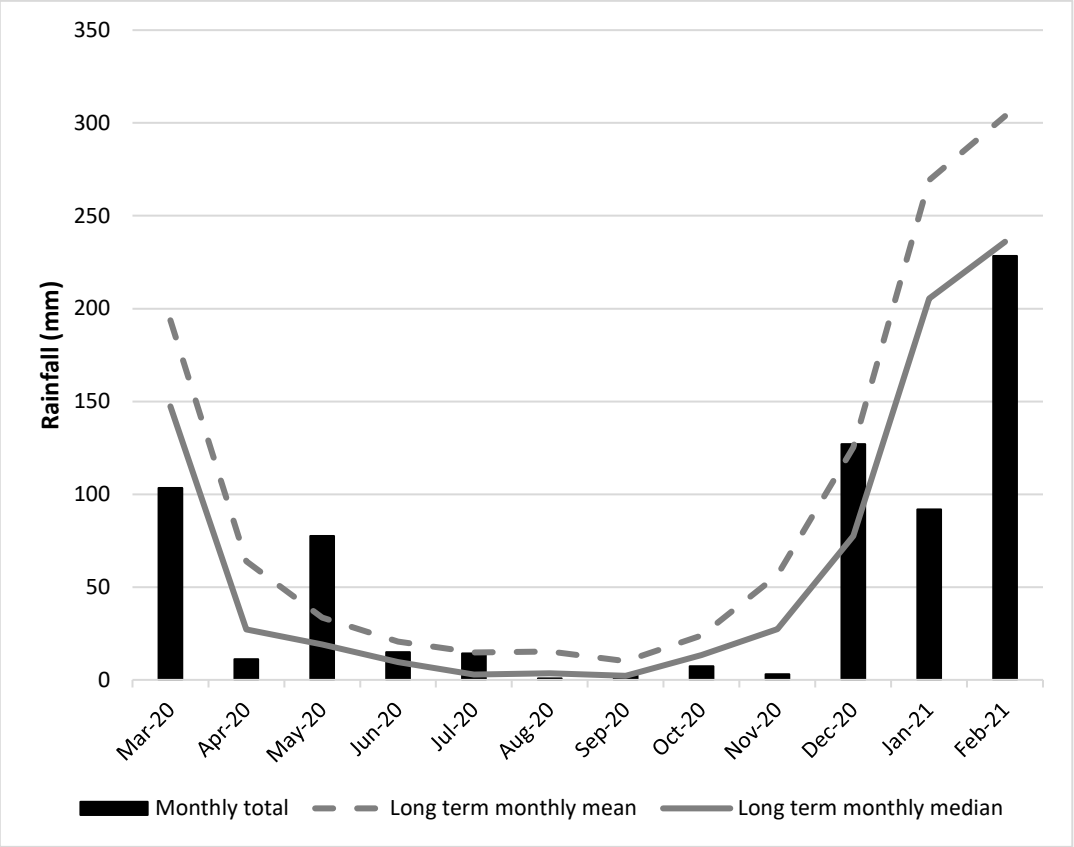
4.1.2 Weather

No extreme weather events (*eg* tropical cyclones, flooding) occurred during or immediately prior to any of the 2020/21 surveys. Monthly rainfall totals for the 2020/21 survey period and preceding months are shown on **Graph 1**. Weather data was obtained from the Bureau of Meteorology website (www.bom.gov.au) and is based on records from the Townsville Aero (station 032040), which is approximately 7 km from the study area. The data shows a typical rainfall pattern during and immediately before the survey period; however, the rainfall quantities in this period were generally below average (**Graph 1**). These rainfall patterns are relevant given that some bird species behaviours are influenced by rainfall.

4.1.3 Tides

Tide times and heights during survey events are shown in **Table 1**. Habitats along the rock wall (sites RW7 to RW9), the intertidal areas (STB1a to STB1c) and the sand spit are influenced by tide heights. The influence of tide heights should be considered when reviewing the following results.

[5] The land reclamation process results in temporary artificial wetland habitats. During the NRA (2012) study, ER2 and MP2 contained sections of shallow water that were used by large numbers of certain Migratory shorebird species.



Source: BOM (2021).

Graph 1: Monthly rainfall (2020/21) and long-term average and median rainfall (1940 to February 2021) recorded at Townsville Aero weather station

4.2 Field survey results

4.2.1 Overview

The following sections focus on results relating to species listed as Migratory under the EPBC Act recorded on PoT *ie* less attention is devoted to non-Migratory species and results from the sand spit. Of the observed species, the Beach Stone Curlew (*Esacus magnirostris*; Vulnerable, NC Act) is the only Threatened species that is not also listed as Migratory.

4.2.2 Species composition, species richness and abundance

Species composition and richness

Sixty-two bird species were recorded during the 2020/21 survey period (all sites including the sand spit). The species, their legislative status and general distribution are shown in **Table 2**.

While more bird species were recorded on PoT (56 species) than on the sand spit (26 species), PoT supported fewer Migratory species (12 species) than the sand spit (17 species) (**Table 2**). The minimum and maximum monthly species richness for Migratory birds across the survey period was as follows:

- PoT (Rock Wall, Eastern Reclamation Area, Marine Precinct and STB1a to STB1c) (**Table 3**):
  - high tide (five surveys): five species (November 2020) to 11 species (December 2020)
  - low tide (three surveys): three species (November 2020 and January 2021) to four species (February 2021)

- sand spit (high tide only):
  - high tide (five surveys): five species (January and February 2021) to 16 species (October 2020) (**Table 4**).

Species richness exceeded the threshold for national significance at the sand spit during the October 2020 survey only.

Abundance of Migratory bird species

The abundance of Migratory bird species recorded on PoT is shown in **Table 3**. Red-necked Stint and Lesser Sand Plover were the most abundant species; however, no species exceeded the threshold for national significance (**Table 3**). Migratory bird species were more abundant on PoT during high tide (*cf* low tide) (**Table 3**).

The abundance of Migratory bird species recorded on the sand spit is shown in **Table 4**. Four species were present in nationally significant abundances during at least one survey event (Eastern Curlew, Great Knot, Greater Sand Plover and Whimbrel), with the Great Knot being the most abundant species overall (**Table 4**). Total Migratory shorebird abundance exceeded the threshold for national significance in February 2021 (**Table 4**).

