SHOREBIRD CONSERVATION ACTION PLAN SURVEYS AND ASSESSMENT

SUNSHINE COAST

Prepared for
Sunshine Coast Council



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EXECUTIVE SUMMARY

BACKGROUND

Sunshine Coast Council (SCC) has developed a Shorebird Conservation Action Plan to raise awareness and educate the public around shorebirds, to manage and protect shorebird habitat and to provide management solutions for shorebird conservation, with a particular focus on important habitat for migratory and resident shorebirds that gather in large numbers on the sandbanks and mudflats of the lower Maroochy River and the Caloundra Banks on the northern Pumicestone Passage.

Three key objectives of the Shorebird Conservation Action Plan are to:

- Identify current migratory and resident shorebird habitats within the SCC local government area (LGA);
- Identify species and abundance of migratory and resident shorebirds in those habitats; and
- Determine the main threats to migratory and resident shorebirds in the SCC LGA and incorporate site management needs and recommendations.

STUDY APPROACH

This study aims to implement the key objectives of the Shorebird Conservation Action Plan through a combination of:

- Review and analysis of shorebird survey data for the SCC LGA collected by the Queensland Wader Study Group (QWSG); and
- Conducting shorebird surveys of the lower Maroochy River and the Caloundra Banks to determine current shorebird distribution and habitat, identify which shorebird species are present and determine the type and extent of disturbance.

KEY RESULTS

Lower Maroochy River

Tidal flats along the lower Maroochy River supported an average of 109 and a maximum of 146 migratory shorebirds, and an average of 9 and a maximum of 16 resident shorebirds during five summer surveys in 2020/21. The migratory shorebirds included an average of 8 and a maximum of 13 of the critically endangered Far Eastern Curlew and an average of 21 and a maximum of 35 of the vulnerable Bar-tailed Godwit. The most important tidal flat area for foraging migratory shorebirds was MR06 on the eastern side of Goat Island, which supported an average of 68 and a maximum of 96 migratory shorebirds at low tide. Other important tidal flats were MR04 (average of 27, maximum of 35 migratory shorebirds) and MR07 (average of 9, maximum of 25 migratory shorebirds), both on the western side of Goat Island. Sources of disturbance were greatest at MR06 and MR03, mostly from people walking dogs off-leash.

Four main roost sites used by shorebirds and other waterbirds occur in the lower Maroochy River: Goat Island (MRGI); Nojoor Road (MRNR); north shore (MRNS); and sand bar (MRSB). During a single high tide survey on 12 November 2020 a total of 84 migratory shorebirds were roosting on a raised sandbank on the eastern side of Goat Island, including 6 critically endangered Far Eastern Curlew and 25 vulnerable Bar-tailed Godwit. Based on QWSG data since 1997 a total of 20 migratory shorebird species and seven resident shorebird species have been recorded roosting at high tide at roost sites on the lower Maroochy River, with the north shore, Goat Island and the sand bank being most frequently used. The QWSG discontinued monitoring of roost sites on the lower Maroochy River after 2012 due to increasing levels of disturbance affecting the counts. Based on QWSG data, the north shore has experienced the

highest frequency of disturbance across all categories, including the presence of dogs. QWSG counters report that the north shore has largely been abandoned as a roost site due to the high frequency of disturbance from recreational activities. The dynamic changes to the sandbanks may also have altered roost suitability. This effective loss of a roost site reduces the resilience of shorebirds to disturbance since there are fewer alternative roost sites available should disturbance cause them to leave a particular roost site.

Caloundra

Four main areas of tidal flat feeding habitat occur in the northern Pumicestone Passage at Caloundra that have been subject to monitoring during this study in 2020/21 and by the QWSG since 1993. During four summer surveys in 2020/21, the tidal flats supported an average combined total of 198 and a maximum of 224 migratory shorebirds, and an average of 8 and maximum of 14 resident shorebirds during the summer season. The migratory shorebirds included an average of 32 and a maximum of 35 of the critically endangered Far Eastern Curlew and an average of 86 and a maximum of 123 of the vulnerable Bar-tailed Godwit. The tidal flat areas of SBN1, SBN2 and PEWA were important feeding areas for migratory shorebirds, particularly for the critically endangered Far Eastern Curlew, vulnerable Bar-tailed Godwit, Eurasian Whimbrel and Pacific Golden Plover. Three other migratory shorebird species were recorded occasionally in small numbers, together with small numbers of five resident shorebird species that included a pair of vulnerable Beach Stone-curlew.

Based on analysis of long-term QWSG data, a total of 19 migratory shorebird species and seven resident shorebird species have been recorded feeding at low tide on tidal flats at Caloundra since 1993. There is evidence that there has been a long-term reduction in the total numbers of migratory shorebirds using the SBN1, SBN2 and BECK tidal flat areas between 1993 and 2020. Several species also appear to have declined in abundance since 1993 across one or more of the four tidal flat areas, including Greater Sand Plover, Lesser Sand Plover, Curlew Sandpiper, Grey-tailed Tattler, Red-necked Stint and Bar-tailed Godwit.

Five known shorebird roost sites occur at Caloundra. Four of these roost sites (CBAR, SBN1, SBN2, BCTR) were surveyed during the 2020/21 season. During four summer surveys in 2020/21, two sandbanks in the centre of the Pumicestone Passage channel (SBN1 and SBN2) were used by roosting shorebirds and other waterbirds (mostly terns, including up to 299 Little Tern) when they remained exposed on neap high tides; these sandbanks were not available as roost sites on higher tides when they were covered by water. As the two passage sandbars became covered by the rising tide, shorebirds sometimes moved to an area of saltmarsh on the shoreline of Bribie Island that also formed part of the SBN1 roost site. A flock of between 24 and 28 Far Eastern Curlew roosted at either SBN1 or CBAR during the summer months. Eurasian Whimbrels used most of the roost sites, including a mangrove tree roost (BCTR) opposite Bell's Creek that was discovered for the first time during the surveys. Bar-tailed Godwits were present on only one of the summer-season surveys when a flock of 126 roosted on the SBN2 sandbar when this remained exposed on a neap high tide.

The three roost sites CBAR, SBN1 and SBN2 have been monitored intermittently by the QWSG since 1993 while a minor roost site at Wickham Point (WICK) has been monitored continuously since 1999. A total of 17 migratory shorebird species and seven resident shorebird species have been recorded roosting at these high tide roost sites at Caloundra. The most commonly recorded migratory shorebird species included the vulnerable Bar-tailed Godwit, the critically endangered Far Eastern Curlew, Eurasian Whimbrel and Pacific Golden Plover, the four species that were also most frequently present feeding on the tidal flats at low tide.

RECOMMENDATIONS

This report identifies the most important areas for shorebirds along the Lower Maroochy River and at Caloundra and existing levels of disturbance to shorebirds in these areas. This disturbance pressure is predicted to continue to increase as the region becomes more developed.

Consequently, there is a need for proactive management of disturbance to shorebirds at the important roosting and feeding habitats along the Lower Maroochy River and at Caloundra.

Recommended approaches for reducing disturbance to feeding and roosting shorebirds include a combination of:

- Site-specific information signage to raise awareness of the presence of shorebirds in the area and the importance of the key habitat areas for shorebirds, particularly migratory shorebirds;
- Other approaches to raising public awareness of how the migration and feeding ecology of shorebirds are impacted by disturbances to try to change public awareness of, and attitudes towards disturbing shorebirds, particularly among dog-owners that exercise their dogs along foreshore areas;
- Planning to ensure suitable dog-walking facilities such as dog-off leash areas are situated in locations convenient and attractive to the public but separated from important shorebird foreshore habitats;
- Planning to limit access to important feeding or roosting areas by people and/or dogs; and
- Effective enforcement of access restrictions and dog on-leash areas, given that compliance to access restrictions or on-leash laws is strongly dependent on the extent of enforcement.

SHOREBIRD CONSERVATION ACTION PLAN SURVEYS AND ASSESSMENT

SUNSHINE COAST

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Table of Terms and Abbreviations

BAAM	Biodiversity Assessment and Management Pty Ltd
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
QWSG	Queensland Wader Study Group
LGA	Local government area
NC Act	Queensland *Nature Conservation Act 1992*
SCC	Sunshine Coast Council

1.0 INTRODUCTION

1.1 BACKGROUND

Sunshine Coast Council (SCC) has developed a Shorebird Conservation Action Plan to raise awareness and educate the public around shorebirds, to manage and protect shorebird habitat and to provide management solutions for shorebird conservation, with a particular focus on important habitat for migratory and resident shorebirds that gather in large numbers on the sandbanks and mudflats of the lower Maroochy River and the Caloundra Banks on the northern Pumicestone Passage.

Three key objectives of the Shorebird Conservation Action Plan are to:

- Identify current migratory and resident shorebird habitats within the SCC local government area (LGA);
- Identify species and abundance of migratory and resident shorebirds in those habitats; and
- Determine the main threats to migratory and resident shorebirds in the SCC LGA and incorporate site management needs and recommendations.

1.2 OBJECTIVES OF THIS STUDY

This study aims to implement the key objectives of the Shorebird Conservation Action Plan identified in **Section 1.1** above through a combination of:

- Review and analysis of shorebird survey data for the SCC LGA collected by the Queensland Wader Study Group (QWSG); and
- Conducting five shorebird surveys of the lower Maroochy River and the Caloundra Banks to determine current shorebird distribution and habitat, identify which shorebird species are present, and determine the type and extent of disturbance.

The QWSG is a special interest group of the Queensland Ornithological Society Incorporated that monitor shorebird populations in Queensland and conducts regular shorebird surveys of different parts of the Queensland coast that have large shorebird populations. The surveys and review of count data supplied by the QWSG aimed to provide information on the following:

- Shorebird statistics: total abundance; species observed; and species abundance;
- Shorebird behaviour: activity (roosting/foraging); and spatial data of foraging locations; and
- Frequency and type of disturbance observed.

2.0 STUDY APPROACH

The QWSG has historical data for roost sites monitored at both Caloundra (Caloundra Bar to 2010, Whickham Point) and the lower Maroochy River (to 2012) and four feeding habitat areas at Caloundra, and still currently undertakes monthly monitoring of many of these sites. The study approach therefore combined an analysis of all existing QWSG high tide and low tide data for the study area with field surveys of shorebirds using roost sites at high tide and tidal flat feeding habitats at low tide, as outlined in more detail below.

2.1 HIGH TIDE SURVEYS

2.1.1 Lower Maroochy River

Based on initial communications with the QWSG, it was understood that the monitoring of known shoreline roost sites on the lower Maroochy River was ongoing by the QWSG on a monthly basis; therefore, only one initial high tide survey was proposed to be undertaken on the lower Maroochy River. This survey used a boat to survey the edges of all mangroves fringing the river for shorebird species that roost in mangroves. In combination with the QWSG data, this was expected to provide a good estimate of the total shorebird roosting population in the lower Maroochy River and inform an assessment of whether any further surveys were required to target mangrove roost sites.

2.1.2 Caloundra

Besides the ongoing monitoring of the roost site at Wickham Point, there has been limited monitoring of roost sites at Caloundra since 2011. This is partly due to the difficulty in accessing potential roost sites without the use of a boat. Surveys by boat were therefore undertaken to provide easier access to the Caloundra Bar and other potential roost sites, including all mangroves fringing the passage from Caloundra Bar south to Bell's Creek. A total of five high tide surveys of roosting habitats were conducted, four in summer and one in winter.

2.2 LOW TIDE SURVEYS

Low tide surveys of tidal flat feeding habitats were undertaken at each of the lower Maroochy River (six surveys, five in summer and one in winter) and Caloundra Banks (five surveys, four in summer and one in winter). The surveys combined observations conducted from a boat with observations from the shoreline. The use of a boat allowed the surveys to be conducted over a shorter period of time and allowed access to areas that are problematic to survey from the shoreline due to the width of the open water channels. The low tide surveys of the lower Maroochy River covered the full length and width of the lower Maroochy River from 1 km upstream of the Sunshine Motorway bridge through to the river mouth. The low tide surveys at Caloundra covered the tidal flats on both sides of Pumicestone Passage from the Caloundra Bar south to Bell's Creek.

