Gladstone Ports Corporation

Report for Migratory Shorebird Monitoring

Port Curtis and the Curtis Coast

Annual Summer Survey - 2016

Report prepared for Gladstone Ports Corporation

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EXECUTIVE SUMMARY

- The 2016 annual shorebird monitoring summer survey was carried out on the new moon spring tide from 8-12 February. A total of 157 roosts were surveyed over five days in the order of Port Curtis, Fitzroy Estuary, North Curtis, Mundoolin-Colosseum, Rodds Peninsula, Mainland Shoreline and the Western Basin Reclamation Area.

- Permission was obtained to survey within Cheetham Salt Works at Bajool. The salt works are non-tidal. A single survey was conducted at mid-tide (falling) on 12 February.

- Weather conditions for the survey were suboptimal due to near-constant, strong south-easterly winds.

- Predicted tide heights were near the top of the range for Gladstone for 2016. Heavy rain over the previous fortnight may also have contributed to the actual tide height. A number of important roosts were inundated and contained very few birds. This illustrates some of the variability around migratory shorebird estimates that contributes to the difficulty determining population trajectories.

- Survey coverage was similar to the 2015 and previous summer surveys.

- A total of 11,574 migratory shorebirds consisting of 20 species was recorded during the high tide roost surveys. This was 16 percent fewer than the equivalent figure from February 2015; however it was only four percent fewer than the summer average calculated from eight surveys conducted in January and February over the life of the project; 2011-2016.

- The reduction in the total abundance in shorebirds compared to the previous year was mostly due to a 42 percent reduction in the number of Red-necked Stints recorded. Red-necked Stints are opportunistic feeders that do not always occupy roosts during high tide, preferring to continue foraging on coastal wetlands. This behaviour has been observed previously on the Curtis Coast and has contributed to the large variation in numbers recorded for this species between years.

- Other species that returned a reduction in abundance compared to 2015 were Greater Sand Plover, Bar-tailed Godwit, Great Knot, Terek Sandpiper and Grey Plover. These decreases were offset by increases in the abundance of Grey-tailed Tattlers and a number of the species which are relatively rare on the Curtis Coast.

- The 10 most abundant species accounted for 97 percent of the records and this is comparable to previous surveys.

- The assemblage of migratory shorebirds at the Cheetham Salt Works and the Clinton Ash Ponds appears to be distinctly different from that present across the rest of the Curtis Coast.

- A total of 327 Red-necked Stints were recorded foraging on the Western Basin Reclamation Area during the high tide survey. In contrast no migratory shorebirds were recorded on the bund wall.

- The total abundance of migratory shorebirds on the Curtis Coast does not appear to be declining; however considerable variation in space and time has been documented for many species.

- Some migratory shorebird roosts in Upper Gladstone Harbour appear to continue to experience a localised reduction in migratory shorebird numbers compared with surveys conducted in 2011. This situation has been documented in previous reports (Wildlife Unlimited, 2012; 2013a; 2013b; 2014; 2015). Whether the apparent localised reductions are due to work associated with the Western Basin Dredging and Disposal Project, or any of the other activities in Port Curtis cannot be determined by monitoring work.

1 INTRODUCTION

1.1 The Project

Development and expansion of port facilities in the Western Basin of the Port of Gladstone is required for the continued growth and operation of the Gladstone Ports Corporation (2011). The facilities to be developed or expanded are a key component of the import/export chain for coal and will support emerging industries in the Gladstone region such as liquefied natural gas. Dredging of the Port of Gladstone is required to provide safe, efficient access to the new port facilities. The aim of the dredging was to increase the depth and width of existing channels and swing basins and the creation of new channels, swing basins and berth pockets. Stage 1A of the Western Basin Dredging and Disposal Project required the removal of 22.5M m3 of which 17.6M m3 was deposited in a 265 hectare land reclamation at Fisherman's Landing.

Figure 1-1 An LNG plant on Curtis Island, February 2016
The South Passage Island tidal flat is in the foreground (Adam Leavesley, Wildlife Unlimited).

1.2 Environmental Approvals

The Queensland Coordinator-General declared the Western Basin Dredging and Disposal Project to be a 'significant project' for which an Environmental Impact Statement (EIS) was required under the *State Development and Public Works Organisation Act 1971* (Gladstone Ports Corporation, 2011). The EIS was approved with conditions by the Queensland Coordinator-General on 23 July 2010. The project was also determined to be a 'controlled action' by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC, now Department of Environment; DoE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) on 18 June 2009 (EPBC 2009/4904). EPBC approval was granted on 22 October 2010, subject to conditions.

1.3 Ecosystem Research and Monitoring Program

Conditions 25 to 37 of the EPBC approval (Gladstone Ports Corporation, 2011) require GPC to develop and implement the 'Port Curtis and Port Alma Ecosystem Research and Monitoring Program'

(ERMP). The aim of the ERMP is to acquire detailed ecological understanding of the marine environment of Port Curtis and Port Alma. This information can be used to monitor, manage and/or improve the regional marine environment and to offset potential impacts from the project on listed threatened and migratory species and values of the Great Barrier Reef World Heritage Area and National Heritage Place.

The ERMP is designed to:

- be a flagship program for future industry developments;
- assist in minimising environmental impacts, and maintaining a functioning ecosystem;
- develop improved understanding of the drivers of ecosystem condition and population trends for key biota and habitats.

The results of the ERMP are to be used to inform adaptive management response to observed impacts or potential impacts identified.

Condition 33 of the EPBC approval requires a study to be conducted to determine the effect of port development activities on migratory shorebirds. During years one and two a comprehensive set of five surveys were to be conducted each year. This report details the results of the fourth of six annual summer surveys to be conducted in fulfilment of condition 33 (i) which states: “single annual summer surveys (October to March) covering the high tide roost sites from years three to eight, with a repeat of the comprehensive surveys during years nine and ten.” The objectives of the program are:

- population censuses of species present;
- mapping of feeding and roosting sites;
- investigation of habitat utilisation relative to the lunar/tide cycles and season; and
- identification of critical characteristics of important habitat.

Port development activities that should be addressed include but are not limited to:

- dredge vessel movement;
- pile driving;
- construction dredging;
- bund wall construction during dredging;
- construction of the bund wall; and
- filling of the reclamation area.

Aspects of construction that should be addressed are:

- noise and associated pressure impacts;
- light spill;
- water quality reduction;
- decreased access to intertidal foreshore habitat;
- increased sedimentation; and
- displacement.

The design of the shorebird monitoring program was developed by GHD and described in the reports covering surveys 1-4, which took place in January, February, March and August 2011 (GHD, 2011a; 2011b; 2011c; 2011d). This report details the results of the fourth annual summer survey – February 2016 – following the established methods.

Figure 1-2 The Wiggins Island Coal Export Terminal (WICET), February 2016
The first coal was exported from WICET on 28 April 2015 on board the 76,000t, Panama-registered vessel; the Toro Orient bound for Hong Kong (Adam Leavesley, Wildlife Unlimited).

Figure 1-3 AN LNG vessel moving into a berth at Curtis Island, February 2016
The Magellan Spirit, a 104,000t Danish-registered vessel berthing at the APLNG plant at Curtis Island on 8 February 2016. The first LNG was exported from APLNG on 11 January 2016, from GLNG on 16 October 2015 and from the second LNG train of the QCLNG plant on 13 July 2015. The last two LNG trains to be constructed on Curtis Island are due to commence exporting in 2016 (Adam Leavesley, Wildlife Unlimited).

Figure 1-4 The MV Pacific Conquest levelling the seabed following maintenance dredging.
The vessel is equipped with a seafloor mapping sonar (Aileen Collyer, Wildlife Unlimited).

Figure 1-5 Maintenance of a navigation aid on the channel to the LNG berths.
(Aileen Collyer, Wildlife Unlimited)

2 MIGRATORY SHOREBIRDS IN AUSTRALIA

2.1 EPBC Act listing

The Commonwealth Government has listed 37 species of migratory shorebirds under the EPBC Act (DEH, 2006; DEWHA, 2009a; DEWHA, 2009b; DoE, 2015) (Appendix 1). These species regularly visit Australia, traversing the East-Asian Australasian Flyway (EAAF) from northern hemisphere breeding grounds in northern Asia and North America to the over-wintering grounds which encompass the region between India, Australia, New Zealand and the Western Pacific (Bamford et al., 2008). Conservation of migratory species is often difficult because their ecology is often poorly understood and they require resources that are distributed throughout a number of jurisdictions. Migratory shorebirds are of particular concern because populations appear to be declining worldwide (Howe et al., 1989; Morrison et al., 2001; International Wader Study Group, 2003; Gosbell & Clemens, 2006; Nebel et al., 2008; Clemens et al., 2010; Minton et al., 2012; Ma et al., 2014; Murray et al., 2015; Piersma et al., 2016; Wetlands International, 2016) (Appendix 2), including Australia (Clemens et al., 2016).

Listing under the EPBC Act signifies that migratory shorebirds are a 'matter of national environmental significance' and any action that may have a 'significant impact' on a 'matter of national environmental significance' requires the approval of the Commonwealth Environment Minister to proceed.

"A 'significant impact' is an impact that is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is affected; and upon the intensity, duration, magnitude and geographic extent of the impacts. You should consider all these factors when determining whether an action is likely to have a significant impact on matters of national environmental significance (DEWHA, 2009a)."

Australia has signed a number of international agreements relating to migratory shorebird conservation, including the Convention on Wetlands of International Importance (Ramsar), the Convention on Conservation of Migratory Species of Wild Animals (Bonn Convention), the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA) and the Republic of Korea Migratory Bird Agreement (ROKAMBA). The EPBC Act is the key mechanism for meeting Australia's responsibilities under these agreements (DEWHA, 2009b; DoE, 2015).

Under the EPBC Act, the Australian Government may prepare wildlife conservation plans for listed species. The first conservation management plan for migratory shorebirds was published in February 2006 (DEH, 2006) and following review, the second plan was published in August 2015 (DoE, 2015). The review of the first plan found that it had "failed to meet its objectives because, it had apparently not reduced the rate of decrease of any of the listed species, nor did it have any measurable influence on the known core impacts in East Asia." The review recommended that: 1) the Little Ringed Plover be added to the EPBC Act list of migratory shorebirds bringing the total number to 37; 2) the plan be updated to include new, focused conservation priorities.

The new plan lists 11 threats to migratory shorebird populations including three for which 'immediate mitigation action is required'. The most serious threat was coastal development outside Australia including the Yellow Sea. The threat was expected to occur annually or more frequently and had the potential to cause population extinctions. The second most serious threat was climate variability and change. The threat was expected to occur five-yearly and had the potential to cause population decreases. The third most serious threat was coastal development in Australia. The threat was expected to occur annually or more frequently and had the potential to stall or reduce population recovery (DoE, 2015).

Two EPBC Act listed migratory shorebird species, the Curlew Sandpiper and the Eastern Curlew are listed as critically endangered. These species are no longer subject to the migratory shorebird conservation plan but have their own specific plans. A further five migratory shorebird species are on the current finalised priority assessment list for birds and their determinations are expected to be completed by 30 September 2017 (DoE, 2016). These are the Red Knot, Great Knot, Graeter Sand Plover, Lesser Sand Plover and two Bar-tailed Godwit sub-species (*baueri* and *menzbieri*). An action of the new migratory shorebird conservation plan with a 'Very High' priority is that the conservation status of all migratory shorebirds be reviewed and published by 2017.

2.2 EPBC Act listed Shorebird Species

The 37 species of migratory shorebirds listed under the EPBC Act exhibit a variety of life history attributes (Marchant & Higgins, 1993; Higgins & Davies, 1996; Colwell, 2010; Hollands & Minton, 2012). These attributes influence the likelihood of their presence in Gladstone Harbour and the Curtis Coast (Appendix 3). They also influence the likelihood of detection during survey (Bamford et al., 2008) so it is important to match the survey method to the attributes of the target species. Key life history attributes include: range in Australia; habitat; roost selection and behaviour; and migration timing.

Of the 37 species, six (Swinhoe's Snipe, Pin-tailed Snipe, Asian Dowitcher, Common Redshank, Red-necked Phalarope and Little Ringed Plover) are extremely rare in central Queensland (Marchant & Higgins, 1993; Higgins & Davies, 1996; Hollands & Minton, 2012). Another nine (Latham's Snipe, Little Curlew, Wood Sandpiper, Ruff, Pectoral Sandpiper, Sharp-tailed Sandpiper, Long-toed Stint, Oriental Plover and Oriental Pratincole) rarely utilise marine environments (Marchant & Higgins, 1993; Higgins & Davies, 1996; Hollands & Minton, 2012) so are unlikely to be present in large numbers in marine ecosystems on the Curtis Coast. The remaining 22 species frequent marine environments, are present on the central Queensland coast (Marchant & Higgins, 1993; Higgins & Davies, 1996) and have been recorded in previous surveys (GHD, 2011a; 2011b; 2011c; 2011d; Sandpiper Ecological Surveys, 2012a; 2012b; 2012c; Wildlife Unlimited, 2012).

Of these 22 species, most will roost in aggregations at high tide (Marchant & Higgins, 1993; Higgins & Davies, 1996; Bamford et al., 2008). Such roosts can be classified into three broad groups: 1) raised high points such as sand banks, mud banks, sand/shell/gravel bars, sand spits, beaches and islets; 2) mangroves and other vegetation; and 3) rocks, ledges, reefs and shipwrecks. Most of the shorebird species on the Curtis Coast use banks, bars, spits and beaches, while some species commonly use trees (e.g. Whimbrel, Terek Sandpiper, Grey-tailed Tattler and Common Sandpiper) and others commonly use rocks (e.g. Ruddy Turnstone, Wandering Tattler and Common Sandpiper). It is therefore important to survey all three types of roosts in order to get an accurate estimate of abundance for all species. A further complication is that some species, notably the Red-necked Stint, are known to move to coastal wetlands during the high tide and continue feeding (Higgins & Davies, 1996; Minton et al., 2012). Notwithstanding this possibility, roost counts in marine ecosystems at high tide appear to the best method for obtaining an accurate count of shorebirds on the Curtis Coast (Bamford et al., 2008; Birdlife Australia, undated; DEWHA, 2009b; GHD, 2011c). Work in locating such roosts for this project was completed by GHD and is described in previous reports (GHD, 2011a; 2011b; 2011c; 2011d).

A migratory shorebird site in the EAAF is considered of international significance if it supports >1 percent of the population estimate for the flyway (Bamford et al., 2008; DEWHA, 2009a). A site is considered of national significance if it supports >0.1 percent of the flyway estimate. The Australian Government accepts the EAAF population estimates of Bamford et al. (2008; DEWHA, 2009a; 2009b). Recent EAAF population estimates have been produced by Wetlands International (2016) and these have been added to accounts of species abundance estimates for comparison. A list is at Appendix 2.