Between 2% and 17% (average = 7%, n = 5) of the local Migratory bird population used PoT (primarily for roosting) at high tide, with the majority of the local population using the sand spit (average 93%, n = 5) (**Table 5**). Within PoT, Migratory bird abundances at high tide were generally greatest in the Eastern Reclamation Area; on average, 5% (n = 5) of the local population used this area (**Table 5**).

Table 2: Bird species recorded at PoT and Ross River sand spit during 2020/21 survey period and their legislative status

Common name	Scientific name	Status [A]		Location	
		EPBC Act	NC Act	PoT [B]	Sand spit
Threatened species					
Eastern Curlew	*Numenius madagascariensis*	CE/M	E		✓
Great Knot	*Calidris tenuirostris*	CE/M	E		✓
Lesser Sand Plover	*Charadrius mongolus*	E/M	E	✓	✓
Western Alaskan Bar-tailed Godwit	*Limosa lapponica baueri*	V/M	V		✓
Greater Sand Plover	*Charadrius leschenaultii*	V/M	V	✓	✓
Beach Stone Curlew	*Esacus magnirostris*	-	V	✓	
Non-threatened migratory species					
Caspian Tern	*Hydroprogne caspia*	M	SL	✓	✓
Common Greenshank	*Tringa nebularia*	M	SL	✓	✓
Common Sandpiper	*Actitis hypoleucos*	M	SL	✓	
Crested Tern	*Thalasseus bergii*	M	SL	✓	✓
Grey Plover	*Pluvialis squatarola*	M	SL		✓
Grey-tailed Tattler	*Tringa brevipes*	M	SL	✓	✓
Gull-billed Tern	*Gelochelidon nilotica*	M	SL	✓	✓
Little Tern	*Sternula albifrons*	M	SL	✓	✓
Pacific Golden Plover	*Pluvialis fulva*	M	SL		✓
Red-necked Stint	*Calidris ruficollis*	M	SL	✓	✓
Ruddy Turnstone	*Arenaria interpres*	M	SL		✓
Sharp-tailed Sandpiper	*Calidris acuminata*	M	SL	✓	✓
Terek Sandpiper	*Xenus cinereus*	M	SL	✓	
Whimbrel	*Numenius phaeopus*	M	SL	✓	✓
Other non-threatened and non-migratory species					
Australasian Darter	*Anhinga novaehollandiae*	-	LC	✓	
Australasian Grebe	*Tachybaptus novaehollandiae*	-	LC	✓	
Australian Pelican	*Pelecanus conspicillatus*	-	LC	✓	✓
Australasian Pipit	*Anthus novaeseelandiae*	-	LC	✓	
Australian Pied Oystercatcher	*Haematopus longirostris*	-	LC	✓	✓
Australian White Ibis	*Threskiornis molucca*	-	LC	✓	
Bare-shouldered Dove	*Geopelia humeralis*	-	LC	✓	
Black Kite	*Milvus migrans*	-	LC	✓	
Black-winged Stilt	*Himantopus himantopus*	-	LC	✓	
Brahminy Kite	*Haliastur indus*	-	LC	✓	
Brown Honeyeater	*Lichmera indistincta*	-	LC	✓	
Bush Stone-curlew	*Burhinus grallarius*	-	LC	✓	
Common Myna	*Sturnus tristis*	-	I	✓	
Eastern Great Egret	*Ardea modesta*	-	LC	✓	
Eastern Reef Egret	*Egretta sacra*	-	LC	✓	
Golden-headed Cisticola	*Cisticola exilis*	-	LC	✓	
Great Bowerbird	*Ptilonorhynchus nuchalis*	-	LC	✓	
Grey Teal	*Anas gracilis*	-	LC	✓	✓
Helmeted Friarbird	*Philemon buceroides*	-	LC	✓	
Lesser Crested Tern	*Thalasseus bengalensis*	-	LC	✓	✓
Little Egret	*Egretta garzetta*	-	LC	✓	✓
Little Pied Cormorant	*Microcarbo melanoleucos*	-	LC	✓	
Magpie-lark	*Grallina cyanoleuca*	-	LC	✓	
Mangrove Honeyeater	*Gavicalis fasciogularis*	-	LC	✓	
Masked Lapwing	*Vanellus miles*	-	LC	✓	
Mistletoe Bird	*Dicaeum hirundinaceu*	-	LC	✓	
Nankeen Kestrel	*Falco cenchroides*	-	LC	✓	
Nutmeg Mannikin	*Lonchura punctulata*	-	LC	✓	
Pacific Black Duck	*Anas superciliosa*	-	LC	✓	✓
Peaceful Dove	*Geopelia striata*	-	LC	✓	
Plumed Whistling-duck	*Dendrocygna eytoni*	-	LC	✓	
Radjah Shelduck	*Radjah radjah*	-	LC	✓	
Rainbow Bee-eater	*Merops ornatus*	-	LC	✓	
Red-capped Plover	*Charadrius ruficapillus*	-	LC	✓	✓
Royal Spoonbill	*Platelea regia*	-	LC	✓	✓
Rock Dove	*Columba livia*	-	LC	✓	
Rufous-throated Honeyeater	*Conopophila rufogularis*	-	LC	✓	
Silver Gull	*Chroicocephalus novaehollandiae*	-	LC	✓	✓
Striated Heron	*Butorides striata*	-	LC	✓	
Wandering Whistling-Duck	*Dendrocygna arcuata*	-	LC	✓	
Welcome Swallow	*Hirundo neoxena*	-	LC	✓	
White-throated Gerygone	*Gerygone olivacea*	-	LC	✓	

[A] Status according to the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and Queensland *Nature Conservation Act* 1994 (NC Act): Critically Endangered (CE), Endangered (E), Vulnerable (V), Near Threatened (NT), Migratory (M), Special Least Concern (SL), Least Concern (LC) and Introduced (I).

[B] PoT species records from incidental observations and from formal count areas (Rock Wall, Eastern Reclamation Area, Marine Precinct, and South Townsville Beach (**Figure 2**)).