2.3 GENERAL SURVEY METHODS

The summer surveys included two surveys in the December-January school holidays to get a better understanding of the amount of disturbance associated with school holidays. The surveys were conducted in accordance with migratory shorebird survey guidelines (Commonwealth of Australia 2015). Specifically:

- The surveys for foraging shorebirds were conducted as close to the time of low tide as practicable and at a maximum of no more than two hours either side of low tide;
- The surveys for roosting shorebirds were conducted as close to the time of high tide as practicable and at a maximum of no more than two hours either side of high tide;
- The surveys were not undertaken during periods of high rainfall or strong winds;
- The surveys determined the total number of individuals of each species present, to enable assessment of site and habitat importance; and
- The surveys collected spatial data of the area used by shorebirds for roosting and feeding to facilitate mapping of roosting and foraging habitat.

Shorebirds were surveyed using a combination of a high-powered spotting telescope mounted on a secure tripod (on land) and high quality 10x40 binoculars (on the boat). Sources of actual or potential disturbance observed within or close to each survey site (close enough to cause disturbance) were recorded as a count of people, dogs on leash, dogs off leash, and watercraft during a single observation sweep of the survey site to provide a snapshot in time as per the

approach of Stigner *et al*. (2016). Disturbance is an event that causes birds to cease foraging or resting activities to become alert, start walking away from the source of disturbance or take flight in response to the disturbance.

The first of the five surveys was undertaken by Dr Penn Lloyd (Principal Ecologist) and Dr Peter Driscoll (shorebird specialist), whereas the remaining four surveys were led by Dr Peter Driscoll with assistance from Laura Smith or Dr Simone Bosshard (Sunshine Coast Council). Both Peter and Penn have extensive experience in the identification, counting and survey of migratory shorebirds.

2.4 STATISTICAL ANALYSIS

Tests for temporal trends in shorebird count numbers at any site were conducted using a non-parametric Mann-Kendall trend test in R (R Core Team 2021) to statistically assess if there is a monotonic upward or downward trend in shorebird numbers over time. A monotonic upward (or downward) trend means that the variable consistently increases (or decreases) through time, but the trend may or may not be linear. Average counts are reported ± 1 standard deviation, where the standard deviation is a measure of the variability in the counts.

3.0 RESULTS AND DISCUSSION

3.1 BACKGROUND ON SHOREBIRD ECOLOGY

Most shorebirds live on or near the coast, on beaches, reefs and tidal mudflats, though some also frequent, or are largely confined to, freshwater habitats (Colwell 2010). Most coastal species feed on flat, tidal shores with extensive muddy or sandy intertidal areas (hereafter referred to as tidal flats). Most species are gregarious, wary and fly strongly and swiftly (Geering *et al*. 2007; Colwell 2010). A large proportion of Australia's shorebird species are migratory, spending their non-breeding season (the Austral summer) in Australia and migrating up to 13,000 km north along the East Asian–Australasian Flyway to breeding grounds in eastern Siberia and western Alaska (most species, Bamford *et al*. 2008) or south to New Zealand (Double-banded Plover (*Charadrius bicinctus*), Pierce 1999).

On their non-breeding grounds in Australia, coastal migratory shorebirds have a daily activity pattern driven largely by the tidal cycle, roosting in flocks at sites above the high-water mark at high tide and moving to tidal flat feeding areas as the tide recedes (Colwell 2010). They are capable of feeding during both the day and night. Shorebirds feed on a wide variety of benthic invertebrates, including crustaceans, molluscs and polychaete worms that are taken either on the surface of tidal flats or extracted from soft, muddy or sandy sediments by probing with bills, which are elongated in many species. Different shorebird species specialise on different prey, prey sizes and feeding styles depending on their evolved bill morphology and body size (Lifjeld 1984; Baker 1989; Barbosa and Moreno1999; Durell 2000). Species with long, slender bills like the Far Eastern Curlew that depend on deep probing of sediments for locating prey tend to prefer feeding in softer sediments with less resistance to bill probing (Finn *et al*. 2008).

Coastal shorebirds also depend on roosting areas near their feeding areas that allow them to rest (during times when their feeding habitat is inundated at high tide) without losing too much energy to disturbance (Colwell 2010). Migratory shorebirds select roost sites on the basis of: distance from feeding areas (preferring sites close to feeding areas since that reduces their energy expenditure flying between roosting and feeding sites); distance from tall cover (preferring sites with little cover to ensure a clear view of approaching predators); climate (preferring sites at the water's edge to stay cool); height of the tide (whether the site will be inundated); and background colour of the roost site (providing camouflage against predators) (Rogers *et al*. 2006a). There is also some evidence that feeding site selection is influenced by distance from available roost sites (Rogers *et al*. 2006a), since energy expended flying between feeding and roosting sites reduces the birds'

ability to store fat for migration (Rogers 2003). As a result of these requirements, both feeding and roosting habitats are essential to migratory shorebirds.

Migratory shorebirds are particularly sensitive to disturbance at roost sites since they are often concentrated into small areas at roost sites that may be quite distant from the nearest suitable alternative. Ongoing urban development and population growth in south-east Queensland is resulting in steadily increasing disturbance pressure on shorebirds at both roost sites and tidal flat feeding habitats sites (Fuller *et al.* 2019).

3.2 SURVEY TIMING AND CONDITIONS

The survey dates and survey conditions during the surveys of the lower Maroochy River and Caloundra are summarised in **Appendix 1**. All surveys were conducted during conditions that were suitable for conducting a shorebird survey.

3.3 LOWER MAROOCHY RIVER

3.3.1 Low tide surveys

The five summer surveys and one winter survey of foraging shorebirds covered seven different areas of tidal flat exposed at low tide. The locations of these areas are shown in **Figure 3.1**. **Table 3.1** summarises the summer-season survey results. Tidal flats along the lower Maroochy River supported an average of 109 and a maximum of 146 migratory shorebirds, and an average of 9 and a maximum of 16 resident shorebirds during the summer season. The migratory shorebirds included an average of 8 and a maximum of 13 critically endangered Far Eastern Curlew and an average of 21 and a maximum of 35 vulnerable Bar-tailed Godwit.

The most important tidal flat area for foraging migratory shorebirds was MR06 on the eastern side of Goat Island, which supported an average of 68 and a maximum of 96 migratory shorebirds at low tide. Other important tidal flats were MR04 (average of 27, maximum of 35 migratory shorebirds) and MR07 (average of 9, maximum of 25 migratory shorebirds), both on the western side of Goat Island. Sources of disturbance were greatest at MR06 and MR03, mostly from people walking dogs off-leash. During the single winter survey, four Bar-tailed Godwit were feeding at MR04 and a single Eurasian Whimbrel was feeding at MR06, but no Double-banded Plovers were observed. Double-banded Plovers are only present in Australia during the winter months, after they migrate from breeding grounds in New Zealand. The large numbers of other waterbirds observed at MR06 (**Table 3.1**) were mostly a variety of terns roosting in large flocks at low tide.

3.3.2 High tide surveys

Four main roost sites used by shorebirds and other waterbirds occur in the lower Maroochy River (see **Figure 3.2** for their current locations): Goat Island (MRGI); Nojoor Road (MRNR); north shore (MRNS); and sand bar (MRSB). The results of the single high tide survey on 12 November 2020 are presented in **Table 3.2**. A total of 84 migratory shorebirds were roosting on a raised sandbank on the eastern side of Goat Island. No birds were observed on the north shore (MRNS), where dogs were being walked off-leash; it was apparent that the north shore has become a popular location to walk dogs off-leash. The other waterbirds roosting at the sand bank (MRSB) and Goat Island included Silver Gulls and several species of tern.

The four Maroochy River roost sites were regularly monitored by the QWSG from 1997 to 2012, with few surveys on high tides since then. The analysis that follows is based on a combination of the one high tide survey undertaken during 2020/21 and all QWSG data. The locations of the roost sites at the mouth of the Maroochy River have changed over time due to the dynamic nature of the sand bars at the river mouth. A total of 20 migratory shorebird species and seven resident shorebird species have been recorded roosting at high tide at roost sites on the lower Maroochy River, with the north shore, Goat Island and the sand bank being most frequently used (**Table 3.3**).

Table 3.1. Summary of shorebird species, their status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) and Queensland *Nature Conservation Act 1992* (NCA) and the average ± 1 standard deviation and maximum (in brackets) numbers recorded in each of the seven low tide survey areas (MR01 to MR07) during the five summer season surveys of the lower Maroochy River in 2020/21.

Common name	Species	EPBC*	NCA*	MR01	MR02	MR03	MR04	MR05	MR06	MR07
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E		1±1.2 (3)	0.2±0.4 (1)	1.2±1.3 (3)		4.4±2.7 (8)	1.2±0.8 (2)
Eurasian Whimbrel	*Numenius phaeopus*	M	S	0.4±0.9 (2)	0.6±0.5 (1)	0.2±0.4 (1)	7±2.5 (9)	1.2±1.3 (3)	22.4±5.3 (29)	3.4±3.2 (8)
Bar-tailed Godwit (Western Alaskan)	*Limosa lapponica baueri*	M, V	V		1±1.4 (3)	0.6±1.3 (3)	13.4±6.1 (23)		4.2±2.5 (6)	1.8±2.7 (6)
Pacific Golden Plover	*Pluvialis fulva*	M	S				4.8±6.7 (14)		36.6±24.1 (58)	2.8±6.3 (14)
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V				0.4±0.9 (2)			
Great Knot	*Calidris tenuirostris*	M, CE	E						0.4±0.9 (2)	
Pied Oystercatcher	*Haematopus longirostris*		LC	0.8±1.1 (2)			0.2±0.4 (1)		1.8±0.8 (3)	1.6±1.8 (4)
Masked Lapwing	*Vanellus miles*		LC	1.4±1.3 (3)					0.4±0.9 (2)	
Red-capped Plover	*Charadrius ruficapillus*		LC						3.2±4.7 (11)	
Total migratory shorebirds				**0.4±0.9 (2)**	**2.6±2.3 (5)**	**1±2.2 (5)**	**26.8±10 (35)**	**1.2±1.3 (3)**	**68±29.8 (96)**	**9.2±9.4 (25)**
Total resident shorebirds				**2.2±1.5 (4)**			**0.2±0.4 (1)**		**5.4±4.8 (13)**	**1.6±1.8 (4)**
Total other waterbirds				6.6±7.5 (18)	4.6±3.8 (9)	3.4±7.6 (17)	19.4±9.2 (32)	3.6±8 (18)	722.8±699.2 (1754)	20.2±11.6 (36)