Figure 2-1 A Red-capped Plover in the Western Basin Reclamation Area, February, 2016
(Aileen Collyer, Wildlife Unlimited)

3 METHODS

3.1 Shorebird Survey Guidelines

DoE (formerly DSEWPAC, DEWHA and DEH) has published guidelines detailing the recommended survey coverage, timing, effort and minimum data requirements for conducting migratory shorebird surveys (DEWHA, 2009b). Survey coverage and effort for this project was determined by DoE in the approval conditions and Ecosystem Research and Monitoring Program for the project (Gladstone Ports Corporation, 2011). DoE has helped fund the *Shorebird 2020* program via the Natural Heritage Trust and there is considerable agreement between the DoE survey guidelines and the *Shorebird 2020* procedures (DEWHA, 2009b). Use of the *Shorebird 2020* procedure is desirable for this study because most shorebird observers in Australia are familiar with it. Consequently training requirements for observers will be minimised and the pool of skilled and experienced observers will be maximised. Over the life of the study this will increase the comparability of the data and minimise difficulty finding suitably experienced survey staff.

Timing for the survey was determined using Australian Government guidelines (DEWHA, 2009b), recommendations from previous surveys (GHD, 2011a; 2011b; 2011c; 2011d) and advice from the Ecosystem Research and Monitoring Program Advisory Panel. Criteria and recommendations for the timing of shorebird surveys are:

- at a suitable time in relation to the seasonal movements of the species known to be present at the study site;
- for surveys of roosting sites, no more than two hours either side of high tide;
- for foraging surveys, no more than two hours either side of low tide;
- high rainfall and strong wind to be avoided; and
- periods when disturbance is occurring to be avoided.

3.1.1 Survey timing

The aim of the summer survey is to count the populations of migratory shorebirds that are present on the Curtis Coast during the Austral summer. To determine the range of suitable times for a summer survey in Gladstone, the timing of migration for 23 species that have been recorded during the study was obtained from Marchant and Higgins (1993) and Higgins and Davies (1996).

All species of migrating shorebirds that breed in the northern hemisphere and are regularly present on the central Queensland coast are present by the beginning of December (Appendix 3). One of these species, the Curlew Sandpiper is believed to begin its northward migration in mid-January but no other species are believed to leave before mid-February. This leaves a window of opportunity for counting from December to mid-February. Other considerations for the timing, in order of importance are tide heights, weather, predictable disturbance and the *Shorebird 2020* national census date. Spring tides are essential to concentrate birds at roosts and tide heights of >3.6m but <4.4m are desirable. At lower tides some of the large, important roosts present difficulties when counting – i.e. some roosts are difficult to reach by boat (e.g. site C2c, Yellow Patch entrance sandbar; site 2, Curtis Island south end west), flocks may be dispersed over large areas (e.g. site PA16, Deception Point; sites 39 and 39B, Curlew Spit; and site C13, Yellow Patch entrance sandbar) and in some cases birds hide in foliage and walk away from surveyors (e.g. sites 39 and 39B, Curlew Spit). At the highest tides and especially after rain when the rivers are high some big important roosts are inundated and cannot be occupied. Examples are site C13 Yellow Patch entrance sandbar; site PA2, Mackenzie Island north and site PA1, Rundle Beach. Stable weather is desirable because surveys cannot be conducted in strong wind or rain. This is particularly important in summer because of the possibility of prolonged bad weather associated with tropical cyclones. Major causes of predictable anthropogenic disturbance such as public holidays and fishing competitions should also be avoided if possible. In winter, longer daylight hours are desirable because a five day program

causes time constraints during the low tide surveys on the fifth day. The *Shorebird 2020* national census dates are January 15 and June 15 (or the earliest survey at each location after that date).

Where a single summer survey is required, this will best serve the aims of the Ecological Research and Monitoring Program (Gladstone Ports Corporation, 2011) if it is carried out when migratory shorebird numbers are at a maximum. This is likely to occur in December and January, but may have to be extended into early February due to the prevalence of prolonged bad weather in the cyclone season. Late-December and early-January should be avoided because of the likelihood of high levels of recreational boat traffic associated with the Christmas holiday period.

3.2 Study Area

The study area is centred on Port Curtis, the site of the Gladstone Western Basin Main Dredging Works and extends north to Cattle Point in the Fitzroy Estuary and south to Rodd's Peninsula as defined in the Ecological Research and Monitoring Program (Gladstone Ports Corporation, 2011). Henceforth we refer to the study area as the 'Curtis Coast'. The Curtis Coast is divided into seven locations following the method of GHD (2011c):

- North Curtis;
- Fitzroy Estuary;
- Port Curtis;
- Colosseum Inlet and Mundoolin Rocks;
- Rodd's Peninsula;
- Cheetham Salt Works; and
- Mainland foreshore.

For the purposes of analysis, the locations have been classified into three putative ecological units following the method of GHD (2011c). The ecological units are: Port Curtis incorporating the mainland foreshore (Figure 3-2); Fitzroy Estuary-North Curtis Island (Figure 3-3); and Colosseum Inlet-Mundoolin Rocks-Rodds Peninsula (Figure 3-4). Data from the Cheetham Salt Works at Bajool has been excluded from analyses using the putative ecological units because of discontinuity of access to the site. The salt works is located in the Fitzroy Estuary.

3.3 Site Selection

Survey sites were selected to be comparable with the previous summer surveys (Sandpiper Ecological Surveys, 2012a; Wildlife Unlimited, 2013a; 2014; 2015). The field work was designed to locate and count as many migratory shorebirds as possible by surveying the largest known and most easily accessible shorebird roosting sites during the two hours either side of a spring high tide (GHD, 2011c). Spring tides tend to have a greater tidal range than average due to high tides being higher and low tides being lower. The standard survey path was followed and counting was conducted from the standard survey points. A known shorebird site within the Cheetham Salt Works mine at Bajool was surveyed at mid-tide on a falling tide.

Low tide surveys were conducted on the ebb tide within two hours of the low tide. The most important intertidal foraging areas adjacent to the high tide roosts were surveyed from the standard observation points as described by GHD (2011d) or from alternative locations with safe access.

3.4 Survey Schedule

The field work was conducted for five consecutive days coinciding with a new moon spring tide, from 8-12 February (Table 3-1). This was one day earlier than originally planned due to difficulty gaining access to the Cheetham Salt Works on a weekend. The salt works is a mine site and an annual induction is required to obtain access.

Table 3-1 Survey schedule for February 2016

Date	Scheduled locations
8 February	Port Curtis
9 February	Fitzroy Estuary
10 February	North Curtis
11 February	Colosseum Inlet and Mundoolin Rocks
12 February	Rodd's Peninsula, Mainland Shore, Cheetham Salt Works

Each location was surveyed in a single day by two pairs of observers working simultaneously (GHD, 2011c). This was done to minimise the possibility that birds would move during the survey, confounding the count. The teams consisted of two experienced shorebird observers equipped with binoculars, a spotting scope with a 20x-60x magnifying lens, a map and a GPS containing the coordinates of all the survey sites. Surveys commenced two hours before high tide and were usually completed within four hours; any counts that took place after this period were included in the dataset provided there was no evidence of birds moving between roosts or to the foraging grounds. All sites with a history of supporting large numbers of birds were surveyed within the prescribed four hour period. The Mainland Shoreline survey including the Western Basin Reclamation Area was completed at high tide. Further survey of the mud flats around the reclamation area was completed during low tide.

3.5 Count Procedure

Shorebirds were counted following the *Shorebirds 2020* procedure (Birdlife Australia, undated) recorded on a modified version of the *Shorebirds 2020* datasheet (Table 3-2). The procedure largely follows Australian Government guidelines (DEWHA, 2009b) and is commonly used around Australia.

Table 3-2 Data collected on each survey

Number of observers and their names	Survey type (land, boat or air)
Date	Tide height (rising, high or falling)
Start time and finish time	Wind direction and wind speed
Shorebird area (Curtis Coast)	Human activity
Count Area	Threats
Site number and name	Species abundance
Location using GPS (datum WGS84)	Notes

In fulfilment of the conditions of the EPBC Act approval, the shorebird species for which data were collected were the 36 migratory species listed in the 2009 EPBC Act guidelines (DEWHA, 2009b). The addition of the Little Ringed Plover to the migratory shorebird list is unlikely to affect the project because it is not known to visit the Curtis Coast. In addition, abundances were also collected for 10 species of non-migratory shorebirds (Appendix 5) that are part of the *Shorebirds 2020* program (Birdlife Australia, undated).

3.5.1 Roost surveys

Roost surveys were conducted two hours either side of the high tide (Table 3-3). The roosts were accessed by boat and the count was preferentially conducted by wading ashore to a suitable location. Where it was not possible to reach the shore, counting was undertaken from the boat. Both observers confirmed species identification and counted each species independently where possible. If birds were flushed care was taken to avoid double counting within the roost or at

succeeding roosts. Surveys on the Mainland Shoreline including the Western Basin Reclamation Area were accessed by vehicle. A photographic record of roosts is being collected to assist with recognition of changes over time.

Table 3-3 Bureau of Meteorology predicted tide heights and times at Gladstone

Date	High tide		Low tide	
	Time	Height	Time	Height
8 February	09:04	4.51m	15:28	0.60m
9 February	09:44	4.58m	16:10	0.50m
10 February	10:25	4.57m	16:51	0.49m
11 February	11:06	4.45m	17:32	0.58m
12 February	11:51	4.23m	18:14	0.75m

3.5.2 Foraging surveys

Foraging surveys were planned to be conducted at low tide at each location on the same day as the roost surveys. Surveys commenced no earlier than two hours before the low tide and finished within 60 minutes after the low tide. The surveys were conducted in one of two ways depending on the shape of the intertidal area. Large intertidal flats were surveyed by wading ashore to reach the survey point. Long, linear flats were surveyed from a slow-moving boat.

3.5.3 Western Basin Reclamation Area high tide surveys

Potential shorebird roosting sites on the Western Basin Reclamation Area were thoroughly investigated at high tide during the mainland shoreline survey on day five. The survey was conducted in two ways: 1) survey of all sites at the reclamation area; and 2) vehicle traverse of the major reclamation roads and investigation of all likely roost sites.

3.5.4 Cheetham Salt Works surveys

Cheetham Salt Works at Bajool is in the Fitzroy Estuary and within the study area of the Ecosystem Research and Monitoring Program (Gladstone Ports Corporation, 2011). The salt works were surveyed over the first 18 months of the project (GHD, 2011a; 2011b; 2011c; 2011d; Sandpiper Ecological Surveys, 2012a; 2012b). During this period, surveys were conducted at five sites within the salt works and at six sites from the Port Alma Road adjacent to the salt works. At the five internal sites, relatively high counts of a suite of migratory and non-migratory shorebirds that were rare elsewhere on the Curtis Coast were regularly obtained from particular concentration ponds where the salinity and water height generated suitable foraging conditions (Houston et al., 2012). Records from the six sites along the road were unpredictable and usually of species that were commonly recorded during the rest of the Curtis Coast survey. Permission to survey the internal salt works sites could not be obtained for the August 2012 survey or subsequent surveys (Wildlife Unlimited, 2012; 2013a; 2013b; 2014; Sandpiper Ecological Surveys, 2012c) until permission was renewed for February 2015 (Wildlife Unlimited, 2015).

The salt works were surveyed on 12 February 2016 during the mainland shoreline schedule. Although the production area of the salt works is not tidal, it is preferable that surveys are conducted at high tide to minimise the possibility of double counting of birds that may move between the salt works and nearby sites in the Fitzroy Estuary. The 2016 survey was conducted at mid-tide. The reason for this was that it was not possible to complete the rest of the mainland shoreline schedule and the mandatory Cheetham Salt Works induction within the four hour high tide window.

(NB Time allocated to the salt works in the earlier surveys was re-allocated to survey of the Western Basin Reclamation Area after it was completed.)

3.6 Taxonomy and nomenclature

Shorebirds were identified according to Simpson and Day (2010), Pizzey and Knight (2012), DEWHA (2007), Birds Australia (2010), Message and Taylor (2005) and Hayman *et al*. (1986). Nomenclature followed Christidis and Boles (2008).

3.7 Mapping

Mapping was completed using ArcGIS 10. The base layers were obtained from the Geoscience Australia 1:250,000 series, via MapConnect. GPC supplied data for the Western Basin Reclamation Area and the built-up areas of Gladstone. The maps were generated using the mainland and islands layers to represent the area above high tide; to this was added the Western Basin Reclamation Area data supplied by GPC. Minor edits were made to the reclamation area data so that they fit seamlessly with the Geoscience Australia data. The area below high tide was represented by tidal foreshore, sea and waterways layers. The flats layer was included to represent the claypans; the pondage layer represented the Cheetham Salt Works. The built up area shows the location of Gladstone and Tannum Sands to aid with orientation. A roost site layer was created from GPS coordinates obtained during the project.

3.8 Analysis

Detrended Correspondence Analysis was used to compare the patterns of migratory shorebird distribution at high tide roosts between the ecological units. Records of birds not identified to species level were excluded. The analysis was performed using CANOCO 3.4. (Ter Braak, 1986). The method follows Ter Braak and Smilauer (2002). The analysis was detrended by segment, data were not transformed and rare species were not downweighted or deleted. One species, the Sharp-tailed Sandpiper was incorporated as a supplementary species because it exerted excessive leverage on the analysis and obscured the dominant relationships. Supplementary species are added to the ordination post-hoc by projection. The ordination was prepared using the first two axes of the analysis and all species and surveys. The surveys were classified according to the ecological units for the Curtis Coast as defined by GHD (2011c). Envelopes were placed around the surveys from each ecological unit to better indicate the proportion of ordination space that each bird community occupied in relation to the other communities.

Migratory shorebird densities were calculated using the high tide roost data from the February 2016 survey and the area of intertidal flat as determined by GHD (2011a). This is a blunt tool which does not take into account the tidal range or the foraging preferences of each species. It does however, serve two useful functions: 1) provides a standardised comparison between ecological units; and 2) helps to contextualise changes in shorebird community composition in Port Curtis through time. For example, the intertidal foraging area in Port Curtis will be reduced by the planned development and this would be expected to cause a decline in the abundance of migratory shorebirds. However, if the density of migratory shorebirds remains the same then this suggests that the quality of the foraging areas has remained unchanged (i.e. no habitat alteration; DEWHA, 2009b) and increased traffic in the port has not affected the birds – they may have become habituated to disturbance as discussed by GHD (2011a; 2011c). In this way the project can be treated as a natural experiment and used to inform migratory shorebird management in Australia and around the world.