Table 3: Abundance of Migratory bird species recorded on PoT land[A] during the 2020/21 survey period

Common name	Scientific name	Status [B]		October 2020		November 2020		December 2020		January 2021		February 2021		Significance thresholds [C]	
		EPBC Act	NC Act	High tide	Low tide	High tide	Low tide	High tide	Low tide	High tide	Low tide	High tide	Low tide	I	N
Caspian Tern	*Hydroprogne caspia*	M	SL	0	NO SURVEY CONDUCTED	0	0	7	NO SURVEY CONDUCTED	11	2	5	4	NA	NA
Common Greenshank	*Tringa nebularia*	M	SL	2		2	1	0		1	0	1	0	1100	110
Common Sandpiper	*Actitis hypoleucos*	M	SL	2		0	1	1		0	0	0	1	1900	190
Crested Tern	*Thalasseus bergii*	M	SL	3		0	0	0		0	0	0	0	NA	NA
Greater Sand Plover	*Charadrius leschenaultii*	V/M	V	1		0	0	45		0	0	0	0	2000	200
Grey-tailed Tattler	*Tringa brevipes*	M	SL	5		3	0	4		0	0	0	0	700	70
Gull-billed Tern	*Gelochelidon nilotica*	M	SL	0		0	0	1		4	0	1	0	NA	NA
Little Tern	*Sternula albifrons*	M	SL	4		2	0	7		0	0	0	0	NA	NA
Lesser Sand Plover	*Charadrius mongolus*	E/M	E	0		0	0	140		0	0	0	0	1800	180
Red-necked Stint	*Calidris ruficollis*	M	SL	180		0	0	97		0	0	0	0	4750	475
Sharp-tailed Sandpiper	*Calidris acuminata*	M	SL	0		0	0	12		41	1	39	5	850	85
Terek Sandpiper	*Xenus cinereus*	M	SL	0		4	0	3		2	0	2	0	500	50
Whimbrel	*Numenius phaeopus*	M	SL	0		2	4	4		2	3	4	5	650	65
Beach Stone Curlew	*Esacus magnirostris*	-	V	0		2	2	1		0	0	0	0	NA	NA
Migratory bird species abundance				197	-	13	6	321	-	61	6	52	15	20000	2000
Migratory bird species richness				7	-	5	3	11	-	6	3	6	4	NA	15
Threatened & migratory bird species richness				7	-	6	4	12	-	6	3	6	4	NA	NA

Shaded cells indicate counts that exceed significance thresholds (no thresholds were exceeded).

[A] PoT land comprises the following formal count areas: Rock Wall, Eastern Reclamation Area, Marine Precinct and South Townsville Beach (**Figure 2**).

[B] Status according to the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and Queensland *Nature Conservation Act* 1994 (NC Act): Critically Endangered (CE), Endangered (E), Vulnerable (V), Migratory (M), Special Least Concern (SL), Least Concern (LC).

[C] International (I) and national (N) thresholds for significance with reference to DoEE (2017) and Hansen *et al.* (2016). NA = not available.

Table 4: Abundance of Migratory bird species recorded at high tide on PoT land[A] and/or on the sand spit during the 2020/21 survey period

Common name	Scientific name	Status [B]		October 2020		November 2020		December 2020		January 2021		February 2021		Significance thresholds [C]	
		EPBC Act	NC Act	PoT	Sand spit	PoT	Sand spit	PoT	Sand spit	PoT	Sand spit	PoT	Sand spit	I	N
Caspian Tern	*Hydroprogne caspia*	M	SL	0	8	0	6	7	18	11	0	5	0	NA	NA
Common Greenshank	*Tringa nebularia*	M	SL	2	6	2	0	0	25	1	0	1	0	1100	110
Common Sandpiper	*Actitis hypoleucos*	M	SL	2	0	0	0	1	0	0	0	0	0	1900	190
Crested Tern	*Thalasseus bergii*	M	SL	3	6	0	0	0	0	0	0	0	0	NA	NA
Eastern Curlew	*Numenius madagascariensis*	CE/M	E	0	85	0	25	0	184	0	38	0	15	350	35
Great Knot	*Calidris tenuirostris*	CE/M	E	0	822	0	55	0	540	0	718	0	3200	4250	425
Greater Sand Plover	*Charadrius leschenaultii*	V/M	V	1	85	0	125	45	228	0	0	0	0	2000	200
Grey Plover	*Pluvialis squatarola*	M	SL	0	0	0	0	0	0	0	0	0	7	800	80
Grey-tailed Tattler	*Tringa brevipes*	M	SL	5	1	3	0	4	0	0	0	0	0	700	70
Gull-billed Tern	*Gelochelidon nilotica*	M	SL	0	3	0	0	1	49	4	4	1	0	NA	NA
Lesser Sand Plover	*Charadrius mongolus*	E/M	E	0	90	0	125	140	152	0	0	0	0	1800	180
Little Tern	*Sternula albifrons*	M	SL	4	86	2	50	7	110	0	0	0	0	NA	NA
Pacific Golden Plover	*Pluvialis fulva*	M	SL	0	13	0	0	0	0	0	0	0	0	1200	120
Red-necked Stint	*Calidris ruficollis*	M	SL	180	140	0	10	97	20	0	0	0	0	4750	475
Ruddy Turnstone	*Arenaria interpres*	M	SL	0	1	0	0	0	0	0	0	0	0	300	30
Sharp-tailed Sandpiper	*Calidris acuminata*	M	SL	0	10	0	26	12	0	41	0	39	0	850	85
Terek Sandpiper	*Xenus cinereus*	M	SL	0	0	4	0	3	0	2	0	2	0	500	50
Western Alaskan Bar-tailed Godwit	*Limosa lapponica baueri*	V/M	V	0	217	0	139	0	127	0	168	0	172	3520	325
Whimbrel	*Numenius phaeopus*	M	SL	0	146	2	49	4	149	2	126	4	25	650	65
Beach Stone Curlew	*Esacus magnirostris*	-	V	0	0	2	0	1	0	0	0	0	0	NA	NA
Migratory bird species abundance				197	1719	13	610	321	1602	61	1054	52	3419	20000	2000
Migratory bird species richness				7	16	5	10	11	11	6	5	6	5	NA	15
Threatened & migratory bird species richness				7	16	6	10	12	11	6	5	6	5	NA	NA

Shaded cells indicate counts that exceed significance thresholds.

[A] PoT comprises the following count areas: Rock Wall, Eastern Reclamation Area, Marine Precinct and South Townsville Beach (**Figure 2**).

[B] Status according to the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and Queensland *Nature Conservation Act* 1994 (NC Act): Critically Endangered (CE), Endangered (E), Vulnerable (V), Migratory (M), Special Least Concern (SL) and Least Concern (LC).

[C] Significance thresholds with reference to DoEE (2017) and Hansen *et al.* (2016). NA = not available.