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

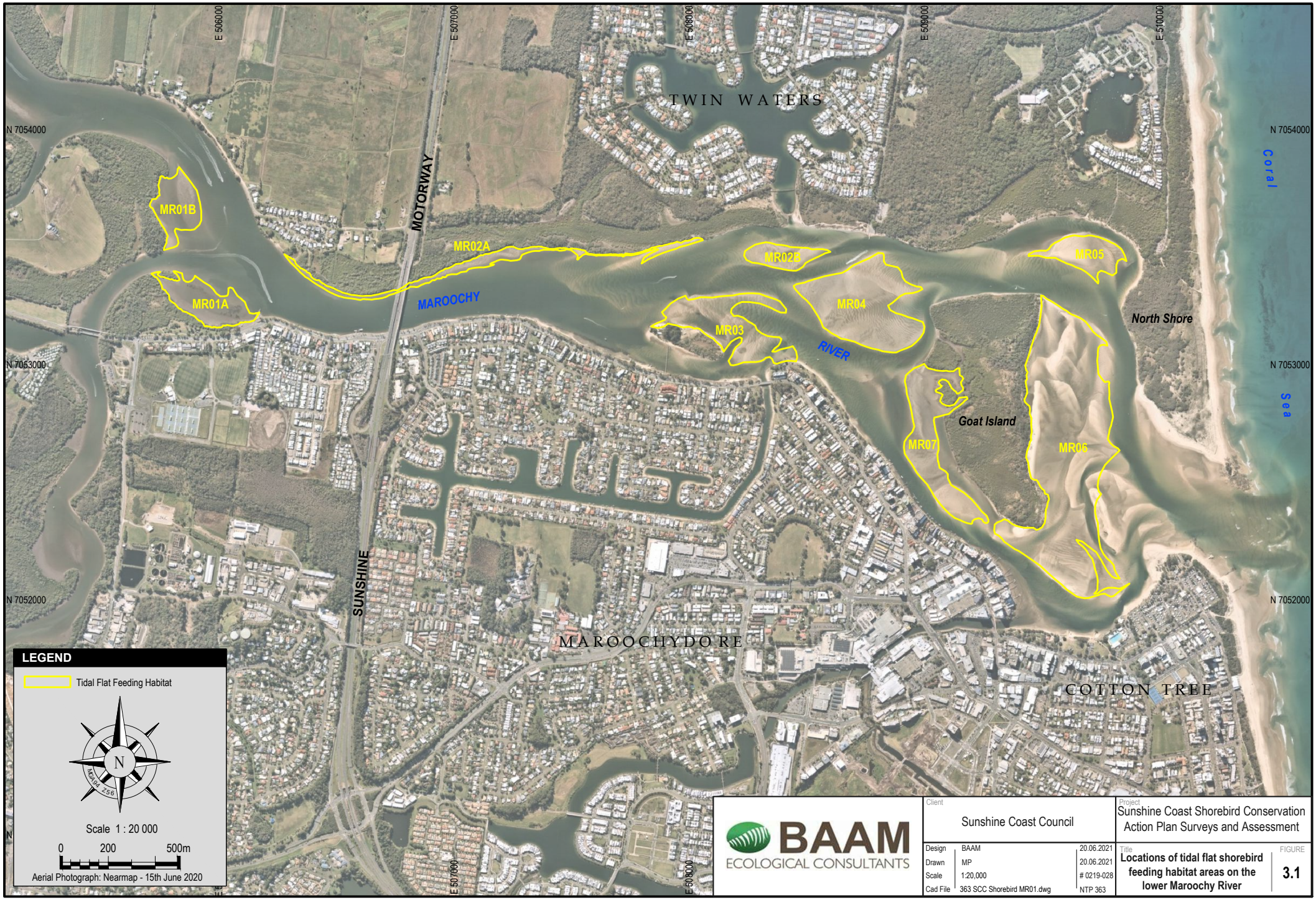

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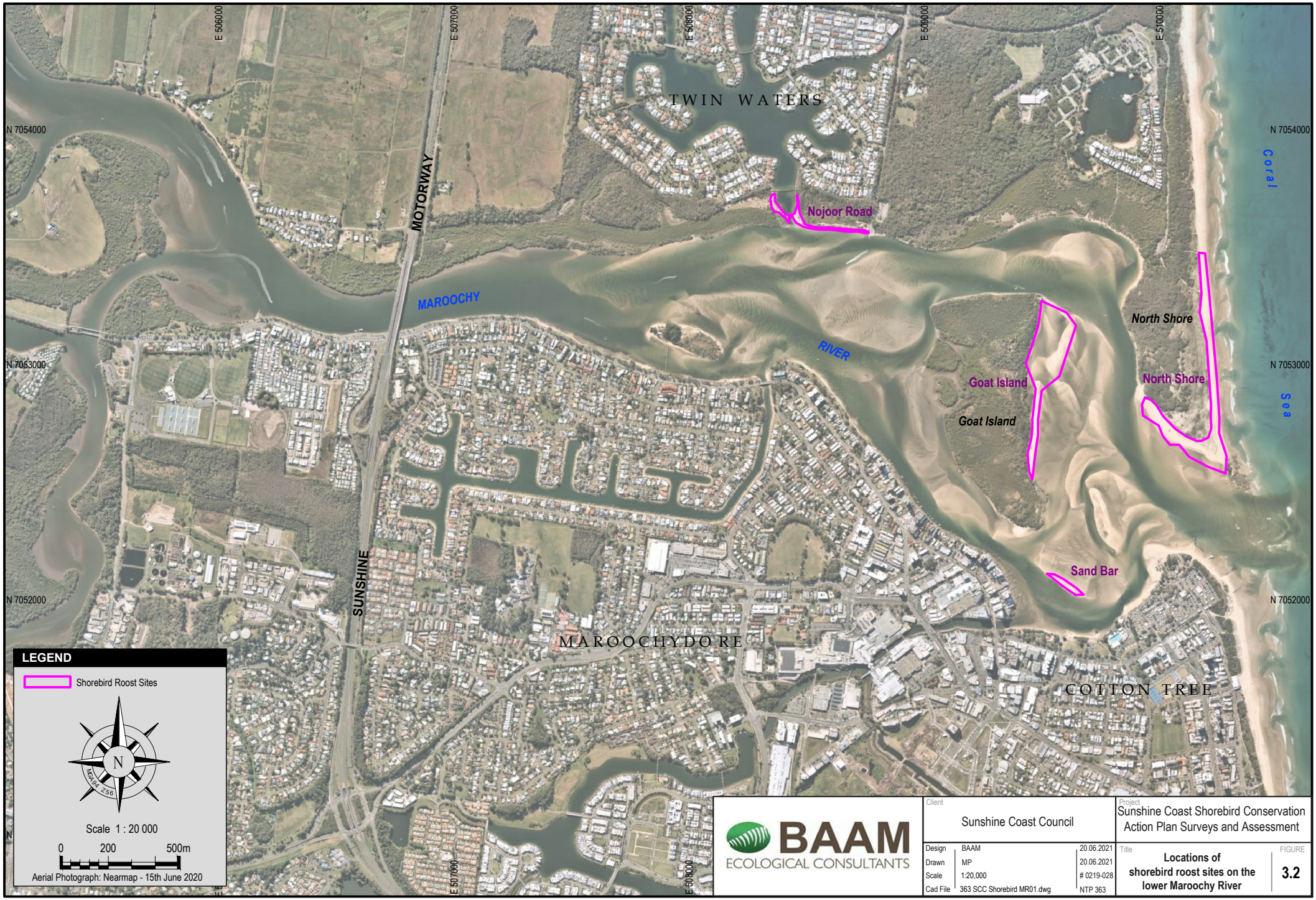
FIGURE **3.1**



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Client	Sunshine Coast Council	Project	Sunshine Coast Shorebird Conservation Action Plan Surveys and Assessment
Design	BAAM	20.06.2021	
Drawn	MP	20.06.2021	
Scale	1:20,000	# 0219-028	
Cad File	363 SCC Shorebird MR01.dwg	NTP 363	
Title	Locations of shorebird roost sites on the lower Maroochy River	FIGURE	3.2

A breakdown of the frequency of use of the roost sites by each species during different times of the year is provided in **Appendix 2**; these data confirm that the roost sites are used by migratory shorebirds during all months of the year, including by overwintering juvenile birds through the winter months. Overwintering juveniles are individuals that choose not to migrate to the northern hemisphere breeding grounds and remain in Australia through the austral winter.

Table 3.2. Summary of the total numbers of shorebird species and other waterbirds roosting at roost sites in the lower Maroochy River during a high tide on 12 November 2020.

Common name	Species	EPBC*	NCA*	MRGI	MRNR	MRNS	MRSB
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	6			
Eurasian Whimbrel	*Numenius phaeopus*	M	S	42			
Bar-tailed Godwit (Western Alaskan)	*Limosa lapponica baueri*	M, V	V	25			
Pacific Golden Plover	*Pluvialis fulva*	M	S	1			
Red-necked Stint	*Calidris ruficollis*	M	S	1			
Grey-tailed Tattler	*Tringa brevipes*	M	S	9			
Beach Stone-curlew	*Esacus magnirostris*		V	1			
Pied Oystercatcher	*Haematopus longirostris*		LC	1			
Total migratory shorebirds				**84**	**0**	**0**	**0**
Total resident shorebirds				**2**	**0**	**0**	**0**
Total other waterbirds				41	0	0	198

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table 3.3. Summary of the percentage of high tide surveys (within 1.5 hours either side of high tide) in all months of the year that shorebirds have been recorded roosting at each of the four main roost sites on the lower Maroochy River: Goat Island (MRGI); Nojoor Road (MRNR); north shore (MRNS); and sand bar (MRSB).

Roost site				MRGI	MRNR	MRNS	MRSB
Total number of high tide surveys (1997 to 2021, all months)				**143**	**159**	**159**	**161**
Common name	**Species**	**EPBC***	**NCA***				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	19%	10%	16%	20%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	27%	9%	36%	16%
Bar-tailed Godwit (Western Alaskan)	*Limosa lapponica baueri*	M, V	V	24%	8%	33%	25%
Black-tailed Godwit	*Limosa limosa*	M	S	1%		1%	1%
Pacific Golden Plover	*Pluvialis fulva*	M	S	10%	1%	45%	7%
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V			11%	1%
Lesser Sand Plover	*Charadrius mongolus*	M, E	E		1%	14%	
Double-banded Plover	*Charadrius bicinctus*	M	S	1%		22%	4%
Ruddy Turnstone	*Arenaria interpres*	M	S		1%	7%	1%
Sharp-tailed Sandpiper	*Calidris acuminata*	M	S	1%		1%	
Sanderling	*Calidris alba*	M	S			1%	
Red Knot	*Calidris canutus*	M, E	E				1%
Broad-billed Sandpiper	*Calidris falcinellus*	M	S			1%	
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E			6%	
Red-necked Stint	*Calidris ruficollis*	M	S	1%	2%	34%	1%
Great Knot	*Calidris tenuirostris*	M, CE	E	1%		6%	2%
Grey-tailed Tattler	*Tringa brevipes*	M	S	9%	3%	6%	1%
Wandering Tattler	*Tringa incana*	M	S			3%	
Common Greenshank	*Tringa nebularia*	M	S	1%	1%		
Terek Sandpiper	*Xenus cinereus*	M	S	1%		4%	
Beach Stone-curlew	*Esacus magnirostris*		V	3%	1%	2%	
Sooty Oystercatcher	*Haematopus fuliginosus*		LC	1%		5%	3%

Roost site				MRGI	MRNR	MRNS	MRSB
Total number of high tide surveys (1997 to 2021, all months)				143	159	159	161
Common name	Species	EPBC*	NCA*				
Pied Oystercatcher	*Haematopus longirostris*		LC	46%	16%	21%	30%
Pied Stilt	*Himantopus leucocephalus*		LC	3%	6%		1%
Masked Lapwing	*Vanellus miles*		LC	2%	13%	4%	1%
Red-capped Plover	*Charadrius ruficapillus*		LC	2%	3%	81%	17%
Black-fronted Dotterel	*Elseyornis melanops*		LC		1%		1%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Figure 3.3 shows the maximum count of migratory shorebirds at each of the four roost sites at different periods of the annual migratory shorebird season in each year that monitoring of high tide roost sites has been undertaken since 1997. The QWSG defines the different periods of the annual migratory shorebird season in Australia as: (1) inbound migration (September to mid-November), the period when shorebirds arrive in Australia after breeding in the northern hemisphere; (2) summer non-breeding (mid-November to mid-March); (3) outbound migration (mid-March to May), the period when shorebirds leave to migrate to their breeding grounds; and (4) winter breeding (June to August) periods. Birds present in Australia during the winter period are typically juvenile birds that do not migrate back to the northern hemisphere breeding grounds for several years until they are ready to start breeding.

The QWSG data show that that the north shore (MRNS) was the most important migratory shorebird roost site in the lower Maroochy River area up until at least 2009. The QWSG discontinued monitoring of roost sites on the lower Maroochy River after 2012 due to increasing levels of disturbance affecting the counts. Based on QWSG data, the north shore has experienced the highest frequency of disturbance across all categories, including the presence of dogs (see **Section 3.3.3** below).