The summer average total abundance of migratory shorebirds was calculated using January and February surveys conducted for this project from 2011-2016. The surveys were conducted in January 2011-2012, and February 2011-2016.

This report presents some single species comparisons between ecological units between years. This approach has been taken because: 1) it a requirement of the Ecosystem Research and Monitoring Program; and 2) the overall number of migratory shorebirds – though an important tool for monitoring – may conceal the substitution of species within the study area. For example a decline in the type and quantity of prey or a change in the physical properties of the substrate (Colwell, 2010) may lead to the abandonment of a foraging area by one species but the change may facilitate greater use by another species with the result being no overall change in the number of shorebirds at the study site.

Figure 3-1 A nesting Black-winged Stilt in the Clinton Ash Ponds, February 2016
(Adam Leavesley, Wildlife Unlimited)

Figure 3-2 Survey sites in the Port Curtis ecological unit.

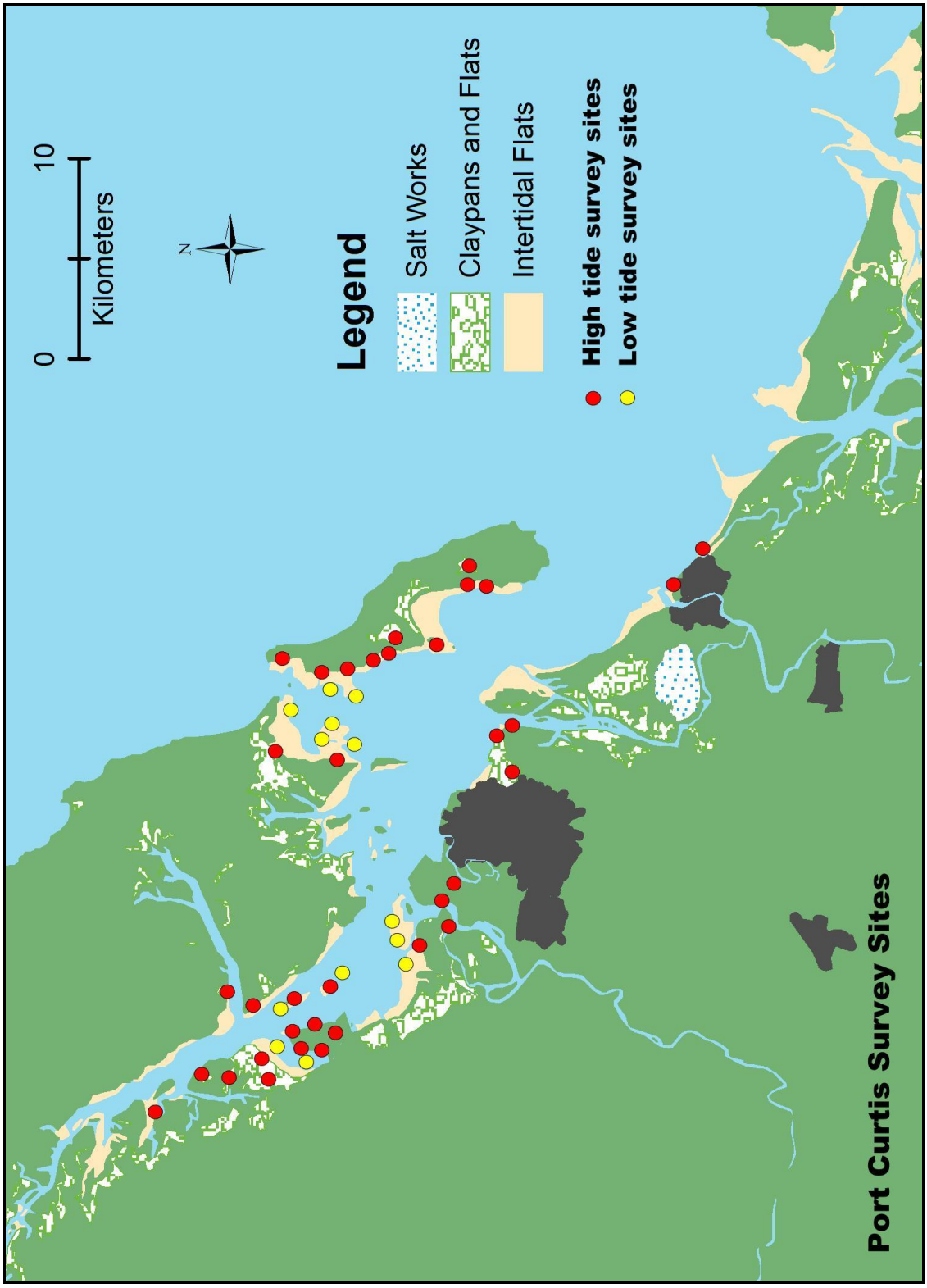


Figure 3-3 Survey sites in the Fitzroy Estuary and North Curtis ecological unit.

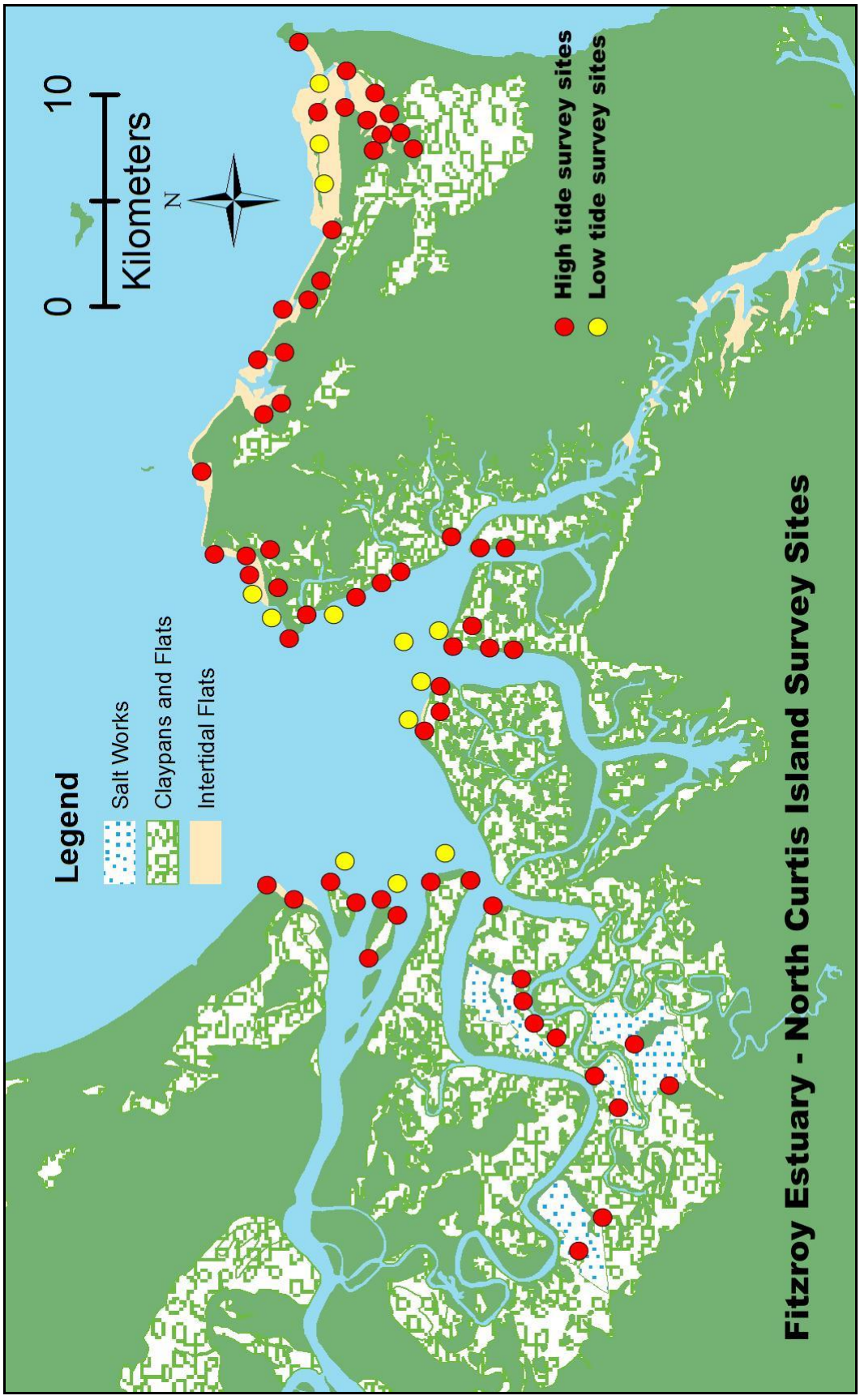
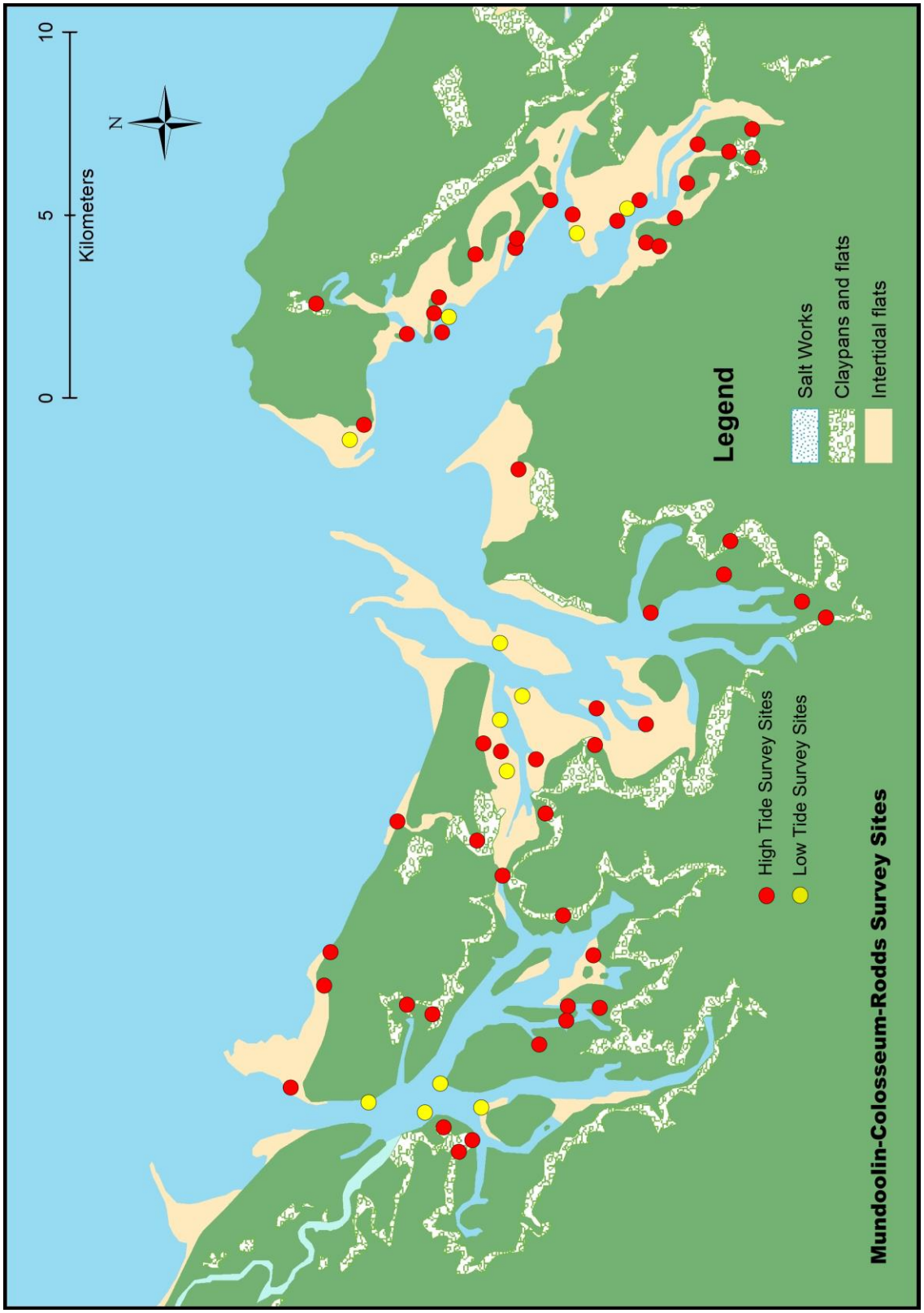


Figure 3-4 Survey sites in the Mundoolin-Colosseum-Rodd's ecological unit.



4 RESULTS

4.1 Survey coverage

The coverage of this survey was comparable with that of previous years; a total of 157 high tide surveys were completed (Table 4-1) which was 13 more than February 2015. The total survey time at high tide was 1270 minutes. The survey at Cheetham Salt Works was conducted on 12 February at mid-tide (N.B. the salt works is not tidal). The completion of some of the development work in Upper Gladstone Harbour has allowed access to areas that have presented difficulty in the past. Site QGC1 which was blocked due to construction of the Wiggins Island Coal Export Terminal appears to have been developed. All major roosts were surveyed strictly within the four hour timeframe, so late surveys involved only small numbers of birds and exclusion of the records would not significantly alter conclusions. All records were time-stamped so future analysis could include or exclude those records.

A total of 31 sites were surveyed at low tide for a duration of 776 minutes. This was four sites more than were surveyed in February 2015.

The weather during the survey was dominated by low pressure systems to the south and the north which brought consistently strong south-easterly winds. Thirty-one percent of sites were counted in winds >28km/h. Conversely only one site was counted during winds <12km/h. The wind was slightly stronger during low tide surveys ranging from 12-49km/h. Australian Government guidelines recommend that migratory shorebird surveys avoid periods of strong wind (DEWHA, 2009b). As wind strength increases, the precision of the survey decreases for several reasons: 1) increased wave action causes the boat to move making observation more difficult; 2) increased wind causes spotting scopes to shake making observation more difficult and reducing the magnification at which the instrument can be used; 3) birds tend to become flightier which makes them harder to count and reduces confidence in the assumption that they are not moving between roosts at high tide; 4) birds tend to occupy different roosting locations to escape from the wind; 5) safety considerations restrict access to some sites during high and low tide surveys; and 6) safety considerations increase the size and survey standard of the boats that can be used, and this may further restrict access to sites.

Two factors may have influenced the results of this survey. 1) The predicted tide heights were near the top of the range for Gladstone. 2) The Curtis Coast experienced in the order of 200mm of rain in the fortnight prior to the survey. The combination of these events meant that a number of large important roosts which often support large numbers of birds were inundated and supported far fewer birds than has been recorded on previous occasions.