Table 5: Proportion of local Migratory bird population recorded at high tide on PoT land[A] and on sand spit during the 2020/21 survey period

Count month	PoT formal count areas[A]				Sand spit
	STB	MP	ER	RW	
October 2020	0%	<1%	9%	<1%	90%
November 2020	0%	2%	0%	<1%	98%
December 2020	0%	1%	15%	<1%	83%
January 2021	0%	<1%	5%	0%	95%
February 2021	<1%	<1%	1%	<1%	99%
Average	**<1%**	**<1%**	**5%**	**<1%**	**93%**

[A] PoT comprises the following formal count areas: Rock Wall (RW), Eastern Reclamation Area (ER), Marine Precinct (MP) and South Townsville Beach (STB) (**Figure 2**).

4.2.3 Habitats and use patterns

Overview

The terrestrial habitats within the developed section of the PoT study area are man-made and created by land reclamation. The fill material used in the reclamation areas includes marine sediments obtained during dredging for the PoT. Land reclamation is a gradual process and the PoT contains areas at, or approaching, final ground surface levels as well as areas just below final levels and that will be filled. The lower lying areas hold water after sustained rainfall and resemble wetland habitats. They are transitional habitats and the use of these areas by Migratory birds (**Table 2**) will change throughout the reclamation process.

The following general habitat types are identifiable within the study area.

- Habitats within the developed sections of PoT:
  - rock wall and adjacent estuarine and marine waters
  - artificial wetlands
  - active work areas
  - raised ground – mostly vegetated
  - raised ground – mostly bare.
- Habitats immediately adjacent to the developed sections of PoT:
  - estuarine and marine coastal waters
  - intertidal banks/flats
  - sand spit.

When the count areas were first established by NRA (2012), they each contained one predominant habitat type. Some count areas now contain multiple habitat types due to progression of the land reclamation process. The habitat types present in the count areas of the developed sections of PoT land are summarised in **Table 6**, with descriptions of each habitat type provided below.

Table 6: Dominant and minor habitat types present in count areas of the developed sections of PoT

Count area [A]	Habitat types				
	Rock wall & estuarine/ marine waters	Artificial wetlands	Active work areas	Raised ground – mostly vegetated	Raised ground – mostly bare
RW7–RW9	D				
ER1		m	D		m
ER2		m	D		m
ER3		D		m	
ER4		D		D	m
ER5		D			
ER6		D			
MP1	m	m			D
MP2	m	D		m	

[A] PoT comprises the following count areas: Rock Wall (RW), Eastern Reclamation Area (ER), Marine Precinct (MP) and South Townsville Beach (STB) (**Figure 2**).

D = dominant.

m = minor.

Rock wall and adjacent estuarine and marine waters

The rock wall contains irregularly shaped boulders placed together to form a wall. The seaward edge of the rock wall provides favourable habitat for molluscs and crustaceans, which are a food source for a variety of waterbirds. The rock wall may also be used as

perches for hunting, feeding and resting. These built structures provide similar habitats to naturally occurring rocky headlands and foreshores. The marine waters adjacent to the rock wall contain a range of prey species for waterbirds (notably members of the Laridae family).

During the survey period, Migratory bird activity along the rock walls of the Eastern Reclamation Area was limited to two Common Sandpiper in October 2020. Little Tern were frequently observed foraging in the waters adjacent to the rock walls. The rock walls of the Marine Precinct were consistently used by small numbers (≤12 birds) of Grey-tailed Tattler, Common Greenshank, Terek Sandpiper, Common Sandpiper and Whimbrel for roosting at high tide.

Artificial wetlands

ER5 and ER6 are evaporation and settling ponds for dredge material from maintenance dredging operations around PoT. The presence and volume of water in these areas varies according to dredging operations and weather (rainfall and evaporation rates), though these sites typically hold shallow and/or deep water for most of the year. There are no aquatic macrophytes, and sparse vegetation (mostly saltmarsh and small exotic grasses and forbs) occurs along the pond margins. During the survey period waterbird activity at ER5 and ER6 was very low between October and December 2020, due mainly to the dry conditions (no surface water present) though also due to maintenance works on the settling ponds between October and November 2020 (machinery excavating soil material from ER5). Waterbird activity at these sites increased in January and February 2021 following sustained rainfall and the return of surface water. Waterbirds were observed roosting, resting and feeding in ER5 and ER6, predominantly Australian Pelican, Pacific Black Duck, Plumed Whistling Duck, Black-winged Stilt and Caspian Tern. Caspian Tern (seven birds in December 2019) and Common Sandpiper (one bird in February 2021) were the only Migratory-listed species observed. Black-winged Stilt may have used ER6 for breeding in January and February 2021.

ER1, ER2, ER3, ER4, MP1 and MP2 are reclamation areas. Following sustained rainfall, shallow pools or ponding temporarily occurs in portions of ER1, ER2, ER4 and MP1, and cover most of ER3 and MP2. In the absence of rainfall, all sites are dry. ER3 and MP2 are lower lying and tend to hold water for longer periods (weeks to months) than ER1, ER2, ER4 and MP1 (days to months). Saltmarsh communities fringe ER3 and MP2, though are sparse at the other sites. Waterbird activity at all these sites corresponds with the presence of water, with lower activity when dry and higher activity when wet. **Plate 1** contains photographs of ER3 and shows the change in habitat conditions that occur following sustained rainfall.

ER3 and ER4 contained surface water in January and February 2021 and supported large numbers of waterbirds during this time; the most abundant species and maximum counts were as follows: Pacific Black Duck (16 in January 2021), Plumed Whistling Duck (211 in January 2021), Black-winged Stilt (36 in February 2021), Silver Gull (43 in January 2021) and Sharp-tailed Sandpiper (41 in January 2021). Migratory-listed species comprised Sharp-tailed Sandpiper (maximum count = 41 birds; January 2021) and small numbers of Caspian Tern and Gull-billed Tern (combined maximum count = 15 birds; January 2021). Nesting and fledgling Black-winged Stilt were recorded in ER4, as was a nesting Australasian Grebe. Waterbird activity was very low at these sites during the drier months (October to December 2020). In December 2020, a mixed-species flock of Migratory Greater Sand Plover (45 birds), Lesser Sand Plover (140 birds) and Red-necked Stint (97 birds) roosted briefly in the south-eastern corner of ER4 (arrived and departed from PoT within the 15 minute observation period) (**Plate 2**).

Waterbird activity was relatively low at ER1, MP1 and MP2, and no birds were recorded using ER2. Sharp-tailed Sandpiper was the only Migratory species to use wetland habitats in these areas. They were recorded using MP2 in December 2020 (12 birds) and February 2021 (two birds).