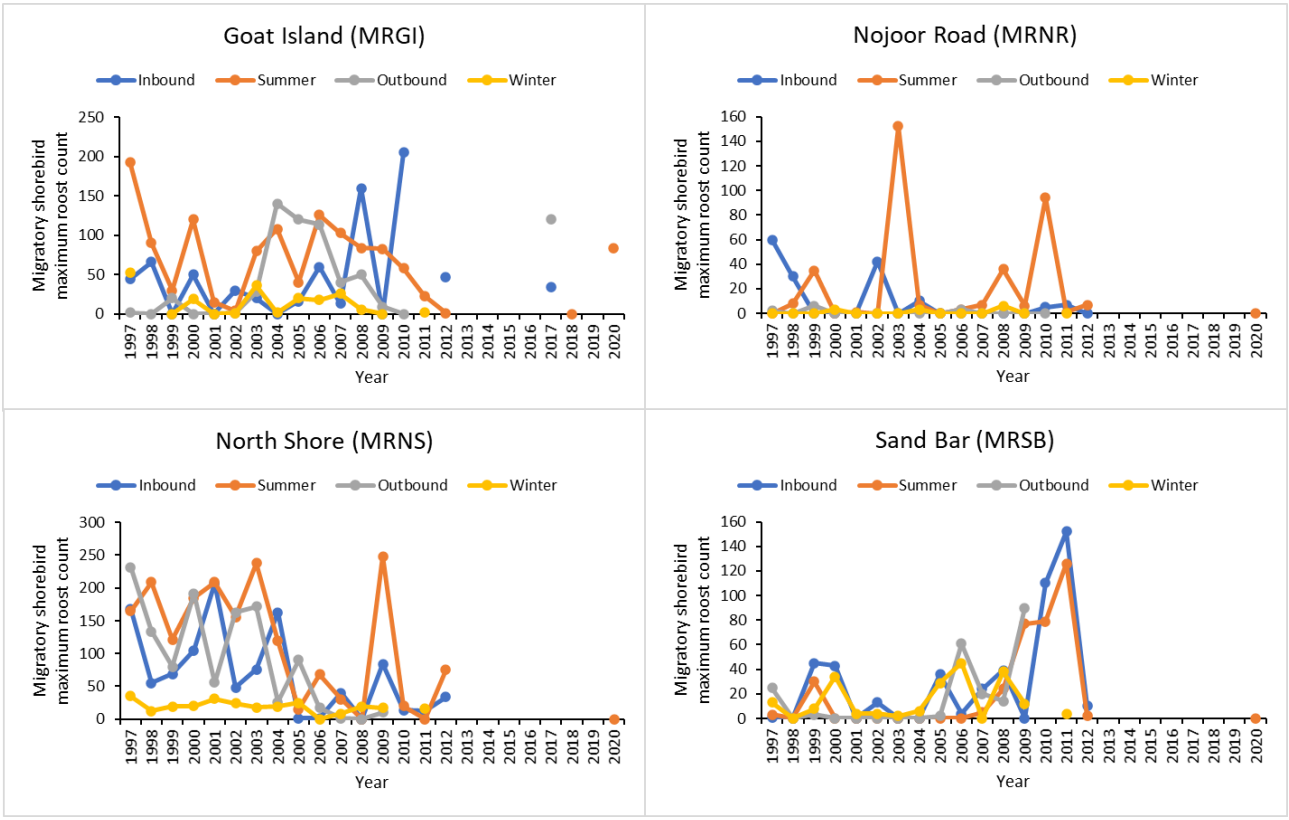

Figure 3.3. Annual maximum count of migratory shorebirds at high tide (within 1.5 hrs either side of high tide) at each of four roost sites in the lower Maroochy River since 1997 based on QWSG data and this study.

QWSG counters report that the north shore has largely been abandoned as a roost site due to the high frequency of disturbance from recreational activities. The dynamic changes to the sandbanks may also have altered roost suitability. This effective loss of a roost site reduces the resilience of shorebirds to disturbance since there are fewer alternative roost sites available should disturbance cause them to leave a particular roost site.

3.3.3 Disturbance

Shorebird roost sites and tidal flat feeding habitat areas in the lower Maroochy River are subject to multiple sources of disturbance to roosting or feeding shorebirds, including people using the area for recreation, dogs being walked on and off-leash and various watercraft. QWSG survey data on disturbance are not captured in a format that allows examination of temporal trends in disturbance with sufficient rigour. However, the data do allow comparison of the relative frequency of different sources of potential or actual disturbance between sites. These data show that the north shore has experienced the highest disturbance pressure, particularly from people and dogs walking along the shoreline at all tides (**Table 3.4**).

Table 3.4. Percentage of surveys in which people, dogs, boats or jetskis were recorded as potential or actual sources of disturbance to roosting or feeding birds at sites in the lower Maroochy River.

Site	Surveys	People	Dogs	Boats	Jetskis
Goat Island (MRGI)	286	42%	17%	33%	13%
Nojoor Rd (MRNR)	295	52%	26%	28%	20%
North shore (MRNS)	294	67%	61%	36%	27%
Sandbank (MRSB)	302	39%	27%	28%	13%

3.4 CALOUNDRA

3.4.1 Low tide surveys

Four main areas of tidal flat feeding habitat occur at Caloundra and have been subject to monitoring during this study in 2020/21 and by the QWSG since 1993 (see **Figure 3.4** for locations). The results of the four summer-season surveys by this study are summarised in **Table 3.5** below. The tidal flat areas of SBN1, SBN2 and PEWA were important feeding areas for migratory shorebirds, particularly for the critically endangered Far Eastern Curlew, vulnerable Bar-tailed Godwit, Eurasian Whimbrel and Pacific Golden Plover. Three other migratory shorebird species were recorded occasionally in small numbers, together with small numbers of five resident shorebird species that included a pair of vulnerable Beach Stone-curlew at SBN1. The tidal flats supported an average combined total of 198 and a maximum of 224 migratory shorebirds but an average of 8 and maximum of 14 resident shorebirds during the summer season. The migratory shorebirds included an average of 32 and a maximum of 35 of the critically endangered Far Eastern Curlew and an average of 86 and a maximum of 123 of the vulnerable Bar-tailed Godwit. The large numbers of other waterbirds recorded on some of the surveys were mostly terns roosting on the tidal flat sandbars at low tide.

Based on analysis of long-term QWSG data, a total of 19 migratory shorebird species and seven resident shorebird species have been recorded feeding at low tide on tidal flats in the northern Pumicestone Passage at Caloundra since 1993 (**Table 3.6**). A breakdown of the frequency of use of the tidal flats by each species during different times of the year is provided in **Appendix 3**; these data confirm that the tidal flats are used by migratory shorebirds during all months of the year, including by overwintering juvenile birds (individuals that choose not to migrate to the northern hemisphere breeding grounds) through the winter months.

BAAM ECOLOGICAL CONSULTANTS

Client: Sunshine Coast Council

Project: Sunshine Coast Shorebird Conservation Action Plan Surveys and Assessment

Design	BAAM	20.06.2021
Drawn	MP	20.06.2021
Scale	1:25,000	# 0219-028
Cad File	363 SCC Shorebird C01.dwg	NTP 363

Title: **Locations of tidal flat shorebird feeding habitat areas at Caloundra**

FIGURE **3.4**

Table 3.5. Summary of shorebird species and the average ± 1 standard deviation and maximum (in brackets) numbers recorded in each of the four low tide survey areas during the four summer-season surveys at Caloundra in 2020/21.

Common name	Species	EPBC*	NCA*	SBN1	SBN2	PEWA	BECK
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	29.3±4 (34)	1.8±0.5 (2)		0.5±1 (2)
Eurasian Whimbrel	*Numenius phaeopus*	M	S	21.3±11.5 (34)	14.3±15.3 (35)		1±2 (4)
Bar-tailed Godwit (Western Alaskan)	*Limosa lapponica baueri*	M, V	V	43.5±22.9 (77)	33.3±16.3 (47)	7.8±15.5 (31)	1.3±2.5 (5)
Pacific Golden Plover	*Pluvialis fulva*	M	S	25.3±22.7 (55)	10.3±9.3 (20)	5±10 (20)	
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E		0.5±1 (2)		
Red-necked Stint	*Calidris ruficollis*	M	S			1.3±2.5 (5)	
Common Sandpiper	*Actitis hypoleucos*	M	S	1±2 (4)	0.3±0.5 (1)		
Pied Oystercatcher	*Haematopus longirostris*		LC	3±1.8 (5)			
Masked Lapwing	*Vanellus miles*		LC	2.5±3 (6)	0.8±1.5 (3)		
Pied Stilt	*Himantopus leucocephalus*		LC				0.5±1 (2)
Red-capped Plover	*Charadrius ruficapillus*		LC	0.3±0.5 (1)			
Beach Stone-curlew	*Esacus magnirostris*		V	0.5±1 (2)			
Total migratory shorebirds				120.3±31 (154)	60.3±21.5 (88)	14±28 (56)	2.8±5.5 (11)
Total resident shorebirds				6.3±5.6 (12)	0.8±1.5 (3)	0±0 (0)	0.5±1 (2)
Total other waterbirds				328.5±293.1 (613)	523.8±468.8 (1072)	0±0 (0)	38.8±27.7 (80)

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table 3.6. Summary of the percentage of low tide surveys (within 1.5 hours either side of low tide) in all months of the year that shorebirds have been recorded feeding at each of the four main tidal flat feeding habitat areas at Caloundra since 1993 based on QWSG data.

Tidal flat feeding habitat area				SBN1	SBN2	PEWA	BECK
Total low tide surveys (all months)				**320**	**363**	**294**	**258**
Common name	**Species**	**EPBC***	**NCA***				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	77%	80%	23%	72%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	77%	79%	42%	70%
Little Curlew	*Numenius minutus*	M	S				<1%
Bar-tailed Godwit	*Limosa lapponica baueri*	M, V	V	61%	86%	52%	78%
Pacific Golden Plover	*Pluvialis fulva*	M	S	46%	74%	25%	40%
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V	30%	57%	2%	
Lesser Sand Plover	*Charadrius mongolus*	M, E	E	15%	28%		<1%
Double-banded Plover	*Charadrius bicinctus*	M	S	5%	20%		
Ruddy Turnstone	*Arenaria interpres*	M	S	<1%	1%	1%	<1%
Sharp-tailed Sandpiper	*Calidris acuminata*	M	S	<1%	1%	3%	5%
Red Knot	*Calidris canutus*	M, E	E	<1%	1%		
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E	29%	56%	10%	11%
Red-necked Stint	*Calidris ruficollis*	M	S	13%	28%	2%	<1%
Great Knot	*Calidris tenuirostris*	M, CE	E	2%	6%		<1%
Grey-tailed Tattler	*Tringa brevipes*	M	S	6%	26%	7%	38%
Common Greenshank	*Tringa nebularia*	M	S	5%	17%	10%	27%
Marsh Sandpiper	*Tringa stagnatilis*	M	S		<1%	<1%	

Tidal flat feeding habitat area				SBN1	SBN2	PEWA	BECK
Total low tide surveys (all months)				320	363	294	258
Common name	Species	EPBC*	NCA*				
Common Sandpiper	*Actitis hypoleucos*	M	S	<1%	<1%	1%	
Terek Sandpiper	*Xenus cinereus*	M	S	4%	14%	2%	9%
Beach Stone-curlew	*Esacus magnirostris*		V	4%	<1%		<1%
Sooty Oystercatcher	*Haematopus fuliginosus*		LC	<1%			<1%
Pied Oystercatcher	*Haematopus longirostris*		LC	31%	38%	17%	14%
Pied Stilt	*Himantopus leucocephalus*		LC	3%	15%	26%	81%
Masked Lapwing	*Vanellus miles*		LC	33%	9%	50%	28%
Red-capped Plover	*Charadrius ruficapillus*		LC	51%	66%	7%	10%
Black-fronted Dotterel	*Elseyornis melanops*		LC			1%	

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Figure 3.5 below shows the average (± 1 standard deviation) total migratory shorebird count at low tide (within 1.5 hours either side of low tide) during the summer-season each year since 1993 for each tidal flat feeding area at Caloundra. There is evidence that there has been a long-term reduction in the total numbers of migratory shorebirds using the SBN1, SBN2 and BECK tidal flat areas between 1993 and 2020 (**Table 3.7**).