Table 4-1 Summary of survey effort: number of sites and duration for each location

Location	High tide		Low tide	
	Sites	Duration (mins)	Sites	Duration (mins)
Port Curtis	47	389	11	131
Fitzroy Estuary	23	239	6	180
North Curtis	38	297	3	174
Mundoolin-Colosseum	28	223	9	146
Rodd's Peninsula	20	122	2	145
Cheetham Salt Works	1	75	0	0
Total	157	1345	31	776

4.2 Abundance Estimates

4.2.1 Curtis Coast

The total number of EPBC-listed migratory shorebirds at high tide roost counts in February 2016 was 11,574 (Table 4-14, Figure 4-1) consisting of 20 species (Figure 4-2). This figure is 16.0 percent fewer than was recorded in February 2015 (13,752 birds). Two species were recorded this year but not last year. These were Common Sandpiper (one bird) and Marsh Sandpiper (two birds). Latham's Snipe (one bird) and Little Curlew (one bird) were recorded last year but not this year. The ten most abundant species last year - Red-necked Stint, Bar-tailed Godwit, Great Knot, Whimbrel, Greater Sand Plover, Grey-tailed Tattler, Eastern Curlew, Terek Sandpiper, Lesser Sand Plover, and Grey Plover - were also the 10 most abundant species this year, however there was some variation in the counts and distributions across the region. The foraging density of migratory shorebirds across the Curtis Coast was 1.15 birds/ha compared to 1.37 birds/ha last year. At Fitzroy Estuary-North Curtis the foraging density was 1.14 birds/ha compared to 1.99 birds/ha last year, at Mundoolin-Colosseum-Rodd's it was 1.15 birds/ha compared to 1.01 birds/ha last year and at Port Curtis was 1.15 birds/ha compared to 0.73 birds/ha last year. It should be noted that foraging density was calculated using the area of foraging habitat on the Curtis Coast prior to the commencement of the Western Basin Dredging and Disposal Project. The area of foraging habitat may have changed and this would affect the density estimate.

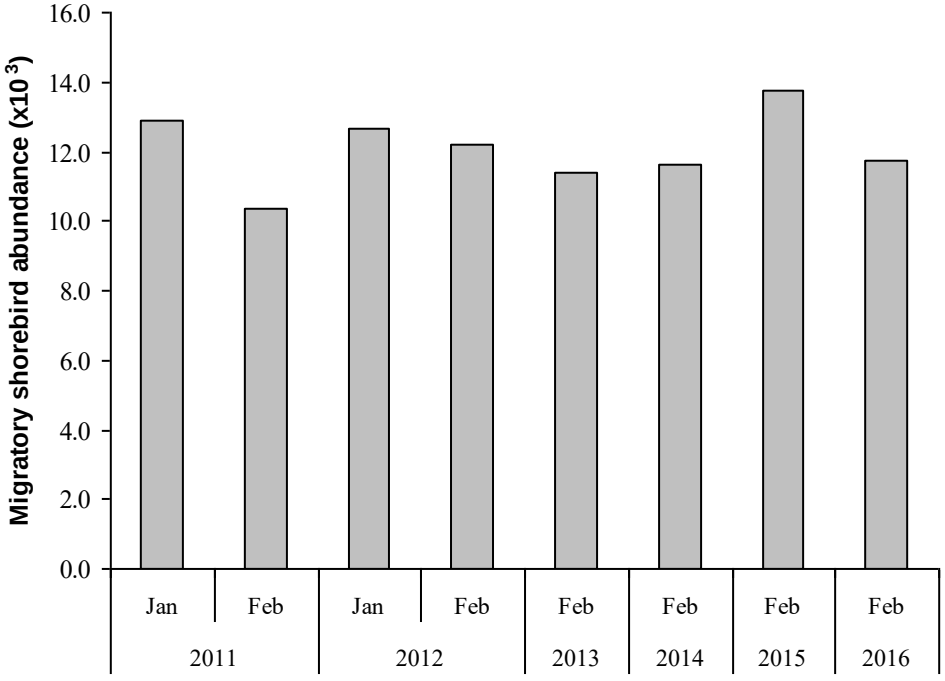


Figure 4-1 Total abundance of migratory shorebirds in summer on the Curtis Coast.
Cheetham Salt Works counts have been excluded due to variability of access over the period of the study.

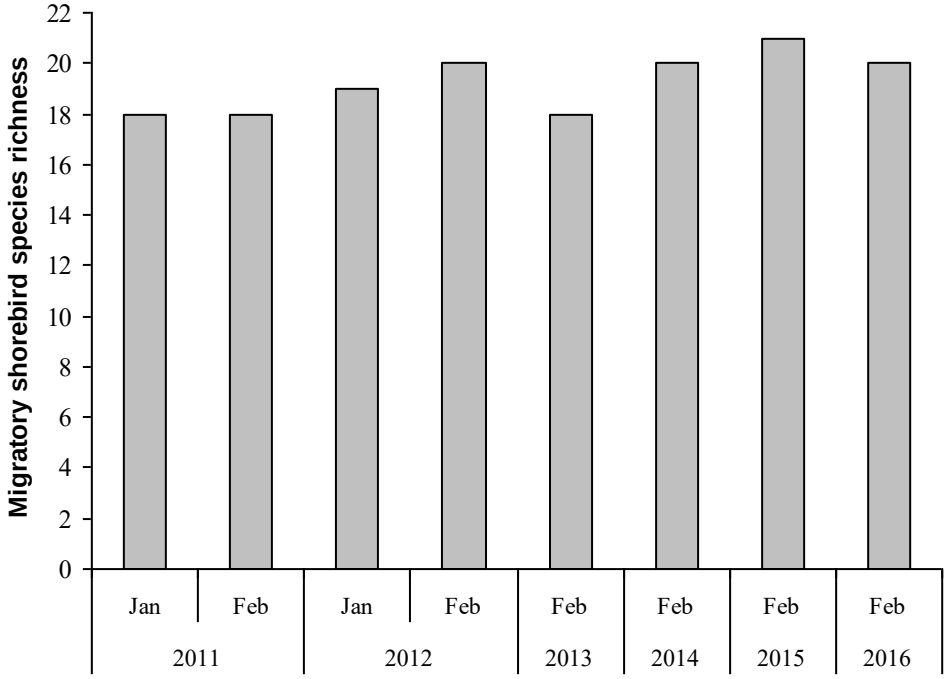


Figure 4-2 Species richness of migratory shorebirds in summer on the Curtis Coast
Cheetham Salt Works counts have been excluded due to variability of access over the period of the study.

The high tide roost dataset from February 2016 was analysed using Detrended Correspondence Analysis (Figure 4-4). The composition of the migratory shorebird communities was relatively uniform across all three of the ecological units as defined by GHD (GHD, 2011c): Fitzroy Estuary and North Curtis Island; Port Curtis; and Mundoolin Rocks, Colosseum Inlet and Rodd's Peninsula. The roost sites were distributed in ordination space in relation to three main criteria: 1) whether the roost was dominated by mangrove roosting species such as Terek Sandpiper, Grey-tailed Tattler or Whimbrel; 2) whether the species composition of the roost was dominated by another abundant species such as Whimbrel at non-mangrove sites, Bar-tailed Godwit, Eastern Curlew, Red-necked Stint; or Great Knot; and, 3) the proportion of rarer species at the roost.

Near the centre of ordination space is the Whimbrel node. Whimbrels were relatively abundant and present in the majority of roosts at which birds were detected, including mangroves. They were often recorded roosting alone or in small groups and therefore dominated the composition of those roosts. Above the Whimbrel node and in close proximity in ordination space are the nodes of the Bar-tailed Godwit and Eastern Curlew. The close proximity indicates that they often used the same roosts and the relatively central location reflects their abundance and relatively even spread across the Curtis Coast. A rarer species the Common Greenshank, was also relatively evenly distributed across the study site. On the right hand side of ordination space are the nodes representing abundant species which predominantly roost in mangroves: Grey-tailed Tattler and Terek Sandpiper. At the other end of ordination space is the Red-necked Stint. Large flocks of this species sometimes dominated claypan roosts where they continued to feed when the mudflats were inundated. The other node in ordination space is related to Great Knots. This species was usually recorded at more exposed locations and in company with Red Knots, Grey Plovers, Greater Sand Plovers and Sanderlings. The species that were clearly external to the envelopes such as Common Sandpiper, Pacific Golden Plover, Marsh Sandpiper, Curlew Sandpiper and Ruddy Turnstone were present in relatively small numbers and recorded at relatively few roosts so that they exhibited a relatively weak connection to the rest of the assemblage. The Sharp-tailed Sandpiper was excluded from the

main analysis because it exerted excessive leverage and obscured the dominant relationships. It was then added to the ordination post-hoc by projection.

Figure 4-3 A Common Greenshank and a Marsh Sandpiper, February 2016.

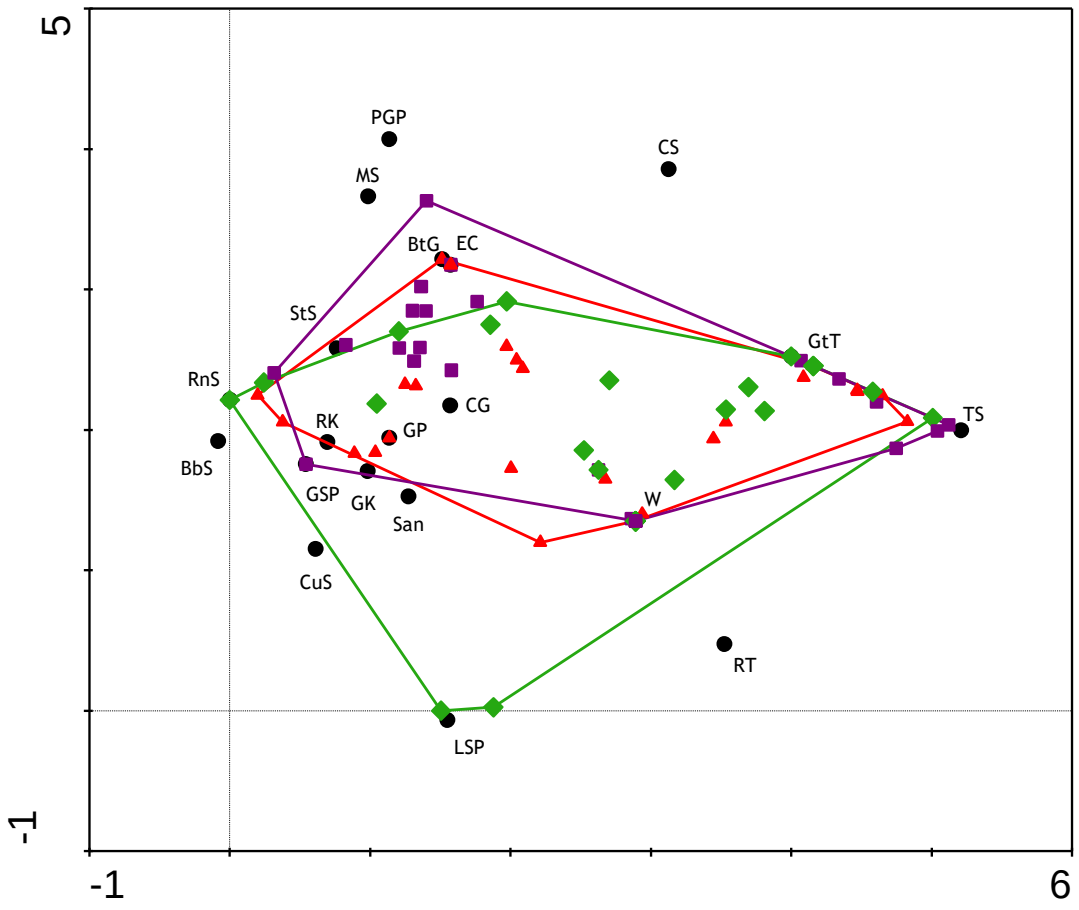


Figure 4-4 Ordination of the migratory shorebird data.
Colours represent ecological units following GHD (2011c)

- Red triangles = Fitzroy Estuary and North Curtis
- Purple squares = Mundoolin-Colosseum-Rodd's Peninsula
- Green diamonds = Port Curtis
- Black circles = shorebird species

The extent of the envelopes around the roost sites suggests that the composition of the shorebird communities was relatively uniform across the three ecological units. For further description of the patterns see section 4.2. Species codes are:

BtG = Bar-tailed Godwit	GSP = Greater Sand Plover	RnS = Red-necked Stint
BbS = Broad-billed Sandpiper	GP = Grey Plover	RT = Ruddy Turnstone
CG = Common Greenshank	GtT = Grey-tailed Tattler	San = Sanderling
CS = Common Sandpiper	LSP = Lesser Sand Plover	StS = Sharp-tailed Sandpiper
CuS = Curlew Sandpiper	MS = Marsh Sandpiper	TS = Terek Sandpiper
EC = Eastern Curlew	PGP = Pacific Golden Plover	W = Whimbrel
GK = Great Knot	RK = Red Knot	

The distribution of large roosts across the Curtis Coast was skewed to the north and south (Table 4-2, Figure 4-16), though the largest roost was central at Port Curtis. There were two roosts with >1000 birds. These were the Curtis Island south end claypan (1347 birds) in the Port Curtis ecological unit and Curlew Spit claypan (1025 birds) in the Fitzroy Estuary-North Curtis ecological unit. There were seven roosts in 500-999 birds class with three in Fitzroy Estuary-North Curtis, four in Mundoolin-Colosseum-Rodds but none in Port Curtis. There were a further 12 roosts with 100-499 birds and they were evenly distributed between the ecological units.

Table 4-2 Place names of the roosts with the greatest abundance of migratory shorebirds

Location	Abundance	Roost
Fitzroy-North Curtis	>1000	1. Curlew Spit Claypan
	500-999	1. Deception Point Claypan - West 2. Cattle Point 3. Mud Bay
	100-499	1. Keppel Creek Entrance 2. Yellow Patch Sandbar Mangrove 3. Salt Works 7* 4. Station Point
Port Curtis	>1000	1. Curtis Island South End Claypan
	500-999	1. Nil
	100-499	1. Western Basin Reclamation Area 2. Facing Island Claypan 3. Friend Point Claypan 4. Facing Island 4
Mundoolin-Colosseum-Rodd's	>1000	1. Nil
	500-999	1. Mundoolin Rocks East Claypan 2. Mundoolin Rocks West Claypan 3. Spit End 4. Central Mangrove Island
	100-499	1. Williams Bay 2. Bird Island 3. Mundoolin Rocks - Opposite 4. Turkey Beach Sand Island

* Cheetham Salt Works was surveyed at mid-tide on a falling tide.