Active work areas

ER1 and ER2 are at, or close to, final ground levels. ER2 is mostly covered by an office area (demountable buildings and car park). Sections of ER1 contain rock stockpiles associated with the CU project. Anthropogenic activities influence bird usage of these sites. Red-capped Plover frequents these areas, including the car park. Use of this habitat by Migratory-listed species was limited 180 Red-necked Stint and one Greater Sand Plover using ER1 in October 2020.

Raised ground – mostly vegetated

This habitat covers ER4 and small parts of ER3 and MP2. ER4, which is the best example of this habitat type, is one of the highest elevation areas in the study area. ER4 supports a sparse to dense coverage of native and exotic grasses and forbs, interspersed with bare patches and saltmarsh in the lower lying areas.

This habitat is mostly used by ground-dwelling specialist birds (*eg* Golden-headed Cisticola and Australian Pipit) and birds that hunt on the wing (*eg* Nankeen Kestrel and Welcome Swallow). Many of the ground-dwelling specialist birds often breed in grasslands. No Migratory birds were observed using this habitat.

Raised ground – mostly bare

This is the dominant habitat of MP1. The habitat comprises a dredge spoil stockpile that is mostly devoid of vegetative cover. Beach Stone Curlew was the only bird species recorded using this site (November and December 2020); they were recorded using it as a roosting/resting area, though they may also nest there. Pied Oystercatcher and Red-capped Plover were recorded nesting there in 2019 (NRA 2019).

ER1, ER2 and ER4 also have small patches of this habitat.

Estuarine and marine coastal waters

This habitat type refers to the inshore waters immediately adjacent to the PoT land. The marine waters adjacent to the rock wall were used infrequently and by very small numbers of birds; mainly Little Tern.

Intertidal banks/flats

Intertidal banks/flats (mud and sand with some areas of dense mangrove) occur along the northern and southern banks of the Ross River mouth and to the south in Cleveland Bay. These intertidal areas are predominantly used by shorebirds that forage at low tide. The only intertidal area surveyed during the current study was the section of Lot 773 on SP223346 between the Marine Precinct and Benwell Road, *ie* sites STB1a to STB1c (**Figure 2**). STB1c and STB1b are mostly covered by mangrove forest. This forest coverage reduces its suitability as foraging habitat for shorebirds. Common Greenshank, Common Sandpiper and Whimbrel were the only shorebirds recorded using STB1a to STB1c, and they were only ever present in very small numbers (maximum count all species = 6 birds; November 2020). They were observed foraging along small sections of unvegetated mud flats.

Sand spit

Suitable roost sites are critical for the persistence of shorebirds in an area. During high tides, shorebirds congregate in mixed-species groups at their roost. The sand spit in the Ross River

mouth is approximately 1.8 km long, and the western extent of this sand spit submerges during the highest spring high tides. Most birds congregate at the eastern end of the sand spit, though large numbers occasionally roost at the western end. The size of the sand spit allows birds to move to different parts of the spit when disturbed. Monthly totals of Migratory birds roosting at this site ranged between 610 (November 2020) and 3,419 (February 2021).

Plate 1: ER3 in October 2020 (dry season; left image) and January 2021 (wet season; right image)

Plate 2: Mixed-species flock (including Greater Sand Plover, Lesser Sand Plover, Red-necked Stint) roosting in south-east of ER4 in December 2020

5. Discussion

5.1 Summary of results

Migratory shorebirds continue to use PoT during the spring and summer months, primarily at high tide when they are roosting. Consistent with the 2019/20 results (NRA 2020a), foraging was rarely observed, suggesting the Migratory shorebirds using PoT acquire most of their sustenance from sites external to PoT. During the October 2020 to February 2021 survey period, the observed species richness of Migratory birds (all species) at high tide on PoT ranged between five and 11 species, and abundances ranged between 13 and 321 individuals (**Table 4**). The smaller shorebird species were most abundant (Red-necked Stint, Sharp-tailed Sandpiper, Greater Sand Plover and Lesser Sand Plover); however, no Migratory species were recorded in nationally significant abundance on PoT land.

5.2 Comparison with previous survey results

5.2.1 Context: factors influencing Migratory bird presence on Port of Townsville

An objective of the current study is to assess the impact of CU project construction activities on shorebird roosting and foraging on PoT. Repeated counts across a season, as per the current and previous (NRA 2012, 2019, 2020a) studies, provide a means for comparing annual changes in Migratory shorebird presence and a basis for identifying potential impacts. However, multiple factors can influence Migratory shorebird presence, making it difficult to proportion an observed change to a single causal factor. These factors are described below and help contextualise the observed changes discussed in **Section 5.2.2**.

Migratory shorebird species composition and abundance on PoT are influenced by site-specific conditions and external factors. External factors include the likely continued decline of the EAA flyway shorebird population and changes in the condition of shorebird habitats in the local area. As described in Clemens *et al.* (2016), factors outside of Australia are primarily responsible for the declines reported for the EAA flyway shorebird population. There is insufficient data on global shorebird populations to determine the degree to which global population trends may affect the results reported for PoT.

Habitats in the local area are changing, though the full impact of these changes on the dynamics of the local Migratory shorebird population (*eg* local abundance and areas used) is not quantifiable. For example, the dimensions of the sand spit at the Ross River mouth changed following heavy rainfall and flooding in February 2019. This change reduced shorebird roosting on the western extent of the sand spit and increased roosting on the eastern extent. Certain shorebird groups have slightly different preferences of roost site selection, and it is not clear if the changes to the sand spit had other, more subtle, impacts on the dynamics of the local shorebird population.

Changes to local shorebird habitats have also occurred in response to the construction of the Townsville Marine Precinct (2011/12) and the bridge over Ross River (2012), with impacts occurring directly via habitat loss and indirectly via changes to sediment movement and local geomorphology. Soon after, and potentially in response to changes in local geomorphology caused by these developments, mangroves expanded their distribution on the southern and northern banks of the river mouth. Most shorebird species in the local population prefer to forage in open, un-forested, areas. Therefore, the mangrove expansion has reduced the area and/or quality of available foraging habitat for the local shorebird population. The impact of this habitat reduction on local Migratory shorebird population dynamics is difficult to quantify.