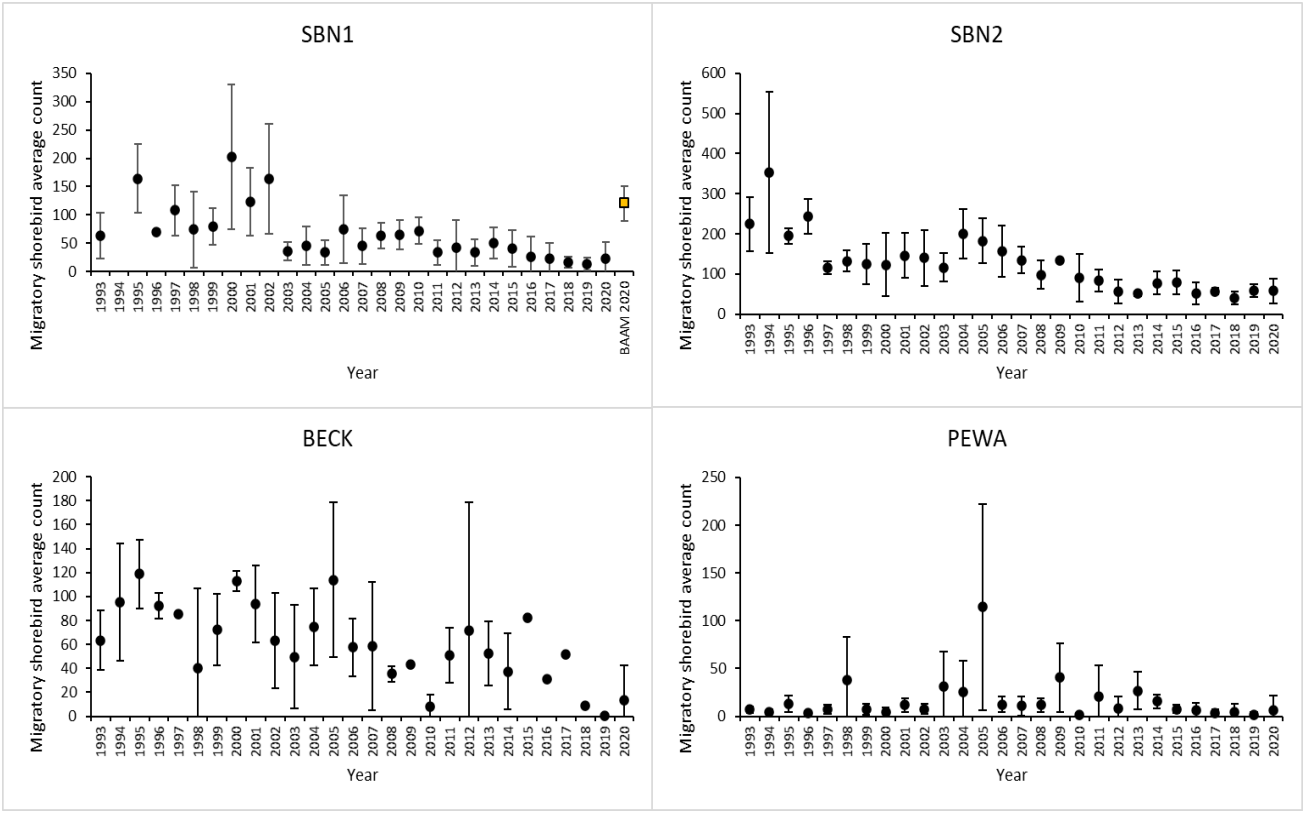

Figure 3.5. Average (± 1 standard deviation) total migratory shorebird count at low tide (within 1.5 hours either side of low tide) during the summer-season each year since 1993 for each tidal flat feeding area at Caloundra based on QWSG data and this study.

Interpretation of temporal change in migratory shorebird use of the SBN1 area is complicated by two factors. First, the position and extent of SBN1 has changed substantially since 1993 due to the dynamic nature of sand movement at the passage entrance. Second, most QWSG surveys of SBN1 have been conducted from the mainland shoreline, up to 900 m from the furthest reaches of SBN1, which results in birds, particularly individuals of smaller species being difficult to detect and identify in some portions of the SBN1 survey area, particularly on spring low tides. The detectability of birds has likely been variable over time and some surveys may have missed birds present across SBN1.

This issue is illustrated when comparing the count data for the 2020/21 summer season collected by BAAM for this study (average of 120±31 migratory shorebirds, using either a boat-based survey that allowed much closer approach to the tidal flat area or land-based survey) to that collected by QWSG volunteers (average of 22±30 migratory shorebirds, surveyed from the mainland on most surveys) over the same time period (**Figure 3.5**); there was no significant difference between BAAM and QWSG surveys of the other tidal flat survey areas that are more easily surveyed from the mainland shoreline, so the data for SBN2, BECK and PEWA are combined in **Figure 3.5**.

Examination of species-specific count data suggests several species have declined in abundance since 1993 across one or more of the four tidal flat areas; declining species include Greater Sand Plover, Lesser Sand Plover, Curlew Sandpiper, Grey-tailed Tattler, Red-necked Stint and Bar-tailed Godwit (**Figure 3.6**, **Table 3.7**). For some species such as Greater Sand Plover, Lesser Sand Plover, Curlew Sandpiper and Bar-tailed Godwit, the decline may be linked to substantial declines in the overall population visiting Australia (Wilson *et al.* 2011, Clemens *et al.* 2016, Studds *et al.* 2017). In this respect, the Far Eastern Curlew is an apparent outlier; while the overall population of this critically endangered species visiting Australia has undergone a severe population decline of 66.8% over 20 years (5.8% per year) and 81.4 % over 30 years (TSSC 2015, Studds *et al.* 2017), the only tidal flat feeding area at Caloundra that has experienced a decline in Eastern Curlew numbers feeding at low tide was the BECK tidal flat area that has generally supported fewer Far Eastern Curlew than the SBN1 and SBN2 areas (**Figure 3.6**, **Table 3.7**). The decline in the use of the Bell's Creek tidal flats has been consistent across nearly all migratory shorebird species that have used this area, whereas the abundance of some species using the SNB1 and SBN2 tidal flats has not declined (**Figure 3.6**, **Table 3.7**), including species such as Far Eastern Curlew and Eurasian Whimbrel that are typically the most sensitive to disturbance. Consequently, it is difficult to determine the relative importance of different factors that might have influenced the observed declines in the use of the various tidal flat areas by different species. These factors may include:

- The background decline in the populations of some species, as outlined above;
- Loss of some shorebird habitat to development (e.g. at Pelican Waters) and/or change in the areas of tidal flat feeding habitat resulting from sediment movement in Pumicestone Passage; and
- Increasing human disturbance of shorebirds at roost sites and feeding habitat areas as the region's population has increased.

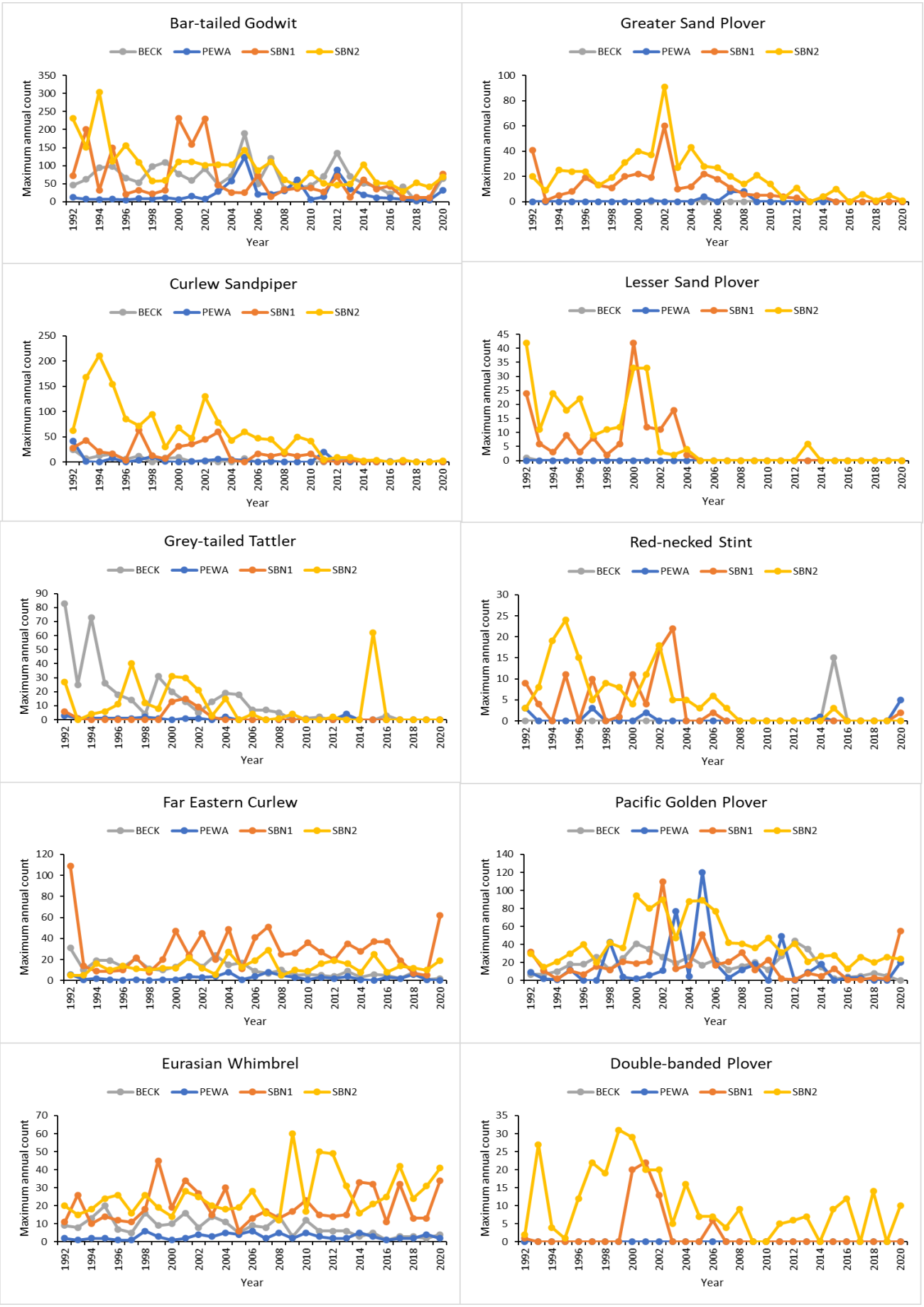

Figure 3.6. Annual maximum count of the migratory shorebird species most commonly recorded feeding at four tidal flat feeding areas at low tide at Caloundra since 1992 based on QWSG data and this study.

Table 3.7. Summary of Mann-Kendall trend test results testing whether there are trends in the abundance of migratory shorebirds and migratory shorebird species feeding on Caloundra tidal flats at low tide between 1992 and 2020.

Species / Site	Mann-Kendall trend test (*z*)[1]			
	SBN1	SBN2	PEWA	BECK
Total migratory shorebirds (average summer-season count)	-3.73 ***	-5.05 ***	-0.67	-3.73 ***
Bar-tailed Godwit (maximum annual count)	-1.61	-4.34 ***	0.96	-2.38 *
Curlew Sandpiper (maximum annual count)	-4.24 ***	-5.67 ***	-2.66 **	-3.96 ***
Greater Sand Plover (maximum annual count)	-4.18 ***	-3.40 ***		
Lesser Sand Plover (maximum annual count)	-4.21 ***	-4.62 ***		
Grey-tailed Tattler (maximum annual count)	-2.34 *	-3.20 **		-5.43 ***
Red-necked Stint (maximum annual count)	-2.48 *	-4.63 ***		
Far Eastern Curlew (maximum annual count)	0.83	1.13	0.15	-4.78 ***
Eurasian Whimbrel (maximum annual count)	0.92	1.95	0.86	-3.71 ***
Pacific Golden Plover (maximum annual count)	-1.24	-1.60	-0.17	-1.30
Double-banded Plover (maximum annual count)	-1.63	-1.71		

[1] Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

3.4.2 High tide surveys

Five known shorebird roost sites occur at Caloundra (see **Figure 3.7**):

- Caloundra bar (CBAR), including a sand bank at the Pumicestone Passage entrance and the beach south of the entrance;
- Sandbank 1 (SBN1), including a sandbank in the passage (remains exposed on neap high tides only), a sandbank on the north-western shoreline of Bribie Island and an adjoining area of saltmarsh on the shoreline of Bribie Island;
- Sandbank 2 (SBN2), a sandbank in the passage that remains exposed on neap high tides only;
- A mangrove tree roost (BCTR) on the opposite side of Pumicestone Passage from Bell's Creek; and
- Wickham Point (WICK), a rock platform on the mainland coastline north of the Pumicestone Passage entrance.

Four of these roost sites (CBAR, SBN1, SBN2, BCTR) were surveyed during the 2020/21 season, with the BCTR roost being identified for the first time on the third survey in January. The results of the four summer-season and one winter surveys are summarised in **Table 3.8**.

BAAM ECOLOGICAL CONSULTANTS

Client	Sunshine Coast Council
Project	Sunshine Coast Shorebird Conservation Action Plan Surveys and Assessment
Design	BAAM — 20.06.2021
Drawn	MP — 20.06.2021
Scale	1:25,000 — # 0219-028
Cad File	363 SCC Shorebird C01.dwg — NTP 363
Title	Locations of shorebird roost sites at Caloundra
FIGURE	3.7

Table 3.8. Results of the four summer-season surveys and one winter survey of four shorebird roost sites at Caloundra.