A total of 384 migratory shorebirds, consisting of five species (Red-necked Stint, Sharp-tailed Sandpiper, Lesser Sand Plover, Common Greenshank and Ruddy Turnstone) were recorded during high tide counts on the mainland shoreline. Of the remaining four species, three were relative rare across the Curtis Coast. The result is a reflection of the diversity of marine, freshwater and rocky habitats along the mainland shoreline.

The Cheetham Salt Works was surveyed at mid-tide, however because the site is non-tidal, the birds present were possibly also present at high tide. A total of 207 migratory shorebirds consisting of five species (Sharp-tailed Sandpiper, Red-necked Stint, Marsh Sandpiper, Curlew Sandpiper and Ruddy Turnstone) were recorded. With the exception of the Red-necked Stint all of these species were relatively rare across the Curtis Coast.

The mean abundance of migratory shorebirds on the Curtis Coast in summer calculated from the eight surveys in January and February 2011-2016 is 12,058 birds with a range of 10,387 to 13,752. This is a variation around the mean of 86 percent to 114 percent. In comparison, the 30 year record

of counts at Corner Inlet in Victoria shows a variation of 79 percent to 137 percent around the mean (Minton et al., 2012). It would therefore appear that the variation on the Curtis Coast is not exceptional for an Australian location.

Figure 4-5 Sharp-tailed Sandpipers at Clinton Ash Ponds, February 2016

4.2.2 Bar-tailed Godwit

EAAF population estimate (Bamford *et al.*, 2008): 325,000
1% population threshold for internationally important sites: 3,250
EAAF population estimate (Wetlands International, 2016) 279,000

The Bar-tailed Godwit was the most abundant species in the 2016 summer survey with 2872 birds recorded at roosts during high tide (Table 4-3; Figure 4-6; Figure 4-17). This figure was 8 percent fewer than recorded during the survey in February 2015 (3125 birds). The figure was <1 percent of the official Australian Government EAAF population estimate (Bamford et al., 2008), but >1 percent of the more recent Wetlands International (2016) population estimate. Bar-tailed Godwits were recorded at 23 roosts, three of which ≥0.01 percent of the official EAAF population estimate. These were Curtis Island South End West Claypan (760 birds) at Port Curtis, Spit End (420 birds) and Mundoolin Rocks West Claypan (325 birds) both in the Mundoolin-Colosseum-Rodds ecological unit. Mean flock size at roosts was 125 birds, though this figure was right-skewed and the median was 70. The foraging density of Bar-tailed Godwits was similar in the Port Curtis and Mundoolin-Colosseum-Rodds ecological units. In contrast the foraging density in the Fitzroy Estuary-North Curtis ecological unit was less than half that in the other two ecological units. Bar-tailed Godwits are believed to be declining across the EAAF (Wetlands International, 2016) and in Australia especially north of 27.8°S which includes the study site (Clemens et al., 2016).

Table 4-3 Comparison of the number of birds, number of roosts occupied and foraging density of Bar-tailed Godwits between three ecological units in February 2016

Location	Roosts	Total	Density[1]
Port Curtis	5	904	0.37
Fitzroy Estuary-North Curtis	11	718	0.17
Mundoolin-Colosseum-Rodd's	7	1250	0.38
Total	**23**	**2872**	**0.29**

1 Foraging density (birds/ha)

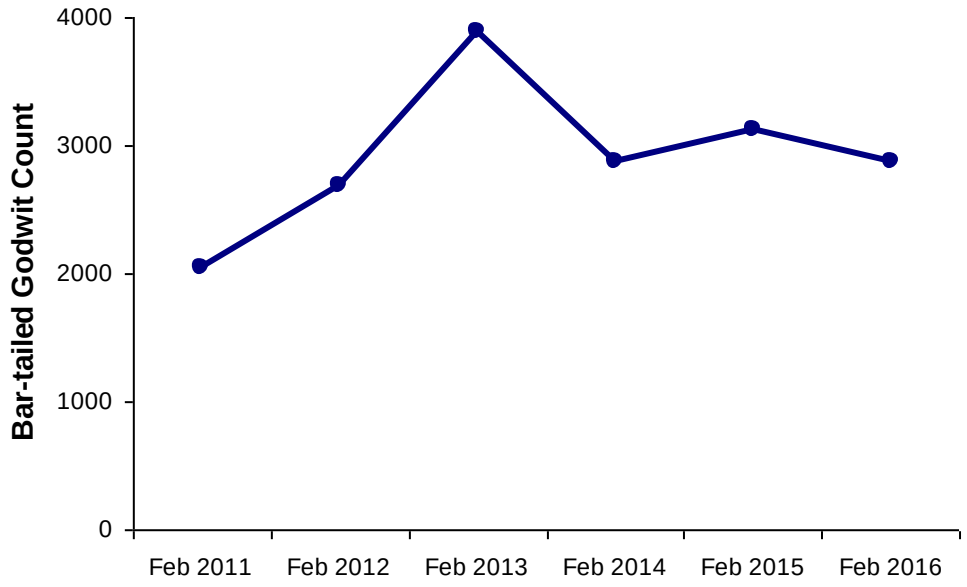


Figure 4-6 Counts of Bar-tailed Godwits on the Curtis Coast, February 2011-2016

4.2.3 Whimbrel

EAAF population estimate (Bamford *et al.*, 2008): 100,000
1% population threshold for internationally important sites: 1,000
EAAF population estimate (Wetlands International, 2016) 55,000

A total of 1099 Whimbrels was recorded on the Curtis Coast in February 2016 (Table 4-4; Figure 4-18). This was one more bird than recorded in February 2015. The 1 percent population threshold for sites of international significance under the Ramsar Agreement has been exceeded during every February survey with the exception of 2014 (Figure 4-7). Whimbrels were present at 61 roosts with the largest at Keppel Creek entrance (184 birds), Yellow Patch sandbar mangrove (150 birds) in North Curtis and Curtis Island south end claypan (104 birds). The 0.1 percent threshold for sites of national significance was exceeded at these three roosts. Foraging density was greatest in the Fitzroy Estuary-North Curtis ecological unit and least in the Mundoolin-Colosseum-Rodds ecological unit. Systematic collection of data relevant to Whimbrel breeding success has not been possible in Australia. However the limited recoveries of flagged birds suggest that those present on the east coast may use Japanese staging areas on migration. This would mean that they have not been subject to the same degree of habitat loss during migration as birds which use the Yellow Sea (Minton et al., 2012). The Whimbrel population in the EAAF (Wetlands International, 2016) is believed to be declining, but there is no evidence of this at a continental scale in Australia where the data suggest an increase in the population north of 27.8°S (Clemens et al., 2016).

Table 4-4 Comparison of the number of birds, number of roosts occupied and foraging density of Whimbrels between three ecological units in February 2016

Location	Roosts	Total	Density[1]
Port Curtis	17	265	0.11
Fitzroy Estuary-North Curtis	24	655	0.15
Mundoolin-Colosseum-Rodd's	20	179	0.05
Total	**61**	**1099**	**0.11**

1 Foraging density (birds/ha)

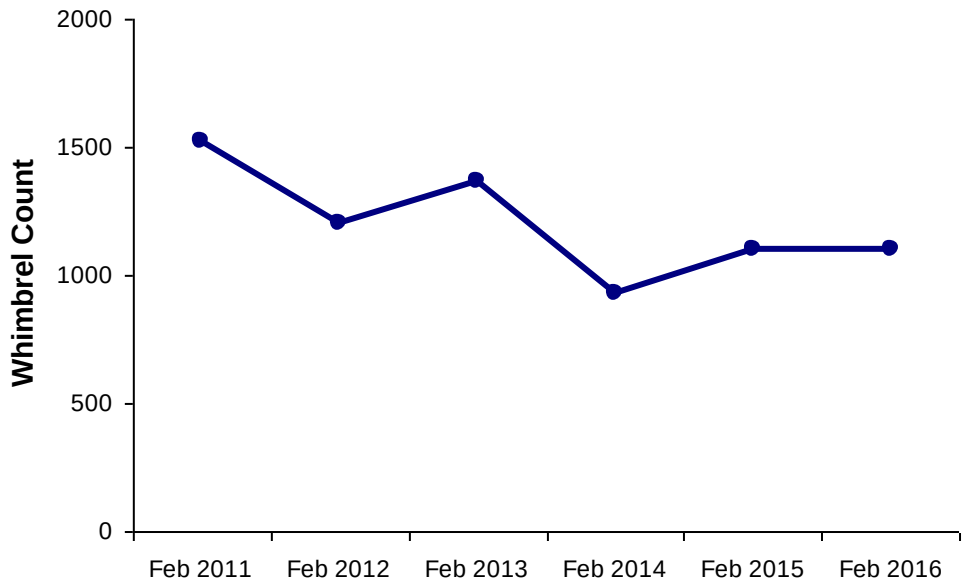


Figure 4-7 Counts of Whimbrels on the Curtis Coast, February 2011-2016

4.2.4 Eastern Curlew

EAAF population estimate (Bamford *et al.*, 2008): 38,000
1% population threshold for internationally important sites: 380
EAAF population estimate (Wetlands International, 2016) 32,000

A total of 786 Eastern Curlew was recorded on the Curtis Coast in February 2016 (Table 4-5; Figure 4-19). This was 3 percent fewer than was recorded in February 2015 (811 birds). The number of Eastern Curlews on the Curtis Coast has exceeded 1 percent population threshold of the official Australian Government population estimate (Bamford et al., 2008) on each of the past six summers (Figure 4-8). Eastern Curlews were present at 24 roosts with the largest at Curtis Island south end claypan (240 birds) and Facing Island claypan (94 birds) in Port Curtis; Mundoolin Rocks east claypan (115 birds), Williams Bay (55 birds) and Spit End (52 birds) in Mundoolin-Colosseum-Rodds ecological unit; and Keppel Creek entrance (43 birds) in the Fitzroy Estuary-North Curtis ecological unit. The numbers recorded at these sites were >0.1 percent of the EAAF population estimate and therefore the sites may be of national significance. The foraging density was greatest at Port Curtis and least at Fitzroy Estuary-North Curtis. The Eastern Curlew is considered to be in decline across the EAAF (Wetlands International, 2016) and also on the Australian continent particular south of 27.8°S and east of 129°E (Clemens et al., 2016). The species is listed as critically endangered under the EPBC Act.

Table 4-5 Comparison of the number of birds, number of roosts occupied and foraging density of Eastern Curlews between three ecological units in February 2016

Location	Roosts	Total	Density[1]
Port Curtis	6	371	0.15
Fitzroy Estuary-North Curtis	6	94	0.02
Mundoolin-Colosseum-Rodd's	24	321	0.10
Total	**24**	**786**	**0.08**

1 Foraging density (birds/ha)

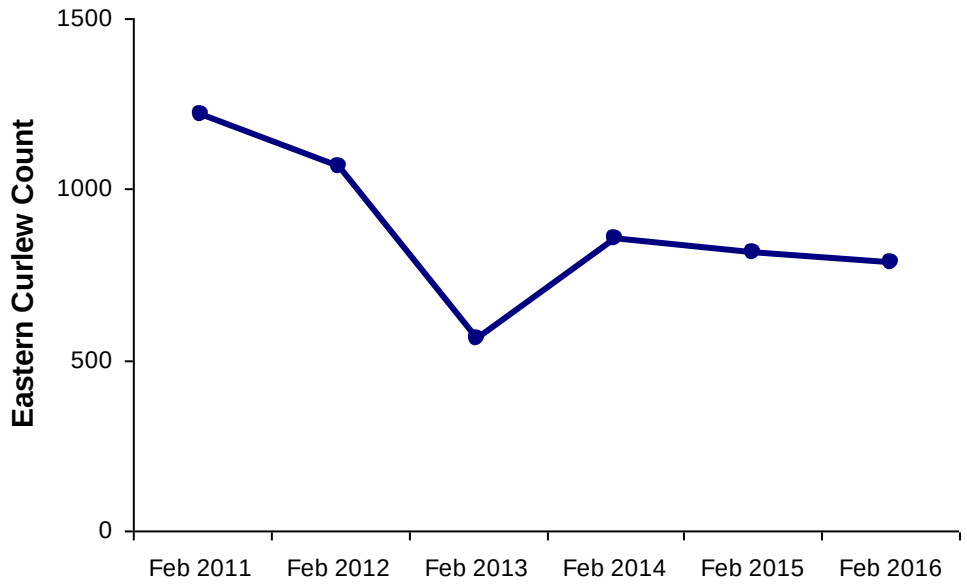


Figure 4-8 Counts of Eastern Curlews on the Curtis Coast, February 2011-2016

4.2.5 Terek Sandpiper

EAAF population estimate (Bamford *et al.*, 2008): 60,000
1% population threshold for internationally important sites: 600
EAAF population estimate (Wetlands International, 2016) 50,000

A total of 603 Terek Sandpipers was recorded at high tide roosts on the Curtis Coast in February 2016 (Table 4-6, Figure 4-20). This was 23 percent fewer than was recorded the previous February (782 birds). The number of Terek Sandpipers on the Curtis Coast has exceeded 1 percent of the official Australian Government population estimate (Bamford et al., 2008) during five of the last six summers (Figure 4-9). Terek Sandpipers were present at 22 roosts the largest of which were Central Mangrove Island (275 birds) and Bird Island Turkey Beach Mangrove Island (70 birds), both in Mundoolin-Colosseum-Rodd's. These two roosts exceeded the 0.1 percent of the official Australian Government EAAF population estimate and may therefore be sites of national significance. The mean flock size at roosts was 27. The foraging density was greatest in Mundoolin-Colosseum-Rodds ecological unit. It is unclear whether the number of Terek Sandpipers in the EAAF population is changing (Wetlands International, 2016). However Australian data suggest it is declining, particularly south of 27.8°S and east of 129°E (Clemens et al., 2016).