The site-specific conditions that influence Migratory shorebird presence on PoT include factors related to Port activities (including the CU project) and weather. Of these factors, the changes in habitat from land reclamation and development will have the greatest and most enduring impact on Migratory shorebird presence[6]. Construction may also impact birds by disrupting their normal patterns of behaviour; however, the impact will be limited to the construction period (*ie* short-term) and will vary according to each species' sensitivity to the construction stimuli. For example, Eastern Curlew and Whimbrels are very sensitive to human presence (Weston *et al.* 2012) and may vacate areas in response to relatively low levels of disturbance, whereas Greater Sand Plover, Lesser Sand Plover and Red-necked Stint are more tolerant, as indicated by their presence near active work areas during the current and previous (NRA 2020a) studies.

Extreme weather events such as cyclones have the potential to impact Migratory shorebirds and influence their presence in the local area. Because many of these species are migratory, a cyclone anywhere along the EAA Flyway may have an effect. Impacts may include disruption to normal migration patterns and the loss of individuals. As discussed in **Section 5.2.2**, more ordinary weather conditions may also influence shorebird presence on PoT.

5.2.2 Changes in Migratory bird presence on Port of Townsville

Graph 2 uses data from low tide surveys and represents Migratory bird presence on PoT when most shorebirds are foraging. The habitats on PoT during the 2020/21 season were similar to those in the 2018/19 and 2019/20 seasons, though markedly different to those in the 2011/12 season. The land reclamation progressed substantially between 2011 and 2018; consequently, the extent of land supporting shallow water (artificial wetlands), where Migratory birds forage, greatly reduced during this period. This habitat change has reduced Migratory bird presence on PoT at low tide (**Table 7**; **Graph 2**) prior to commencement of the PEP. The 2018/19, 2019/20 and 2020/21 results for low tide are comparable (**Graph 2**), suggesting the CU project has not negatively impacted Migratory bird presence on PoT at low tide.

Graph 3 uses data from high tide surveys and represents Migratory bird presence on PoT when intertidal areas are not available for foraging and most shorebirds are at their roost site. Migratory birds continue to roost on PoT, generally in lower numbers than in previous seasons (**Table 7**; **Graph 3**). The lower abundances in the 2020/21 season compared with the 2011/12 season may in part be due to the changes in habitats on PoT, though the habitat changes do not explain the continued decline post the 2018/19 season. It is also unlikely that construction, and its impact on Migratory bird behaviours, was responsible for the lower abundances. Construction around the Eastern Reclamation Area in the 2020/21 season was concentrated in relatively small areas and is unlikely to have caused birds to move away *en masse*. Therefore, activities associated with the CU project are likely to have had a minor influence on the apparent decline in Migratory bird abundance at high tide post the 2018/19 season.

Red-necked Stint, Sharp-tailed Sandpiper and Sand Plover (Greater and Lesser) are the Migratory bird species that have consistently occurred in highest numbers on PoT at high tide. The local population of Red-necked Stint, and to a lesser extent Sharp-tailed Sandpiper,

[6] Noting the area started as unsuitable habitat for shorebirds (open water), became suitable (artificial wetlands) to varying degrees during the land reclamation process, and ultimately will be unsuitable habitat (developed land) once reclamation is complete.

has declined substantially across the four study periods (**Table 8**)[7]. Location-specific and external factors (*ie* unrelated to the CU project) may be involved with the decline. Red-necked Stint and Sharp-tailed Sandpiper prefer to forage in saturated substrates and very shallow waters of wetlands, and the progressive loss of this habitat on PoT during land reclamation has contributed to their reduced presence in this area. The overall decline of these species has contributed to the lower abundances of Migratory birds observed on PoT at high tide in the 2020/21 season.

Rainfall is also influencing the abundance of Migratory birds on PoT. **Graph 4** shows that peaks in Migratory bird abundance on PoT coincide with large rainfall events, though the relationship is not linear, with Migratory birds apparently using PoT in higher numbers when rainfall exceeds certain threshold quantities. Rogers *et al.* (2006) found that roost site selection by Great Knot was influenced by proximity to foraging grounds and micro-climate, with birds preferring nearby roosts where they could stand on cool, wet substrates. It is likely that Red-necked Stint, Sharp-tailed Sandpiper and Sand Plover (Greater and Lesser) have similar preferences, meaning PoT currently provides suitable roost habitat for these species following sustained rainfall.

5.3 Monitoring program review and future considerations

The sampling intensity implemented in this study is generally consistent with the minimum effort recommended by DoEE (2017) for determining the presence of 'important habitat'; *ie* four surveys for roosting shorebirds during the period when the majority of shorebirds is present in the area. DoEE (2017) recognises that replicate surveys over this period are important to measure population variability, and that in most cases one survey in December, two surveys in January, and one survey in February are adequate. However, measuring local scale population changes at some locations, *ie* the Ross River mouth, where shorebird populations may vary substantially daily or weekly (NRA 2008, 2019, 2020a, 2020b), requires higher intensity sampling.

The sampling intensity recommended by NRA (2019) during the construction period, and adopted for the current study, together with general observations, allows for detection of gross scale changes in, or impacts concerning, the Migratory bird population using PoT. However, the ability to decipher finer scale impacts from the natural background variation is limited. This is an acceptable level of precision for the current context.

The current study has confirmed the limited value of low tide surveys, and the continuation of a reduced effort at low tide is recommended. The recommended low tide survey effort is one survey each in November, January and February. High tide surveys are providing data of value to the Shorebird Monitoring Program, and it is recommended that monthly high tide surveys between October and February continue.

[7] Local population abundance is based on counts made at high tide at the Ross River mouth sand spit and on PoT.

Table 7: Abundance of Migratory birds recorded on PoT during spring and summer of 2011/12, 2018/19, 2019/20 and 2020/21[A]