Common name	Species	EPBC*	NCA*	13 Nov 2020	18 Dec 2020	17 Jan 2021	10 Feb 2021	10 May 2021
Caloundra Bar (CBAR)								
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E		26	28	27	
Eurasian Whimbrel	*Numenius phaeopus*	M	S				28	
Pied Oystercatcher	*Haematopus longirostris*		LC	3		2	4	
Masked Lapwing	*Vanellus miles*		LC	2			2	
Total migratory shorebirds				0	26	28	55	0
Total resident shorebirds				5	0	2	6	0
Total other waterbirds				69	590	770	40	0
Sandbank 1 (SBN1)								
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	24				1
Eurasian Whimbrel	*Numenius phaeopus*	M	S	19				1
Bar-tailed Godwit (Western Alaskan)	*Limosa lapponica baueri*	M, V	V					4
Pacific Golden Plover	*Pluvialis fulva*	M	S					2
Double-banded Plover	*Charadrius bicincutus*	M	S					10
Pied Oystercatcher	*Haematopus longirostris*		LC		5	5		7
Masked Lapwing	*Vanellus miles*		LC					3
Red-capped Plover	*Charadrius ruficapillus*		LC					4
Total migratory shorebirds				43	0	0	0	18
Total resident shorebirds				0	5	5	0	14
Total other waterbirds				1	190	162	0	102
Sandbank 2 (SBN2)								
Bar-tailed Godwit (Western Alaskan)	*Limosa lapponica baueri*	M, V	V	126				
Total migratory shorebirds				126	0	0	0	0
Total resident shorebirds				0	0	0	0	0
Total other waterbirds				247	0	0	0	0
Tree roost opposite Bell's Creek (BCTR)								
Eurasian Whimbrel	*Numenius phaeopus*	M	S	Not surveyed	Not surveyed	51	5	
Total migratory shorebirds						51	5	0
Total resident shorebirds						0	0	0
Total other waterbirds						0	0	0

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Two sandbanks in the centre of the Pumicestone Passage channel (SBN1 and SBN2) were used by roosting shorebirds and other waterbirds (mostly terns, including up to 299 Little Tern) when they remained exposed on neap high tides; these sandbanks were not available as roost sites on higher tides when they were covered by water. As the two passage sandbars became covered by the rising tide, shorebirds sometimes moved to an area of saltmarsh on the shoreline of Bribie Island that also formed part of the SBN1 roost site. A flock of between 24 and 28 Far Eastern Curlew roosted at either SBN1 or CBAR during the summer months. Eurasian Whimbrels used most of the roost sites, including a mangrove tree roost opposite Bell's Creek that was discovered for the first time during

the surveys. Bar-tailed Godwits were present on only one of the summer-season surveys when a flock of 126 roosted on the SBN2 sandbar when this remained exposed on a neap high tide.

The three roost sites CBAR, SBN1 and SBN2 have been monitored intermittently by the QWSG since 1993 while the WICK roost site has been monitored continuously since 1999. A total of 17 migratory shorebird species and seven resident shorebird species have been recorded roosting at these high tide roost sites at Caloundra (**Table 3.9**). The commonly recorded migratory shorebird species included the vulnerable Bar-tailed Godwit, the critically endangered Far Eastern Curlew, Eurasian Whimbrel and Pacific Golden Plover, the four species that were also most frequently present feeding on the tidal flats at low tide (**Tables 3.5** and **3.6**). A breakdown of the frequency of use of the roost sites by each species during different times of the year is provided in **Appendix 2**; these data confirm that the roost sites are used by migratory shorebirds during all months of the year, including by overwintering juvenile birds through the winter months.

Table 3.9. Summary of the percentage of high tide surveys (within 1.5 hours either side of high tide) in all months of the year that shorebirds have been recorded roosting at each of four roost sites at Caloundra since 1993.

Roost site				CBAR	SBN1	SBN2	WICK
Total high tide surveys (all months)				49	53	31	238
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	57%	68%	39%	
Eurasian Whimbrel	*Numenius phaeopus*	M	S	59%	62%	35%	
Bar-tailed Godwit	*Limosa lapponica baueri*	M, V	V	49%	72%	48%	<1%
Pacific Golden Plover	*Pluvialis fulva*	M	S	47%	32%	26%	<1%
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V	47%	26%	6%	
Lesser Sand Plover	*Charadrius mongolus*	M, E	E	41%	19%	6%	
Double-banded Plover	*Charadrius bicinctus*	M	S	16%	23%	10%	
Ruddy Turnstone	*Arenaria interpres*	M	S	2%			2%
Sharp-tailed Sandpiper	*Calidris acuminata*	M	S	4%			
Red Knot	*Calidris canutus*	M, E	E	4%	2%		
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E	45%	36%	19%	
Red-necked Stint	*Calidris ruficollis*	M	S	51%	30%	13%	
Great Knot	*Calidris tenuirostris*	M, CE	E	16%	19%	10%	
Grey-tailed Tattler	*Tringa brevipes*	M	S	2%	15%	13%	
Wandering Tattler	*Tringa incana*	M	S	2%			43%
Common Greenshank	*Tringa nebularia*	M	S	2%	9%	13%	
Terek Sandpiper	*Xenus cinereus*	M	S	6%	6%	6%	
Australian Painted Snipe	*Rostratula australis*	E	E				<1%
Beach Stone-curlew	*Esacus magnirostris*		V	4%	2%		
Sooty Oystercatcher	*Haematopus fuliginosus*		LC	4%	6%		81%
Pied Oystercatcher	*Haematopus longirostris*		LC	39%	32%	6%	4%
Pied Stilt	*Himantopus leucocephalus*		LC			3%	<1%
Masked Lapwing	*Vanellus miles*		LC	6%	25%		3%
Red-capped Plover	*Charadrius ruficapillus*		LC	69%	55%	16%	

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Analysis of these data shows that the CBAR, SBN1 and SBN2 roost sites were used by up to around 550 migratory shorebirds in the period 2000 to 2002 and up to around 280 migratory shorebirds in 2008-2010 (**Figure 3.8**), but the 2020 surveys recorded up to 169 migratory shorebirds (**Table 3.8**). This suggests there may have been a decline in the number of migratory shorebirds using these roost sites over this time period.

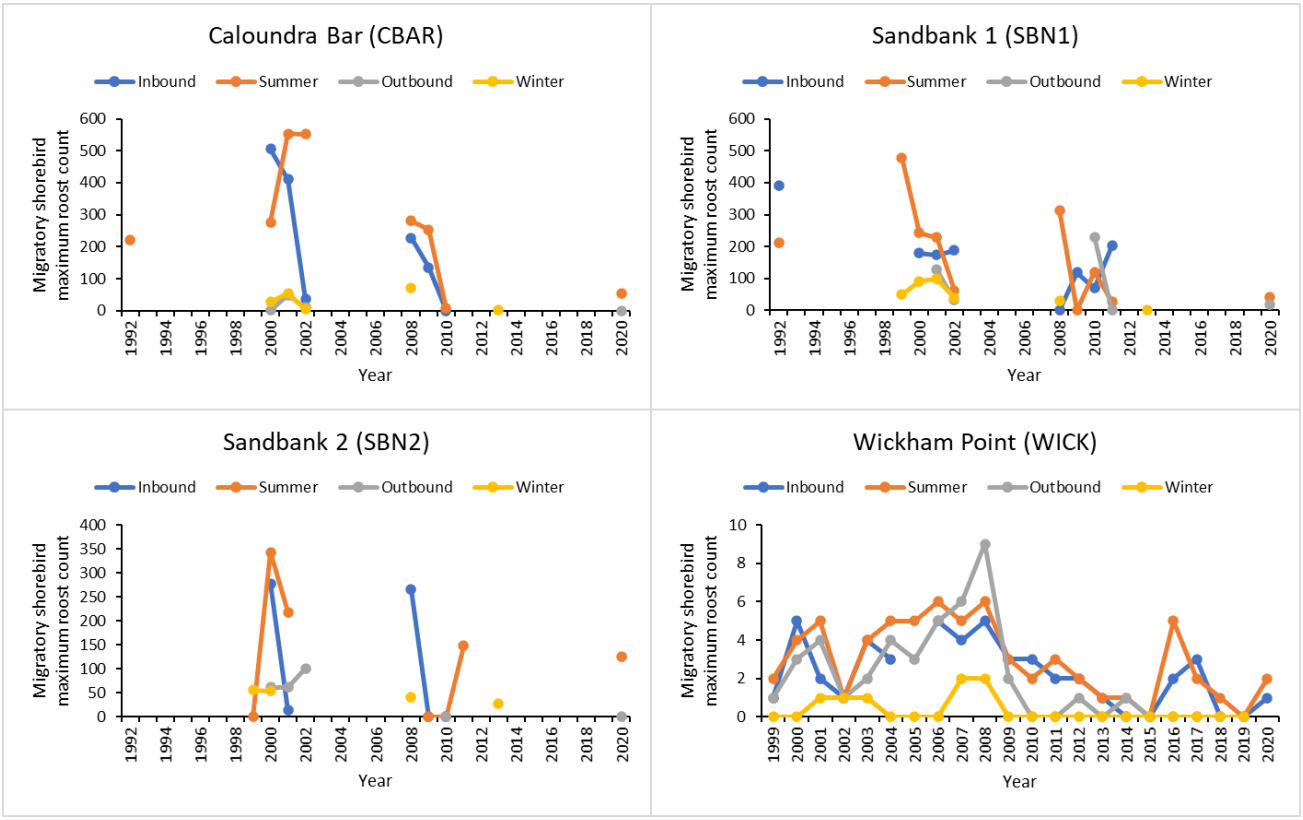

Figure 3.8. Annual maximum count of migratory shorebirds at high tide (within 1.5 hrs either side of high tide) at each of four roost sites at Caloundra since 1992 based on QWSG data and this study.

The Wickham Point (WICK) roost site is used regularly by small numbers of one migratory shorebird species, Wandering Tattler (average of 3 birds in summer) and one resident shorebird species, Sooty Oystercatcher (average of 4 birds in summer), both species being associated with rocky shorelines.

3.4.3 Disturbance

Shorebird roost sites and tidal flat feeding habitat areas at Caloundra are subject to multiple sources of disturbance to roosting or feeding shorebirds, including people using the area for recreation, dogs being walked on and off-leash and various watercraft. These data show that the Wickham Point experiences the highest disturbance pressure, particularly from people and dogs visiting the rocky shoreline (**Table 3.10**); however, this site is used by small numbers of shorebirds that are likely to be able to move along the extensive rocky shoreline at this site in response to disturbance. The other roost sites at CBAR, SBN1, SBN2 and BCTR appear to experience moderate to low levels of disturbance.

Table 3.10. Percentage of surveys in which people, dogs, boats or jetskis were recorded as potential or actual sources of disturbance to roosting or feeding birds at sites at Caloundra.

Site	Surveys	People	Dogs	Boats	Jetskis
Caloundra bar (CBAR)	160	2	0	0	0
Sandbank 1 (SBN1)	517	26	4	16	32
Sandbank 2 (SBN2)	492	24	6	9	23
Pelican Waters (PEWA)	339	42	25	15	27
Bell's Creek (BECK)	344	57	29	18	39
Tree roost (BCTR)	3	0	0	0	0
Wickham Point (WICK)	252	58	32	17	9

4.0 RECOMMENDATIONS

4.1 LOWER MAROOCHY RIVER

While it was historically one of the most important roost sites for shorebirds on the lower Maroochy River, the north shore (MRNS) has largely been abandoned as a roost site by shorebirds due to the high levels of disturbance by people using the sandy shoreline for recreation and walking dogs off-leash. Consequently, the sandy shoreline and sand bars on the eastern side of Goat Island (MRGI and MRSB) are currently the most important shorebird roost sites, which enjoy a moderate level of protection from disturbance by being accessible at high tide only by watercraft. Nonetheless, boaters with pets on board do regularly come ashore at Goat Island and walk their dogs, often off-leash. The tidal flats on the eastern and western edges of Goat Island (MR06, MR04 and MR07) are also the most important feeding areas on the lower Maroochy River. While the MR04 and MR07 tidal flats are seldom visited by people, people regularly access the MR06 tidal flats via watercraft or wading/swimming across the southern channel at low tide, causing regular disturbance to feeding shorebirds, including by dogs being walked off-leash. These disturbance pressures are expected to continue to increase as the population of the region continues to grow. Research has shown that off-leash dogs in particular cause severe disturbance to shorebirds, reducing their use of important habitats (Dhanjal-Adams *et al.* 2016) and are a key threat to migratory shorebirds in Moreton Bay (Fuller *et al.* 2019).