Table 4-6 Comparison of the number of birds, number of roosts occupied and foraging density of Terek Sandpipers between three ecological units in February 2016

Location	Roosts	Total	Density[1]
Port Curtis	6	49	0.02
Fitzroy Estuary-North Curtis	9	135	0.03
Mundoolin-Colosseum-Rodd's	7	419	0.13
Total	**22**	**603**	**0.06**

1 Foraging density (birds/ha)

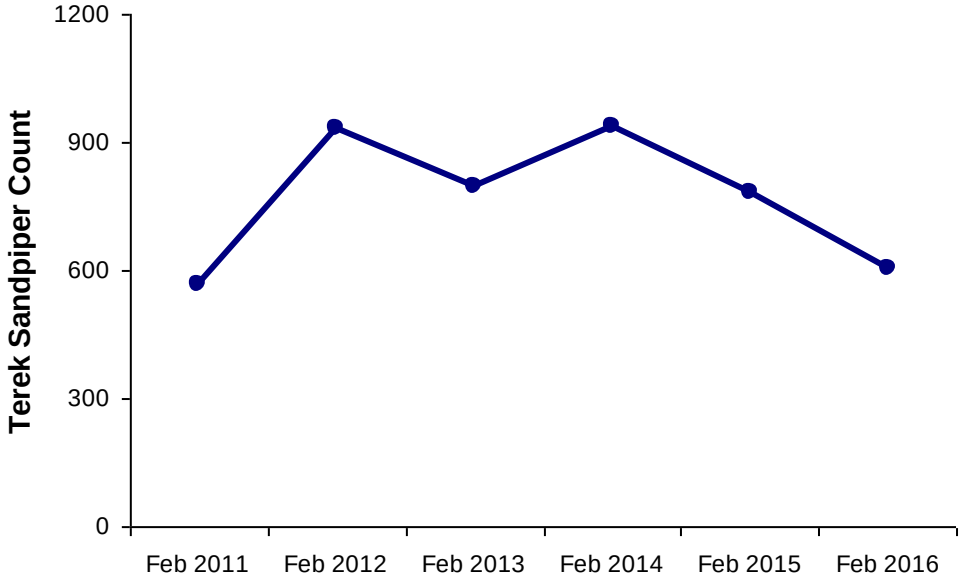


Figure 4-9 Counts of Terek Sandpipers on the Curtis Coast, February 2011-2016

4.2.6 Grey-tailed Tattler

EAAF population estimate (Bamford *et al.*, 2008): 50,000
1% population threshold for internationally important sites: 500
EAAF population estimate (Wetlands International, 2016) 44,000

A total of 1218 Grey-tailed Tattlers was recorded at high tide roosts on the Curtis Coast in February 2016 (Table 4-7, Figure 4-21). This was 46 percent more birds than was recorded at roosts the previous February (835) and the highest count during the project. The number of Grey-tailed Tattlers on the Curtis Coast has exceeded the 1 percent of the official Australian Government EAAF population estimate (Bamford et al., 2008) during every summer of the project (Figure 4-10). Grey-tailed Tattlers were present at 30 roosts across the study area. The largest roosts were Central Mangrove Island (225 birds) and Bird Island (170 birds) in the Mundoolin-Colosseum-Rodds ecological unit; Yellow Patch sandbar mangrove (220 birds) in the Fitzroy Estuary-North Curtis ecological unit; Curtis Island south end claypan (200 birds) and Facing Island 4 (88 birds) in Port Curtis. The count at these roosts was >0.1 percent of the official Australian Government EAAF population estimate and they may therefore be sites of national significance. The foraging density was greatest at the Port Curtis ecological unit and least at the Fitzroy Estuary-North Curtis ecological unit. The Grey-tailed Tattler is believed to be in decline in the EAAF (Wetlands International, 2016). However data from Australian suggest it may be increasing, particularly north of 27.8°S and east of 129°E (Clemens et al., 2016).

Table 4-7 Comparison of the number of birds, number of roosts occupied and foraging density of Grey-tailed Tattlers between three ecological units in February 2016

Location	Roosts	Total	Density[1]
Port Curtis	11	402	0.17
Fitzroy Estuary-North Curtis	13	377	0.09
Mundoolin-Colosseum-Rodd's	6	439	0.13
Total	**30**	**1218**	**0.12**

1 Foraging density (birds/ha)

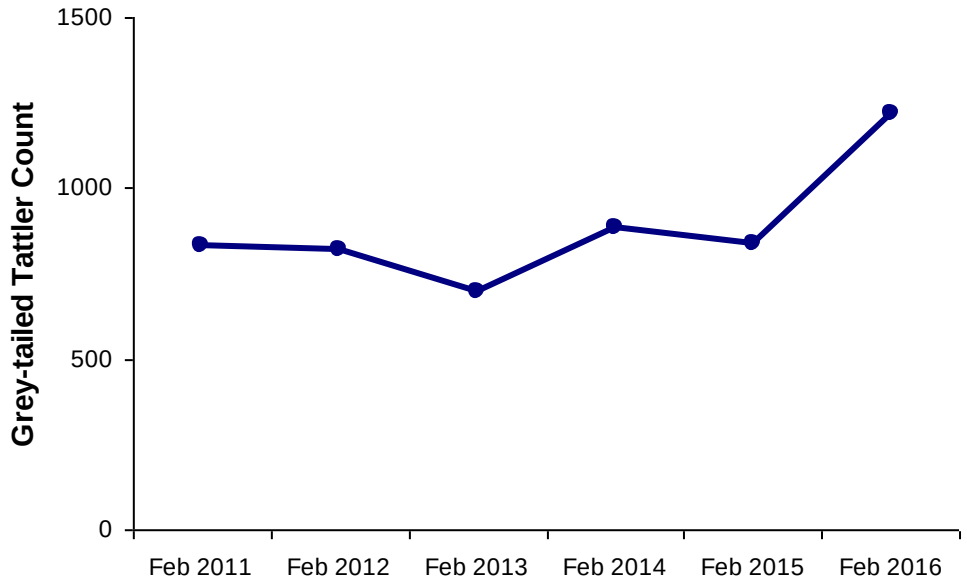


Figure 4-10 Counts of Grey-tailed Tattlers on the Curtis Coast, February 2011-2016

4.2.7 Great Knot

EAAF population estimate (Bamford *et al.*, 2008): 375,000
1% population threshold for internationally important sites: 3,750
EAAF population estimate (Wetlands International, 2016) 290,000

A total of 1,107 Great Knots was recorded at high tide roosts on the Curtis Coast in February 2016 (Table 4-8, Figure 4-22). This was 19 percent fewer than was recorded at roosts the previous February (1,359 birds). The number of Great Knots on the Curtis Coast has not exceeded 1 percent of the official Australian Government EAAF population estimate (Bamford et al., 2008) during the project (Figure 4-11). Great Knots were present at 10 roosts, the largest of which were Cattle Point (423 birds), and Mud Bay (220 birds) in the Fitzroy Estuary-North Curtis ecological unit and Mundoolin Rocks west claypan (265 birds) in the Mundoolin-Colosseum-Rodds ecological unit. The mean flock size at roosts was 111 birds. Outside of the breeding season, most of the Great Knots in the world are thought to be present in Australia (Minton et al., 2012). The species is believed to be in decline in the EAAF (Wetlands International, 2016) and in Victoria (Minton et al., 2012). However Australian continent-wide data suggest it may be increasing, particularly north of 27.8°S and east of 129°E (Clemens et al., 2016).

Table 4-8 Comparison of the number of birds, number of roosts occupied and foraging density of Great Knots between three ecological units in February 2016

Location	Roosts	Total	Density[1]
Port Curtis	2	13	0.01
Fitzroy Estuary-North Curtis	3	644	0.15
Mundoolin-Colosseum-Rodd's	5	450	0.14
Total	**10**	**1107**	**0.11**

1 Foraging density (birds/ha)

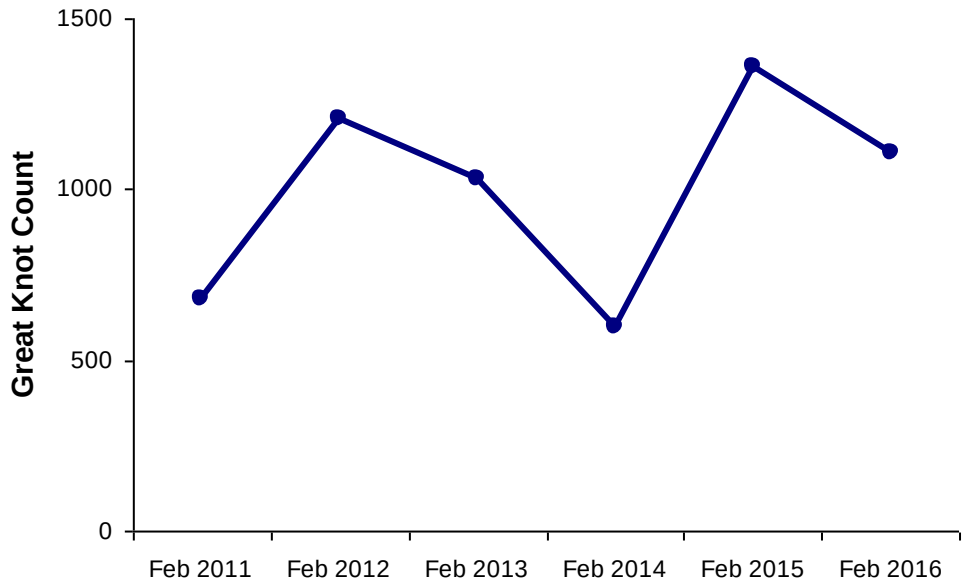


Figure 4-11 Counts of Great Knots on the Curtis Coast, February 2011-2016

4.2.8 Red-necked Stint

EAAF population estimate (Bamford *et al.*, 2008): 325,000
1% population threshold for internationally important sites: 3,250
EAAF population estimate (Wetlands International, 2016) 315,000

A total of 2241 Red-necked Stints was recorded at high tide roosts on the Curtis Coast in February 2016 (Table 4-9, Figure **4**-**23**). This was 42 percent fewer than was recorded at roosts the previous February (3852 birds). The number of Red-necked Stints on the Curtis Coast has exceeded 1 percent of the official Australian Government EAAF population estimate (Bamford et al., 2008) during February surveys on one occasion – 2015 (Figure 4-12). Red-necked Stints were present at 17 roosts, the biggest of which were the Deception Point claypan west (760 birds) and the Curlew Spit claypan (528 birds) in the Fitzroy Estuary-North Curtis ecological unit, the Western Basin Reclamation Area (327 birds) in the Port Curtis ecological unit. The count at these three sites was >0.1 percent of the EAAF population estimate indicating that they may be sites of national significance. The foraging density was greatest at Fitzroy Estuary-North Curtis and least at Mundoolin-Colosseum-Rodds. Red-necked Stints present a particular problem when estimating numbers based on counts at high tide roosts. The species is flexible in its use of feeding habitat and is known to move to coastal wetlands during the high tide (Higgins & Davies, 1996; Hollands & Minton, 2012; Minton et al., 2012). It has been postulated that stint distribution at the Curtis Coast may relate to the amount of moisture in the claypans and this in turn relates to tide height and recent rainfall (GHD, 2011d; Sandpiper Ecological Surveys, 2012a). It is unclear whether the population of Red-necked Stints in the EAAF is changing (Wetlands International, 2016). However Australian data suggest it is declining, particularly east of 129°E (Clemens et al., 2016).

Table 4-9 Comparison of the number of birds, number of roosts occupied and foraging density of Red-necked Stints between three ecological units in February 2016

Location	Roosts	Total	Density[1]
Port Curtis	5	513	0.21
Fitzroy Estuary-North Curtis	4	1309	0.30
Mundoolin-Colosseum-Rodd's	8	419	0.13
Total	**17**	**2241***	**0.22**

1 Foraging density (birds/ha)

* An additional 72 Red-necked Stints were recorded at Cheetham Salt Works at mid-tide.

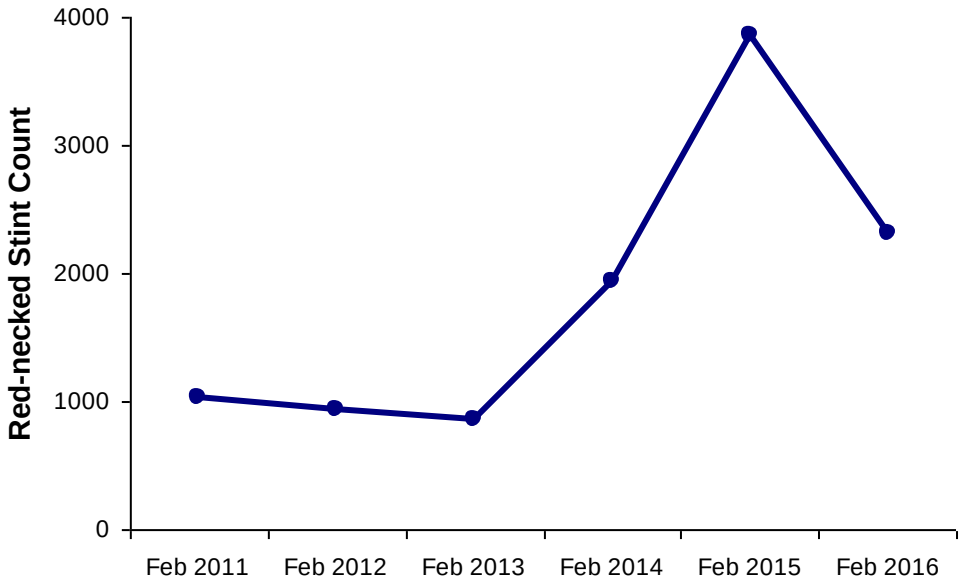


Figure 4-12 Counts of Red-necked Stints on the Curtis Coast, February 2011-2016

Figure 4-13 Curlew Sandpiper and Sharp-tailed Sandpiper, February 2016

4.2.9 Grey Plover

EAAF population estimate (Bamford *et al.*, 2008): 125,000
1% population threshold for internationally important sites: 1,250
EAAF population estimate (Wetlands International, 2016) 104,000

A total of 130 Grey Plovers was recorded at high tide roosts on the Curtis Coast in February 2016 (Table 4-10, Figure 4-24). This was 30 percent fewer birds than was recorded at roosts the previous February (187 birds). The number of Grey Plover on the Curtis Coast has not exceeded 1 percent of the official Australian Government EAAF population estimate during the project (Figure 4-14). Grey Plovers were present at 7 roosts with the largest one at Mud Bay (90 birds) in the Fitzroy Estuary-North Curtis ecological unit. Foraging density was greatest at this ecological unit. Grey Plover numbers collapsed in 1996 in Victoria and have remained at a lower level since (Minton et al., 2012). Genetic work has shown that virtually all the Grey Plovers in Australia are female and this may increase the species' vulnerability to habitat change in the EAAF (Rogers, 2012). Grey Plovers are believed to be declining in the EAAF (Wetlands International, 2016) and in Australia, particularly south of 27.8°S and west of 129°E (Clemens et al., 2016).