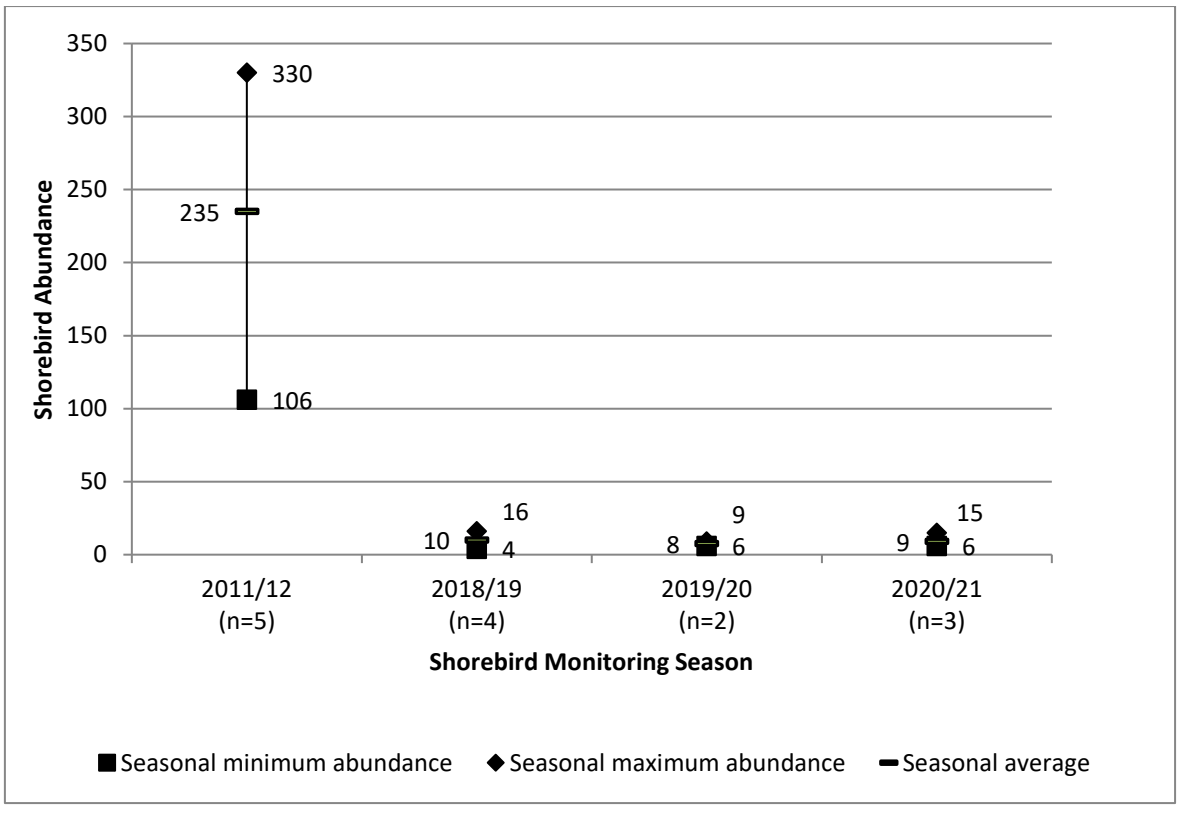
Survey season	Survey month							Total	Average
	October	November	November	November	December	January	February		
2011/12 (NRA 2012)	NA	552 (222/330)	– (85/–)	– (–/312)	423 (104/319)	993 (885/108)	1001 (895/106)	2969 (2191/1175)	742 (438/235)
2018/19 (NRA 2019)	564 (556/8)	600 (589/11)	NA	NA	840 (836/4)	376 (360/16)	NA	2380 (2341/39)	595 (585/10)
2019/20 (NRA 2020a)	NA	– (63/–)	NA	NA	– (207/–)	114 (105/9)	810 (804/6)	924 (1179/15)	462 (295/8)
2020/21 (this study)	– (197/–)	19 (13/6)	NA	NA	– (321/–)	67 (61/6)	67 (52/15)	147 (644/27)	49 (129/9)

[A] Total abundance is provided with high and low tide results in parenthesis. 'NA' = months where survey data is not available because no survey was conducted. For some months, only a high or low tide survey was conducted; the '–' symbol denotes the absence of a corresponding estimate.

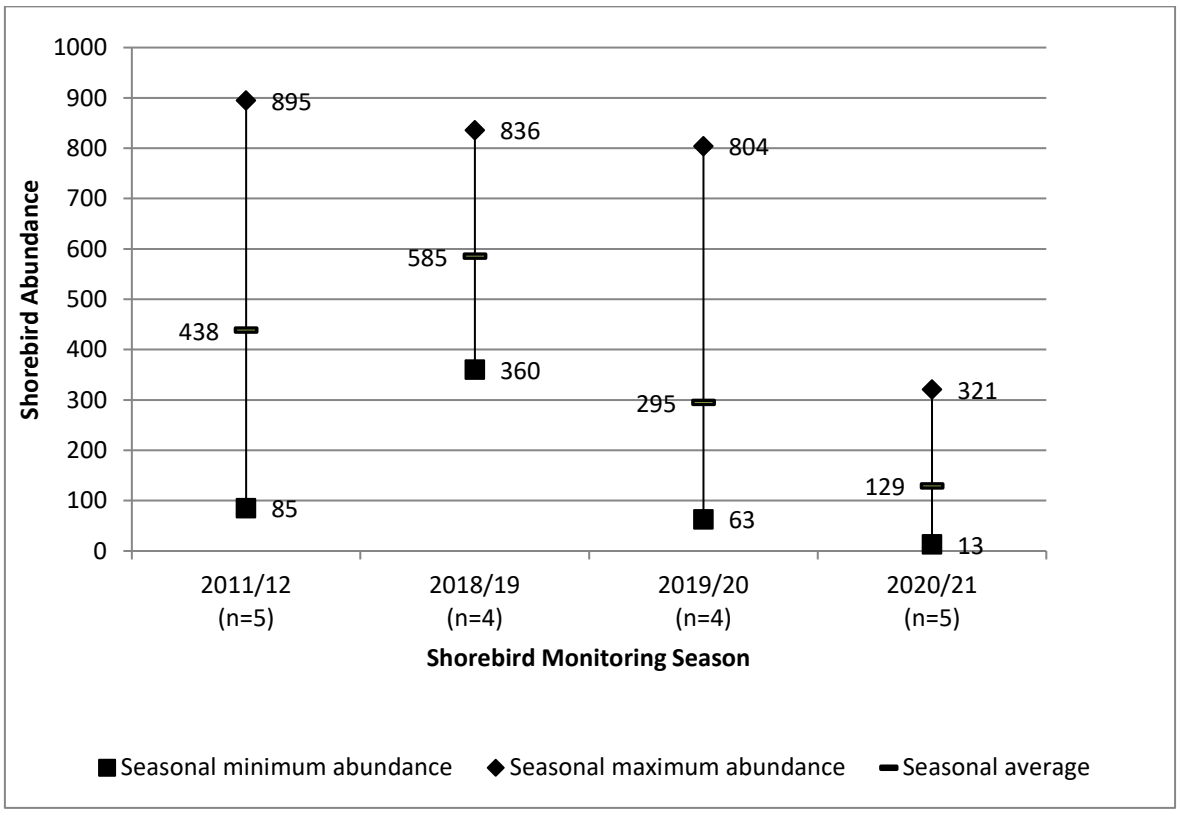
Table 8: Local population abundance[A] of the main Migratory bird species that occur on PoT