Recommended approaches for reducing disturbance to feeding and roosting shorebirds include a combination of:

- Site-specific information signage to raise awareness of the presence of shorebirds in the area and the importance of the key habitat areas for shorebirds, particularly migratory shorebirds (Antos *et al.* 2006, Williams *et al.* 2009);
- Other approaches to raising public awareness of how the migration and feeding ecology of shorebirds are impacted by disturbances to try to change public awareness of, and attitudes towards disturbing shorebirds, particularly among dog-owners that exercise their dogs along foreshore areas (Antos *et al.* 2006, Williams *et al.* 2009);
- Planning to ensure suitable dog-walking facilities such as dog-off leash areas are situated in locations convenient and attractive to the public but separated from important shorebird foreshore habitats (Stigner *et al.* 2016);
- Planning to limit access to important feeding or roosting areas by people and/or dogs (Weston *et al.* 2012, Stigner *et al.* 2016); and
- Effective enforcement of access restrictions and dog on-leash areas, given that compliance to access restrictions or on-leash laws is strongly dependent on the extent of enforcement (Dhanjal-Adams *et al.* 2016, Stigner *et al.* 2016).

Research based on structured decision-making has shown that cost-effective sites for enforcement are the cheapest sites with the greatest number of target species in combination with the greatest number of illegal wildlife activities (Dhanjal-Adams *et al.* 2016). Other research suggests that trying to ensure all dogs are kept on-leash in foreshore areas may be impractical where walking dogs off-leash has already become a pervasive activity; in such situations, designating foreshore dog off-leash areas in places where shorebird foraging abundance is relatively low and recreational demand is relatively high could result in reduced overall disturbance to migratory shorebirds if there is also more effective enforcement of access restrictions or on-leash laws in important shorebird areas (Stigner *et al.* 2016, Fuller *et al.* 2019).

4.2 CALOUNDRA

The important roost sites at Caloundra, including CBAR, SBN1, SBN2 and BCTR appear to experience moderate to low levels of disturbance. The BCTR tree roost is located in a position where the risk of disturbance is very low. Disturbance to birds roosting on the in-channel sandbanks of SBN1

and SBN2 on neap high tides is mostly from passing jet-skis and watercraft putting ashore. The tidal flat feeding areas experience moderate to low levels of disturbance, with the risk of disturbance greatest along the mainland shoreline of the PEWA and BECR tidal flats, where recreational activities, including walking dogs on and off-leash across the sandy tidal flats occur more frequently. This recreational disturbance pressure is predicted to continue to increase as the region becomes more developed. Consequently, there is a need for proactive management of disturbance to shorebirds at the important roosting and feeding habitats at Caloundra that are identified above. Recommended approaches for reducing disturbance to feeding and roosting shorebirds are as recommended under **Section 4.1** above.

5.0 REFERENCES

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APPENDIX 1

Shorebird survey conditions

Date	Site	LT time	LT ht (m)	HT time	HT ht (m)	Low tide (LT)			High tide (HT)		
						Wind	Cloud	Rain	Wind	Cloud	Rain
12/11/2020	Maroochy River	13:22	0.34	6:34	1.53	1	2	0	3	0	0
13/11/2020	Caloundra	13:32	0.29	6:43	1.67	2	4	0	3	0	0
11/12/2020	Maroochy River	13:06	0.48			3	3	0			
12/12/2020	Caloundra	13:40	0.55			4	4	1			
18/12/2020	Caloundra			11:21	2.49				2	1	0
12/01/2021	Maroochy River	15:55	0.40			2	3	0			
13/01/2021	Caloundra	16:22	0.49			3	1	0			
17/01/2021	Caloundra			11:32	2.38				2	4	0
10/02/2021	Caloundra	14:45	0.53	8:14	2.55	2	1	0	2	2	0
26/02/2021	Maroochy River	15:34	0.40			1	1	9			
26/03/2021	Maroochy River	14:27	0.43			2	1	0			
10/05/2021	Caloundra	14:23	0.46	7:41	2.09	1	0	0	1	0	0
12/05/2021	Maroochy River	16:04	0.34			1	4	0			

APPENDIX 2

Seasonal frequency of roost site use

Table A2.1. Seasonal breakdown of the percentage of high tide surveys (within 1.5 hours either side of high tide) that shorebirds have been recorded roosting at Goat Island (MRGI) on the lower Maroochy River during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total HT surveys				35	54	29	25
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	26%	22%	7%	16%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	31%	28%	24%	20%
Bar-tailed Godwit (Western Alaskan)	*Limosa lapponica baueri*	M, V	V	26%	28%	24%	12%
Black-tailed Godwit	*Limosa limosa*	M	S		2%		
Pacific Golden Plover	*Pluvialis fulva*	M	S	11%	15%	10%	
Double-banded Plover	*Charadrius bicinctus*	M	S			3%	
Sharp-tailed Sandpiper	*Calidris acuminata*	M	S	3%			
Red-necked Stint	*Calidris ruficollis*	M	S	6%			
Great Knot	*Calidris tenuirostris*	M, CE	E			3%	
Grey-tailed Tattler	*Tringa brevipes*	M	S	14%	9%	7%	4%
Common Greenshank	*Tringa nebularia*	M	S		2%		
Terek Sandpiper	*Xenus cinereus*	M	S	3%			4%
Beach Stone-curlew	*Esacus magnirostris*		V	3%	2%	7%	4%
Sooty Oystercatcher	*Haematopus fuliginosus*		LC		2%		
Pied Oystercatcher	*Haematopus longirostris*		LC	54%	33%	66%	40%
Pied Stilt	*Himantopus leucocephalus*		LC		2%	7%	8%
Masked Lapwing	*Vanellus miles*		LC		4%		4%
Red-capped Plover	*Charadrius ruficapillus*		LC	6%			4%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table A2.2. Seasonal breakdown of the percentage of high tide surveys (within 1.5 hours either side of high tide) that shorebirds have been recorded roosting at Nojoor Road (MRNR) on the lower Maroochy River during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total HT surveys				39	57	34	29
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	15%	14%	3%	3%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	10%	16%	3%	
Bar-tailed Godwit (Western Alaskan)	*Limosa lapponica baueri*	M, V	V	8%	12%	3%	7%
Pacific Golden Plover	*Pluvialis fulva*	M	S	3%	2%		
Lesser Sand Plover	*Charadrius mongolus*	M, E	E		2%		
Ruddy Turnstone	*Arenaria interpres*	M	S		2%		
Red-necked Stint	*Calidris ruficollis*	M	S		4%	3%	
Grey-tailed Tattler	*Tringa brevipes*	M	S	3%	2%	3%	3%
Common Greenshank	*Tringa nebularia*	M	S		4%		
Beach Stone-curlew	*Esacus magnirostris*		V		2%	3%	
Pied Oystercatcher	*Haematopus longirostris*		LC	21%	9%	29%	7%
Pied Stilt	*Himantopus leucocephalus*		LC	5%	2%	9%	10%
Masked Lapwing	*Vanellus miles*		LC	3%	9%	32%	10%
Red-capped Plover	*Charadrius ruficapillus*		LC	3%	4%	3%	
Black-fronted Dotterel	*Elseyornis melanops*		LC				3%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table A2.3. Seasonal breakdown of the percentage of high tide surveys (within 1.5 hours either side of high tide) that shorebirds have been recorded roosting at the north shore (MRNS) on the lower Maroochy River during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total HT surveys				35	54	29	25
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	26%	15%	9%	11%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	38%	48%	34%	7%
Bar-tailed Godwit (Western Alaskan)	*Limosa lapponica baueri*	M, V	V	26%	48%	38%	7%
Black-tailed Godwit	*Limosa limosa*	M	S		2%	3%	
Pacific Golden Plover	*Pluvialis fulva*	M	S	44%	53%	41%	32%
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V	13%	13%	13%	
Lesser Sand Plover	*Charadrius mongolus*	M, E	E	8%	12%	31%	11%
Double-banded Plover	*Charadrius bicinctus*	M	S	3%		31%	86%
Ruddy Turnstone	*Arenaria interpres*	M	S	5%	10%	3%	7%
Sharp-tailed Sandpiper	*Calidris acuminata*	M	S		2%		
Sanderling	*Calidris alba*	M	S	3%	2%		
Broad-billed Sandpiper	*Calidris falcinellus*	M	S			3%	
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E	3%	8%	9%	
Red-necked Stint	*Calidris ruficollis*	M	S	28%	38%	44%	21%
Great Knot	*Calidris tenuirostris*	M, CE	E	5%	12%		
Grey-tailed Tattler	*Tringa brevipes*	M	S	8%	3%	16%	
Wandering Tattler	*Tringa incana*	M	S	8%	2%	3%	
Terek Sandpiper	*Xenus cinereus*	M	S	3%	3%	9%	
Beach Stone-curlew	*Esacus magnirostris*		V	5%		3%	
Sooty Oystercatcher	*Haematopus fuliginosus*		LC	5%	7%	6%	
Pied Oystercatcher	*Haematopus longirostris*		LC	15%	23%	34%	11%
Masked Lapwing	*Vanellus miles*		LC	3%	3%	3%	7%
Red-capped Plover	*Charadrius ruficapillus*		LC	79%	77%	78%	93%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table A2.4. Seasonal breakdown of the percentage of high tide surveys (within 1.5 hours either side of high tide) that shorebirds have been recorded roosting at a sand bar (MRSB) on the lower Maroochy River during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total HT surveys				35	54	29	25
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	25%	14%	6%	41%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	20%	17%	9%	14%
Bar-tailed Godwit (Western Alaskan)	*Limosa lapponica baueri*	M, V	V	23%	22%	32%	28%
Black-tailed Godwit	*Limosa limosa*	M	S		2%		
Pacific Golden Plover	*Pluvialis fulva*	M	S	3%	5%	9%	17%
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V			3%	
Double-banded Plover	*Charadrius bicinctus*	M	S	3%		9%	7%
Ruddy Turnstone	*Arenaria interpres*	M	S	3%			
Red Knot	*Calidris canutus*	M, E	E				3%
Red-necked Stint	*Calidris ruficollis*	M	S			3%	
Great Knot	*Calidris tenuirostris*	M, CE	E	3%		3%	3%
Grey-tailed Tattler	*Tringa brevipes*	M	S	3%		3%	
Sooty Oystercatcher	*Haematopus fuliginosus*		LC	3%	3%	6%	
Pied Oystercatcher	*Haematopus longirostris*		LC	30%	19%	35%	45%
Pied Stilt	*Himantopus leucocephalus*		LC	3%		3%	
Masked Lapwing	*Vanellus miles*		LC	3%			3%
Red-capped Plover	*Charadrius ruficapillus*		LC	13%	10%	29%	21%
Black-fronted Dotterel	*Elseyornis melanops*		LC				7%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table A2.5. Summary of the percentage of high tide surveys (within 1.5 hours either side of high tide) that shorebirds have been recorded roosting at Caloundra Bar (CBAR) at the northern entrance to Pumicestone Passage during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total high tide surveys				9	20	8	12
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	56%	80%	38%	33%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	89%	75%	38%	25%
Bar-tailed Godwit	*Limosa lapponica baueri*	M, V	V	67%	65%	25%	25%
Pacific Golden Plover	*Pluvialis fulva*	M	S	33%	60%	50%	33%
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V	78%	65%	13%	17%
Lesser Sand Plover	*Charadrius mongolus*	M, E	E	44%	60%	25%	17%
Double-banded Plover	*Charadrius bicinctus*	M	S			13%	58%
Ruddy Turnstone	*Arenaria interpres*	M	S		5%		
Sharp-tailed Sandpiper	*Calidris acuminata*	M	S		10%		
Red Knot	*Calidris canutus*	M, E	E	11%	5%		
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E	56%	65%	25%	17%
Red-necked Stint	*Calidris ruficollis*	M	S	56%	80%	13%	25%
Great Knot	*Calidris tenuirostris*	M, CE	E	33%	25%		
Grey-tailed Tattler	*Tringa brevipes*	M	S	11%			
Wandering Tattler	*Tringa incana*	M	S		5%		
Common Greenshank	*Tringa nebularia*	M	S			13%	
Terek Sandpiper	*Xenus cinereus*	M	S	11%	10%		
Beach Stone-curlew	*Esacus magnirostris*		V		5%		8%
Sooty Oystercatcher	*Haematopus fuliginosus*		LC	11%	5%		
Pied Oystercatcher	*Haematopus longirostris*		LC	44%	55%		33%
Masked Lapwing	*Vanellus miles*		LC		5%	13%	8%
Red-capped Plover	*Charadrius ruficapillus*		LC	56%	75%	63%	75%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table A2.6. Summary of the percentage of high tide surveys (within 1.5 hours either side of high tide) that shorebirds have been recorded roosting at sandbank 1 (SBN1) at Caloundra during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total high tide surveys				11	19	10	13
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	82%	79%	60%	46%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	64%	63%	60%	62%
Bar-tailed Godwit	*Limosa lapponica baueri*	M, V	V	82%	79%	60%	62%
Pacific Golden Plover	*Pluvialis fulva*	M	S	27%	26%	40%	38%
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V	27%	26%	40%	15%
Lesser Sand Plover	*Charadrius mongolus*	M, E	E	36%	16%	30%	
Double-banded Plover	*Charadrius bicinctus*	M	S			60%	46%
Red Knot	*Calidris canutus*	M, E	E	9%			
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E	45%	42%	60%	
Red-necked Stint	*Calidris ruficollis*	M	S	45%	16%	50%	23%
Great Knot	*Calidris tenuirostris*	M, CE	E	36%	21%		15%
Grey-tailed Tattler	*Tringa brevipes*	M	S	27%	5%	20%	15%
Common Greenshank	*Tringa nebularia*	M	S		21%	10%	
Terek Sandpiper	*Xenus cinereus*	M	S	9%	11%		
Beach Stone-curlew	*Esacus magnirostris*		V			10%	
Sooty Oystercatcher	*Haematopus fuliginosus*		LC		16%		
Pied Oystercatcher	*Haematopus longirostris*		LC	55%	21%	20%	38%
Masked Lapwing	*Vanellus miles*		LC		21%	10%	62%
Red-capped Plover	*Charadrius ruficapillus*		LC	27%	58%	70%	62%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table A2.7. Summary of the percentage of high tide surveys (within 1.5 hours either side of high tide) that shorebirds have been recorded roosting at sandbank 2 (SBN2) at Caloundra during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total high tide surveys				8	10	6	7
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	25%	40%	50%	43%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	25%	40%	67%	14%
Bar-tailed Godwit	*Limosa lapponica baueri*	M, V	V	38%	50%	50%	57%
Pacific Golden Plover	*Pluvialis fulva*	M	S	13%	40%	33%	14%
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V	13%		17%	
Lesser Sand Plover	*Charadrius mongolus*	M, E	E			33%	
Double-banded Plover	*Charadrius bicinctus*	M	S			33%	14%
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E	13%	20%	33%	14%
Red-necked Stint	*Calidris ruficollis*	M	S	13%	10%	33%	
Great Knot	*Calidris tenuirostris*	M, CE	E	25%		17%	
Grey-tailed Tattler	*Tringa brevipes*	M	S		10%	33%	14%
Common Greenshank	*Tringa nebularia*	M	S		30%	17%	
Terek Sandpiper	*Xenus cinereus*	M	S		10%	17%	
Pied Oystercatcher	*Haematopus longirostris*		LC		10%	17%	
Pied Stilt	*Himantopus leucocephalus*		LC				14%
Red-capped Plover	*Charadrius ruficapillus*		LC		10%	50%	14%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table A2.8. Summary of the percentage of high tide surveys (within 1.5 hours either side of high tide) that shorebirds have been recorded roosting at Wickham Point (WICK) at Caloundra during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total high tide surveys				55	89	49	45
Common name	Species	EPBC*	NCA*				
Bar-tailed Godwit	*Limosa lapponica baueri*	M, V	V		1%		
Pacific Golden Plover	*Pluvialis fulva*	M	S		1%		
Ruddy Turnstone	*Arenaria interpres*	M	S	7%	1%		
Wandering Tattler	*Tringa incana*	M	S	45%	61%	37%	13%
Australian Painted Snipe	*Rostratula australis*	E	E				2%
Sooty Oystercatcher	*Haematopus fuliginosus*		LC	78%	82%	86%	76%
Pied Oystercatcher	*Haematopus longirostris*		LC	7%	6%		2%
Masked Lapwing	*Vanellus miles*		LC		1%		
Red-capped Plover	*Charadrius ruficapillus*		LC	2%	2%	4%	2%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table A2.9. Summary of the percentage of high tide surveys (within 1.5 hours either side of high tide) that shorebirds have been recorded roosting at a mangrove tree roost opposite Bell's Creek (BCTR) at Caloundra during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total high tide surveys					2	1	
Common name	Species	EPBC*	NCA*				
Eurasian Whimbrel	*Numenius phaeopus*	M	S		100%	0%	