Table 4-10 Comparison of the number of birds, number of roosts occupied and foraging density of Grey Plovers between three ecological units in February 2016

Location	Roosts	Total	Density[1]
Port Curtis	0	0	0.00
Fitzroy Estuary-North Curtis	5	118	0.03
Mundoolin-Colosseum-Rodd's	2	12	0.00
Total	**7**	**130**	**0.01**

1 Foraging density (birds/ha)

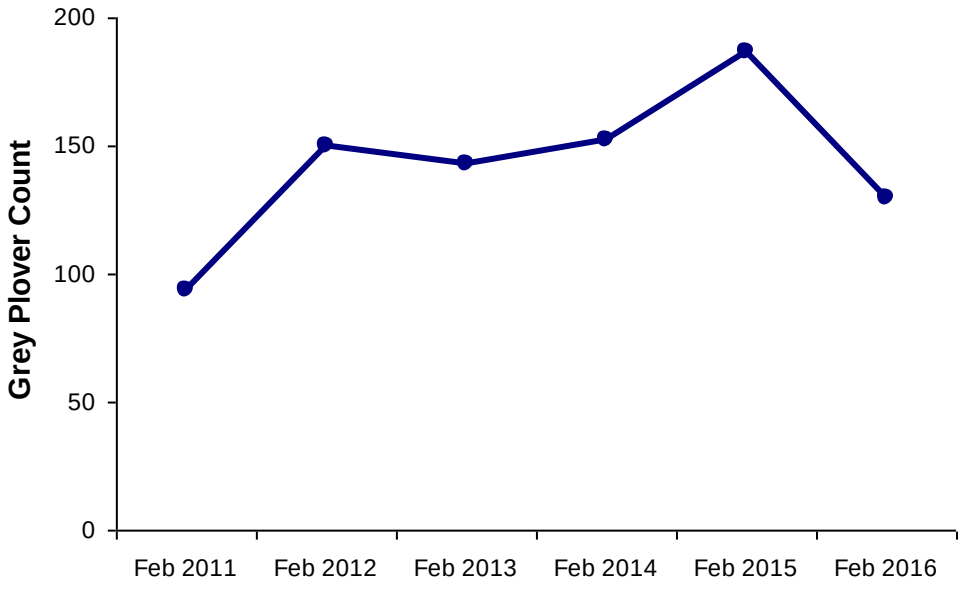


Figure 4-14 Counts of Grey Plovers on the Curtis Coast, February 2011-2016

4.2.10 Sand Plover Species

A total of 1171 Sand Plovers was recorded at high tide roosts on the Curtis Coast in February 2016. This was 24 percent fewer than the February 2015 survey (1549 birds). The 2016 total comprised 228 Lesser Sand Plovers, 791 Greater Sand Plovers and 152 Sand Plover spp. that could not be distinguished. The proportion of birds that cannot be distinguished is affected by weather conditions. Summaries of the two species are presented below.

The official Australian Government EAAF population estimate (Bamford et al., 2008) for Lesser Sand Plover is 140,000 and for Greater Sand Plover is 110,000 giving a combined total of 250,000. The February 2012 total of Sand Plover spp. was marginally <1 percent of the combined populations suggesting that the numbers of one of the species may have exceeded the threshold on that occasion.

4.2.10.1 Lesser Sand Plover

EAAF population estimate (Bamford *et al.*, 2008): 140,000
1% population threshold for internationally important sites: 1,400
EAAF population estimate (Wetlands International, 2016) 68,500

A total of 228 Lesser Sand Plovers was recorded at high tide roosts on the Curtis Coast in February 2016 (Table 4-11, Figure 4.12). A further 152 birds were identified as sand plovers but the species could not be determined. The number of Lesser Sand Plovers on the Curtis Coast did not exceed 1 percent of the official Australian Government EAAF population estimate (Bamford et al., 2008). Lesser Sand Plovers were recorded at 11 roosts, the largest of which were Curtis Island south end dump claypan (68 birds) at Port Curtis, Keppel Creek entrance (53 birds) and Cattle Point (38 birds) both at the Fitzroy Estuary-North Curtis Island ecological unit. The highest foraging densities occurred in the Fitzroy Estuary-North Curtis and Port Curtis ecological units. The population of Lesser Sand Plovers in the EAAF is believed to be declining (Wetlands International, 2016) and in Australia, particularly north of 27.8°S and east of 129°E (Clemens et al., 2016).

Table 4-11 Comparison of the number of birds, number of roosts occupied and foraging density of Lesser Sand Plovers between three ecological units in February 2016

Location	Roosts	Total	Density[1]
Port Curtis	3	79	0.03
Fitzroy Estuary-North Curtis	6	127	0.03
Mundoolin-Colosseum-Rodd's	2	22	0.01
Total	**11**	**228**	**0.02**

1 Foraging density (birds/ha)

4.2.10.2 Greater Sand Plover

EAAF population estimate (Bamford *et al.*, 2008): 110,000
1% population threshold for internationally important sites: 1,100
EAAF population estimate (Wetlands International, 2016) 79,000

A total of 791 Greater Sand Plovers was recorded at high tide roosts on the Curtis Coast in February 2016 (Table 4-12, Figure 4.12). A further 152 birds were identified as Sand Plovers but the species could not be determined. The number of Greater Sand Plovers on the Curtis Coast did not exceed 1 percent of the official Australian Government population estimate (Bamford et al., 2008). Greater Sand Plovers were recorded at 13 roosts, the largest of which were Curlew Spit claypan (372 birds), Deception Point claypan (75 birds) and Keppel Creek entrance (53 birds) in the Fitzroy Estuary-North Curtis ecological unit and Facing Island claypan (95 birds) in the Port Curtis ecological unit. The

greatest foraging density occurred in the Fitzroy Estuary-North Curtis ecological unit. The population of Greater Sand Plovers in the EAAF is believed to be declining (Wetlands International, 2016) but there is no evidence of this at a continental scale in Australia though the data do suggest a decrease in the population south of 27.8°S and west of 129°E (Clemens et al., 2016).

Table 4-12 Comparison of the number of birds, number of roosts occupied and foraging density of Greater Sand Plovers between three ecological units in February 2016

Location	Roosts	Total	Density[1]
Port Curtis	2	125	0.05
Fitzroy Estuary-North Curtis	5	543	0.13
Mundoolin-Colosseum-Rodd's	6	123	0.04
Total	**13**	**791**	**0.08**

1 Foraging density (birds/ha)

4.3 Other Migratory Shorebird Species

The 10 most abundant species accounted for 97 percent of the migratory shorebirds recorded at high tide roosts in February 2016. Of the remaining 10 species, the counts for five were >40. Common Greenshank (61 birds) were recorded in small numbers from 11 sites across the Curtis Coast. Curlew Sandpiper (57 birds) were recorded from four sites, three of which were in the Fitzroy estuary-North Curtis ecological unit. The majority of birds were recorded from Cattle Point (35 birds). Pacific Golden Plover (56 birds) were all recorded from two sites in the Mundoolin-Colosseum Rodds ecological unit. Broad-billed Sandpiper (46 birds) were all recorded from two nearby sites in the Fitzroy-North Curtis ecological unit. Sharp-tailed Sandpiper (42 birds) were all recorded from a single site in Port Curtis.

The abundances obtained for many of the rarely recorded species using the *Shorebird 2020* method may be under-estimates. Species which may be dispersed through coastal freshwater ecosystems, such as Red-necked Stint, Sharp-tailed Sandpiper, Curlew Sandpiper, Marsh Sandpiper, Common Greenshank, Common Sandpiper and Latham's Snipe are likely to be undercounted using the *Shorebird 2020* method (Wildlife Unlimited, 2012; Sandpiper Ecological Surveys, 2012c). Additional targeted surveys could help to complete the picture however the vast area of coastal saltmarsh and mangroves is difficult to access and renders any aspiration of a regular exhaustive survey impractical.

4.4 Low Tide Surveys

A total of 31 low tide surveys were completed in February 2016, 4 more than in the 2015 survey. The duration of the low tide surveys was 776 minutes (Table 4-1). A total of 4135 birds comprising 14 species was counted at low tide (Table 4-15). No additional migratory shorebird species were recorded. The figure is not strictly comparable with previous surveys because shorebirds move quickly around the intertidal zone in response to the movement of the tide. It is therefore difficult to replicate surveys even when they occur at the same location.

4.5 Non-migratory Species

A total of 757 non-migratory birds of eight species were recorded during the high tide roost counts (Table 4-13). This compares with 874 birds of eight species recorded in February 2015. A Bush Stone-curlew was detected during the high tide counts this year but not last year, while a Red-necked Avocet was detected last year but not this year.

The key assumption making roost counting the preferred method for estimating migratory shorebird numbers – that the majority of birds congregate in communal roosts at high tide – does not hold for all non-migratory species. Consequently, the counts obtained using the method were unlikely to give an accurate estimate of the populations of these species on the Curtis Coast. Nonetheless, collection

of the data make the survey comparable with the *Shorebird 2020* counts; help describe the distributions of the species; may be a valid index of the populations and have intrinsic value as records of presence and abundance. No further analysis was conducted because non-migratory species are beyond the scope of the ERMP (Gladstone Ports Corporation, 2011).

Table 4-13 Summary of the high tide roost counts by location for non-migratory species.

Species	PC	FE	NC	M-C	RP	SW	Total
Beach Stone-curlew	3	2	2	0	2	0	9
Bush Stone-curlew	0	0	0	1	0	0	1
Pied Oystercatcher	62	21	12	162	93	0	350
Sooty Oystercatcher	17	0	5	0	2	0	24
Black-winged Stilt	31	1	0	0	0	0	32
Red-necked Avocet	0	0	0	0	0	0	0
Red-capped Plover	45	23	31	145	86	0	330
Black-fronted Dotterel	1	0	0	1	0	0	2
Red-kneed Dotterel	0	0	0	0	0	0	0
Masked Lapwing	5	1	0	3	0	0	9
Total abundance	164	48	50	312	183	0	757
Total species	7	5	4	5	4	0	8

PC = Port Curtis including the Mainland Shoreline and Reclamation Area, FE = Fitzroy Estuary, NC = North Curtis Island, MC = Mundoolin-Colosseum, RP = Rodd's Peninsula.

4.6 Cheetham Salt Works

One survey was completed at Cheetham Salt Works at mid-tide on 12 February for a duration of 75 minutes. A total of 207 migratory shorebirds were recorded of six species: Sharp-tailed Sandpiper (82 birds); Red-necked Stint (72 birds); Marsh Sandpiper (33 birds); Curlew Sandpiper (14 birds); Common Greenshank (5 birds) and Ruddy Turnstone (1 bird). The total counts of Sharp-tailed Sandpiper and Marsh Sandpiper exceeded those from main high tide roost survey. All the other species with the exception of Red-necked Stints were relatively rare elsewhere. Only one other site, the Clinton Ash Ponds at Port Curtis supported a similar combination of species. An account of regular surveys at the Cheetham Salt Works (Houston et al., 2012) assists in better understanding the contribution that the salt works makes to migratory shorebird diversity on the Curtis Coast and the population dynamics of some of the species which are rare elsewhere.

The survey was conducted at a location inside the salt works at which migratory waders have been regularly recorded. The salt works is not tidal and the survey takes the form of a search along the salt pond embankments from near the entrance gate to the survey point.

4.7 Western Basin Reclamation Area

A thorough survey of the Western Basin Reclamation Area at high tide was conducted on 12 February. The aim was to investigate whether the facility was being used by migratory shorebirds as a roost.

Nine surveys were completed with a total duration of 65 minutes. The duration represents the time spent surveying at each site and surveying from a moving vehicle between sites. A total of 327

migratory shorebirds was recorded, all Red-necked Stints. The stints were recorded from the southern pond. A non-migratory species the Red-capped Plover (14 birds) was also recorded.

Figure 4-15 A pair of Curlew Sandpiper at Cheetham Salt Works, February 2016

Table 4-14 Summary of the roost counts for migratory shorebirds at each survey location.
Includes data collected from Cheetham Salt Works at mid-tide.

Species	PC	FE	NC	M-C	RP	SW*	Total
Pacific Golden Plover	0	0	0	56	0	0	56
Grey Plover	0	18	100	12	0	0	130
Double-banded Plover	0	0	0	0	0	0	0
Lesser Sand Plover	79	47	80	14	8	0	228
Greater Sand Plover	125	490	53	16	107	0	791
Latham's Snipe	0	0	0	0	0	0	0
Black-tailed Godwit	0	0	0	0	0	0	0
Bar-tailed Godwit	904	251	467	672	578	0	2872
Little Curlew	0	0	0	0	0	0	0
Whimbrel	265	5	650	157	22	0	1099
Eastern Curlew	371	0	94	231	90	0	786
Terek Sandpiper	49	40	95	288	131	0	603
Common Sandpiper	1	0	0	0	0	0	1
Grey-tailed Tattler	402	51	326	265	174	0	1218
Wandering Tattler	0	0	0	0	0	0	0
Common Greenshank	9	13	33	6	0	5	66
Marsh Sandpiper	0	0	0	2	0	33	35
Ruddy Turnstone	2	0	0	3	1	1	7
Great Knot	13	424	220	365	85	0	1107
Red Knot	0	16	0	12	0	0	28
Sanderling	0	0	11	0	0	0	11
Red-necked Stint	513	1304	5	384	35	72	2313
Sharp-tailed Sandpiper	42	0	0	0	0	82	124
Curlew Sandpiper	0	51	0	6	0	14	71
Broad-billed Sandpiper	0	46	0	0	0	0	46
Sand Plover spp.	0	68	0	84	0	0	152
Tattler/Terek	0	0	0	0	0	0	0
Unidentified medium wader	0	0	0	0	0	0	0
Unidentified small wader	8	0	2	0	0	0	10
Total abundance	**2783**	**2824**	**2136**	**2573**	**1231**	**207**	**11754**
Total species	**13**	**13**	**12**	**16**	**10**	**6**	**20**

PC = Port Curtis including the Mainland Shoreline and Reclamation Area, FE = Fitzroy Estuary, NC = North Curtis Island, MC = Mundoolin-Colosseum, RP = Rodd's Peninsula.

* Cheetham Salt Works was surveyed at mid-tide.