Common name	Status		Average species abundance (minimum – maximum)			
	EPBC Act	NC Act	2011/12 (NRA 2012)	2018/19 (NRA 2019)	2019/20 (NRA 2020a)	2020/21 (this study)
Red-necked Stint	M	SL	681 (509–848)	398 (10–695)	205 (40–570)	89 (0–320)
Sharp-tailed Sandpiper	M	SL	157 (92–326)	169 (42–314)	36 (9–64)	26 (10–41)
Greater Sand Plover	V/M	V	90 (21–200)	139 (5–274)	183 (30–350)	97 (0–273)
Lesser Sand Plover	E/M	E	133 (62–242)	47 (0–115)	25 (0–60)	101 (0–292)

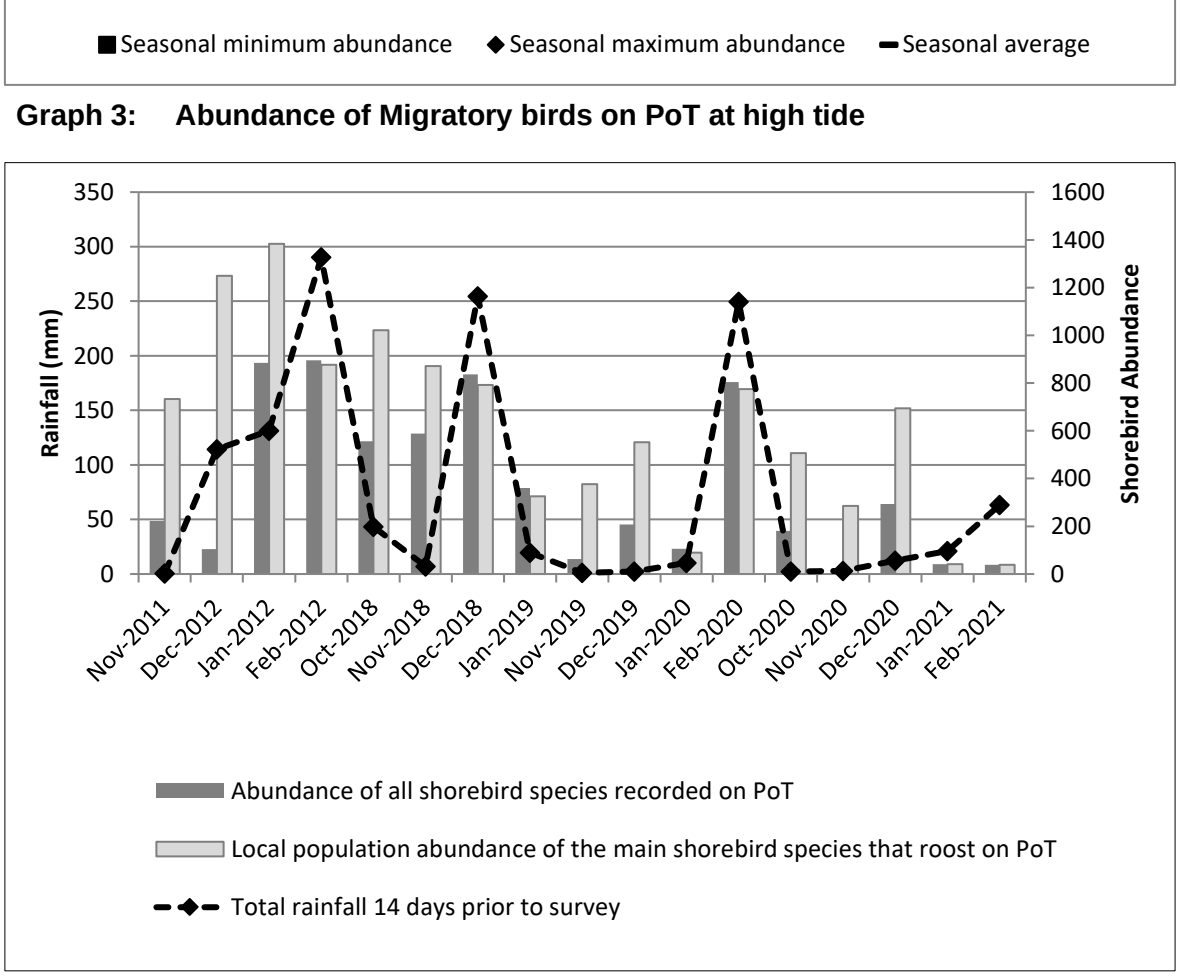
[A] Local population abundance is based on counts made at high tide at the Ross River mouth sand spit and PoT.



Graph 2: Abundance of Migratory birds on PoT at low tide



Graph 3: Abundance of Migratory birds on PoT at high tide



Graph 4: Abundance of main Migratory bird species[8] that roost on PoT at high tide in relation to local population size and rainfall

[8] Red-necked Stint, Sharp-tailed Sandpiper and Sand Plover (Greater and Lesser).

6. Conclusion

Migratory shorebirds continue to use PoT during spring and summer, primarily as a high tide roost site. Foraging was rarely observed, suggesting the Migratory shorebirds using PoT acquire most of their sustenance from sites external to PoT. Unlike previous seasons (NRA 2012, 2019, 2020a), no Migratory bird species were recorded in nationally significant numbers at PoT in the 2020/21 season.

The abundance of Migratory shorebirds using PoT in the 2020/21 season was less than in previous seasons (**Graphs 3** and **4**). The decline since the 2018/19 season is primarily due to fewer Migratory shorebirds using PoT at high tide. The decline is attributable to external factors and the progressive loss of the artificial wetlands on PoT which formed during the land reclamation and are reducing in extent and suitability (as shorebird habitat) as the reclamation progresses. Activities associated with the CU project are likely to have had a minor impact.

It is recommended that the 2021/22 monitoring event involve monthly surveys at high tide between October 2021 and February 2022, and low tide surveys in November 2021, January 2022 and February 2022. The general survey approach and locations should, as far as practical, replicate those implemented for the 2020/21 study.

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Appendix A:
Site Plan for CU Project Capital Dredging Activities
(Source: Port of Townsville Limited)

Figure 3: Site Plan for CU Project Capital Dredging Activities

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