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

APPENDIX 3

Seasonal frequency of tidal flat use

Table A3.1. Seasonal breakdown of the percentage of low tide surveys (within 1.5 hours either side of low tide) that shorebirds have been recorded feeding at Sandbank #1 (SBN1) in the northern Pumicestone Passage at Caloundra during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total LT surveys				73	112	71	64
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	93%	92%	49%	61%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	89%	92%	68%	47%
Bar-tailed Godwit	*Limosa lapponica baueri*	M, V	V	58%	79%	63%	33%
Pacific Golden Plover	*Pluvialis fulva*	M	S	41%	70%	51%	6%
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V	18%	47%	32%	9%
Lesser Sand Plover	*Charadrius mongolus*	M, E	E	12%	22%	14%	6%
Double-banded Plover	*Charadrius bicinctus*	M	S		1%	15%	8%
Ruddy Turnstone	*Arenaria interpres*	M	S	1%			
Sharp-tailed Sandpiper	*Calidris acuminata*	M	S	1%			
Red Knot	*Calidris canutus*	M, E	E				2%
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E	23%	46%	25%	11%
Red-necked Stint	*Calidris ruficollis*	M	S	11%	19%	8%	8%
Great Knot	*Calidris tenuirostris*	M, CE	E	1%	4%	1%	
Grey-tailed Tattler	*Tringa brevipes*	M	S	4%	7%	8%	3%
Common Greenshank	*Tringa nebularia*	M	S	7%	5%	4%	2%
Common Sandpiper	*Actitis hypoleucos*	M	S		1%		
Terek Sandpiper	*Xenus cinereus*	M	S	4%	4%	8%	
Beach Stone-curlew	*Esacus magnirostris*		V	3%	4%	3%	5%
Sooty Oystercatcher	*Haematopus fuliginosus*		LC			1%	
Pied Oystercatcher	*Haematopus longirostris*		LC	33%	29%	28%	33%
Pied Stilt	*Himantopus leucocephalus*		LC		6%	1%	5%
Masked Lapwing	*Vanellus miles*		LC	29%	20%	49%	45%
Red-capped Plover	*Charadrius ruficapillus*		LC	41%	60%	59%	36%

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Table A3.2. Seasonal breakdown of the percentage of low tide surveys (within 1.5 hours either side of low tide) that shorebirds have been recorded feeding at Sandbank #2 (SBN2) in the northern Pumicestone Passage at Caloundra during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total LT surveys				83	127	82	71
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	95%	92%	54%	70%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	96%	88%	68%	52%
Bar-tailed Godwit	*Limosa lapponica baueri*	M, V	V	92%	98%	87%	56%
Pacific Golden Plover	*Pluvialis fulva*	M	S	83%	88%	60%	54%
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V	66%	63%	49%	46%
Lesser Sand Plover	*Charadrius mongolus*	M, E	E	35%	33%	22%	18%
Double-banded Plover	*Charadrius bicinctus*	M	S	1%	2%	35%	56%
Ruddy Turnstone	*Arenaria interpres*	M	S	2%			
Sharp-tailed Sandpiper	*Calidris acuminata*	M	S	2%			
Red Knot	*Calidris canutus*	M, E	E	2%			
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E	67%	69%	41%	35%
Red-necked Stint	*Calidris ruficollis*	M	S	33%	28%	27%	21%
Great Knot	*Calidris tenuirostris*	M, CE	E	5%	7%	7%	1%
Grey-tailed Tattler	*Tringa brevipes*	M	S	23%	31%	33%	15%
Common Greenshank	*Tringa nebularia*	M	S	14%	25%	18%	3%
Marsh Sandpiper	*Tringa stagnatilis*	M	S	1%			
Common Sandpiper	*Actitis hypoleucos*	M	S		1%		
Terek Sandpiper	*Xenus cinereus*	M	S	16%	20%	16%	1%
Beach Stone-curlew	*Esacus magnirostris*		V				1%
Pied Oystercatcher	*Haematopus longirostris*		LC	31%	31%	45%	51%
Pied Stilt	*Himantopus leucocephalus*		LC	7%	6%	22%	32%
Masked Lapwing	*Vanellus miles*		LC	5%	7%	12%	13%
Red-capped Plover	*Charadrius ruficapillus*		LC	65%	55%	74%	79%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table A3.3. Seasonal breakdown of the percentage of low tide surveys (within 1.5 hours either side of low tide) that shorebirds have been recorded feeding at Pelican Waters Lamerough Creek (PEWA) in the northern Pumicestone Passage at Caloundra during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total LT surveys				66	107	66	55
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	39%	28%	9%	13%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	70%	59%	18%	5%
Bar-tailed Godwit	*Limosa lapponica baueri*	M, V	V	68%	70%	33%	18%
Pacific Golden Plover	*Pluvialis fulva*	M	S	32%	39%	15%	2%
Greater Sand Plover	*Charadrius leschenaultii*	M, V	V	6%		2%	
Ruddy Turnstone	*Arenaria interpres*	M	S	3%			
Sharp-tailed Sandpiper	*Calidris acuminata*	M	S	6%	5%	2%	
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E	18%	10%	3%	5%
Red-necked Stint	*Calidris ruficollis*	M	S	5%	2%	2%	
Grey-tailed Tattler	*Tringa brevipes*	M	S	12%	7%	5%	4%
Common Greenshank	*Tringa nebularia*	M	S	12%	15%	8%	2%
Marsh Sandpiper	*Tringa stagnatilis*	M	S	2%			
Common Sandpiper	*Actitis hypoleucos*	M	S	2%	1%		
Terek Sandpiper	*Xenus cinereus*	M	S	2%	2%	3%	
Pied Oystercatcher	*Haematopus longirostris*		LC	15%	12%	14%	35%
Pied Stilt	*Himantopus leucocephalus*		LC	26%	15%	29%	45%
Masked Lapwing	*Vanellus miles*		LC	48%	50%	62%	36%
Red-capped Plover	*Charadrius ruficapillus*		LC	14%	8%	2%	4%
Black-fronted Dotterel	*Elseyornis melanops*		LC		1%		4%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.

Table A3.4. Seasonal breakdown of the percentage of low tide surveys (within 1.5 hours either side of low tide) that shorebirds have been recorded feeding at Bell's Creek (BECK) in the northern Pumicestone Passage at Caloundra during each of the inbound migration (September to mid-November), summer (mid-November to mid-March), outbound migration (mid-March to May) and winter (June to August) periods.

Period				Inbound	Summer	Outbound	Winter
Total LT surveys				62	87	61	48
Common name	Species	EPBC*	NCA*				
Far Eastern Curlew	*Numenius madagascariensis*	M, CE	E	97%	83%	34%	69%
Eurasian Whimbrel	*Numenius phaeopus*	M	S	94%	80%	52%	44%
Little Curlew	*Numenius minutus*	M	S				2%
Bar-tailed Godwit	*Limosa lapponica baueri*	M, V	V	92%	87%	74%	46%
Pacific Golden Plover	*Pluvialis fulva*	M	S	69%	49%	20%	8%
Lesser Sand Plover	*Charadrius mongolus*	M, E	E			2%	
Ruddy Turnstone	*Arenaria interpres*	M	S	2%			
Sharp-tailed Sandpiper	*Calidris acuminata*	M	S	13%	5%		
Curlew Sandpiper	*Calidris ferruginea*	M, CE	E	26%	9%	3%	4%
Red-necked Stint	*Calidris ruficollis*	M	S		1%		
Great Knot	*Calidris tenuirostris*	M, CE	E		1%		
Grey-tailed Tattler	*Tringa brevipes*	M	S	45%	52%	33%	8%
Common Greenshank	*Tringa nebularia*	M	S	31%	41%	20%	6%
Terek Sandpiper	*Xenus cinereus*	M	S	10%	14%	7%	
Beach Stone-curlew	*Esacus magnirostris*		V				2%
Sooty Oystercatcher	*Haematopus fuliginosus*		LC				2%
Pied Oystercatcher	*Haematopus longirostris*		LC	18%	6%	10%	27%
Pied Stilt	*Himantopus leucocephalus*		LC	61%	77%	95%	94%
Masked Lapwing	*Vanellus miles*		LC	18%	16%	52%	29%
Red-capped Plover	*Charadrius ruficapillus*		LC	19%	6%		17%

* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or Queensland *Nature Conservation Act 1992* (NCA): CE = critically endangered; E = endangered; LC = least concern; M = migratory; S = special least concern (migratory); V = vulnerable.