Figure 4-16 Important roosts on the Curtis Coast, February 2016

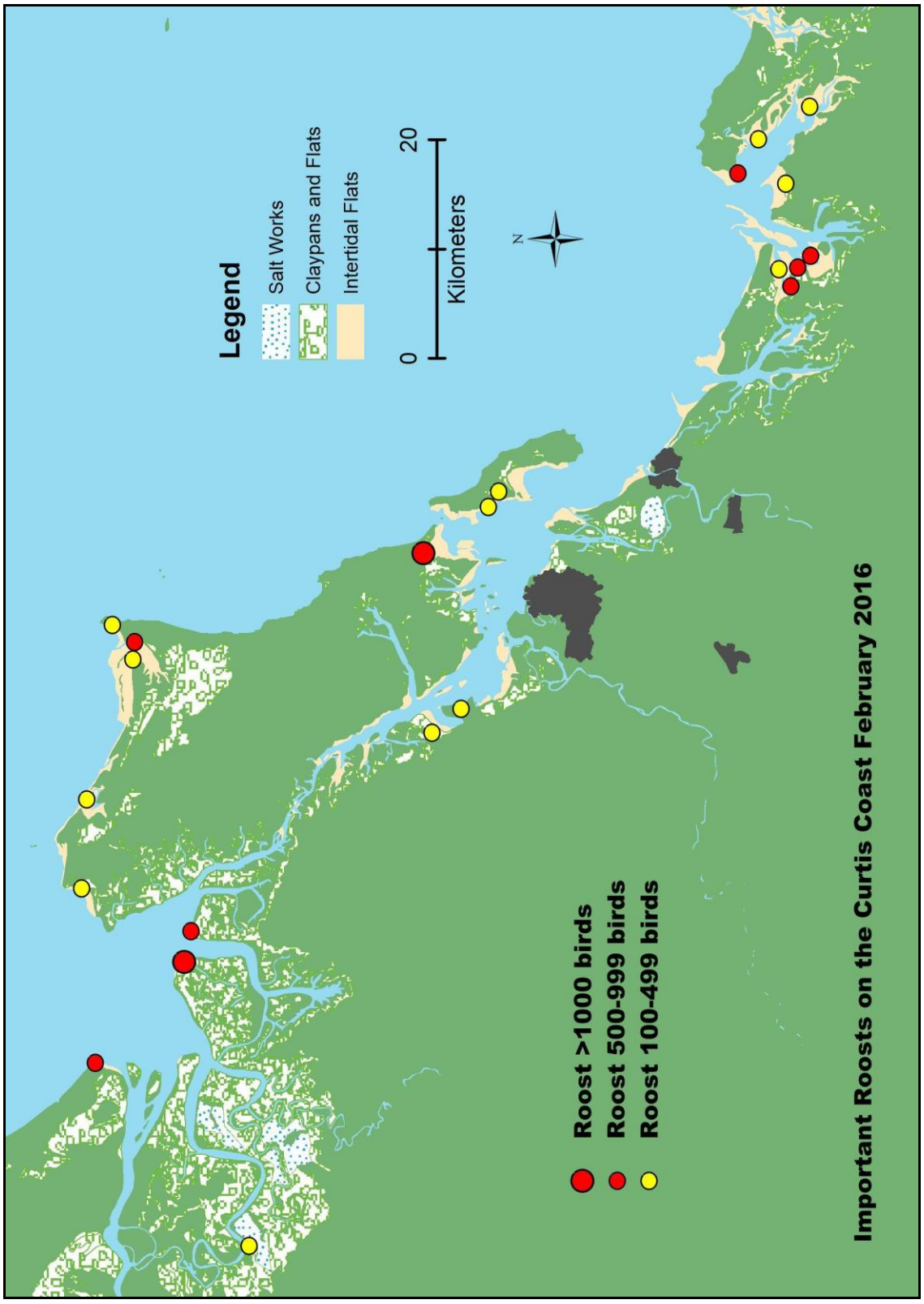


Figure 4-17 Bar-tailed Godwit roosts on the Curtis Coast, February 2016

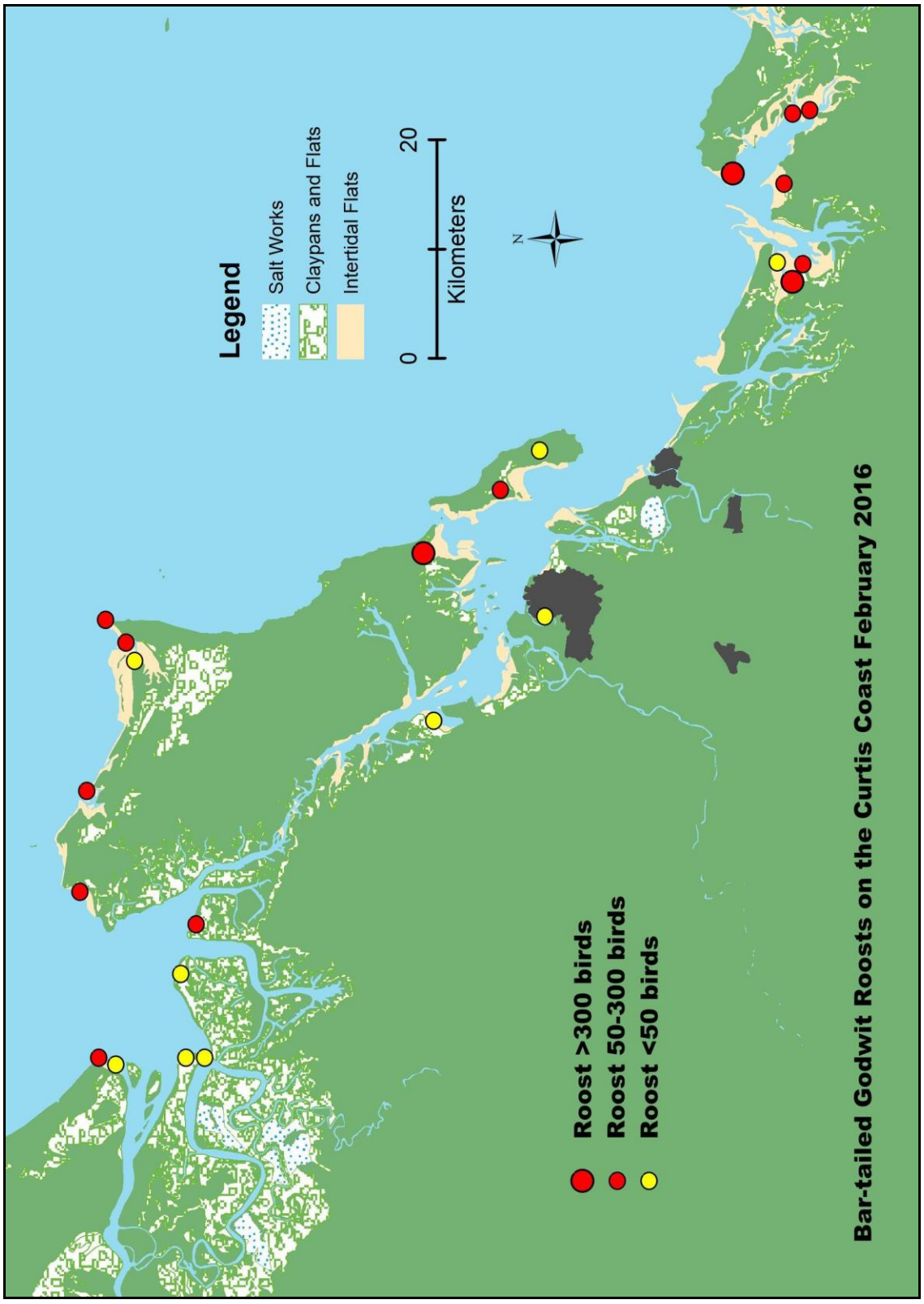


Figure 4-18 Whimbrel roosts on the Curtis Coast, February 2016

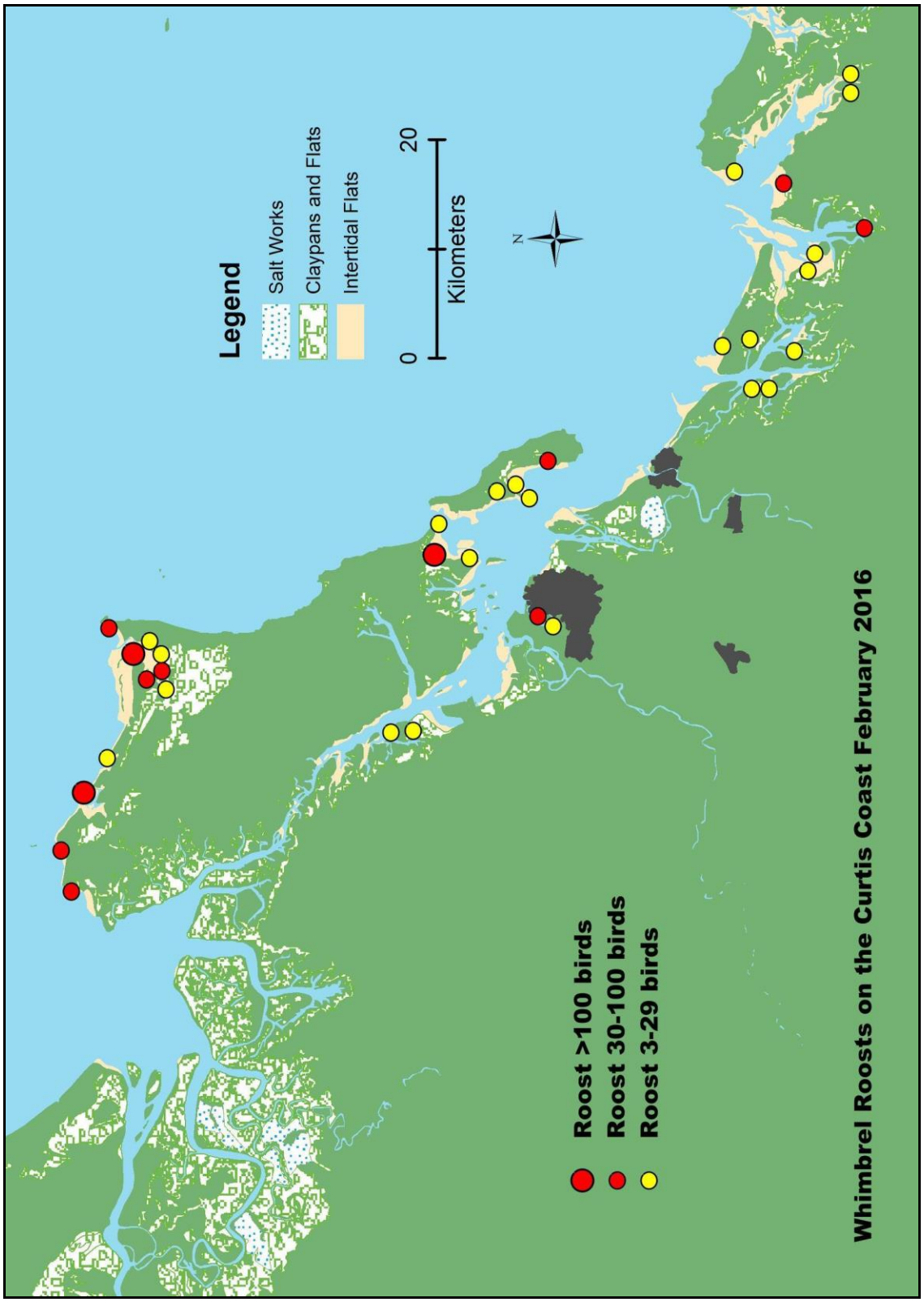


Figure 4-19 Eastern Curlew roosts on the Curtis Coast, February 2016

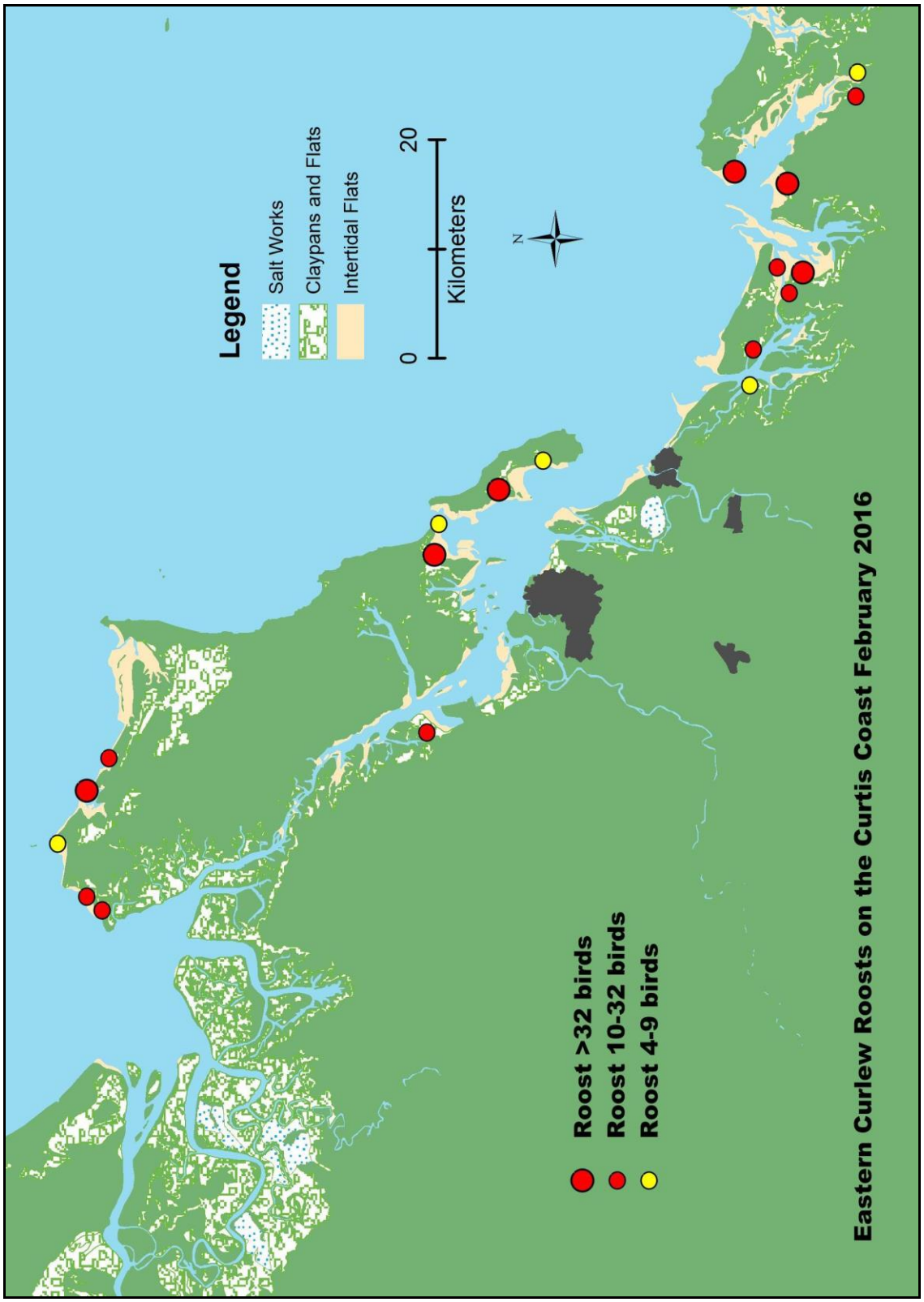


Figure 4-20 Terek Sandpiper roosts on the Curtis Coast, February 2016

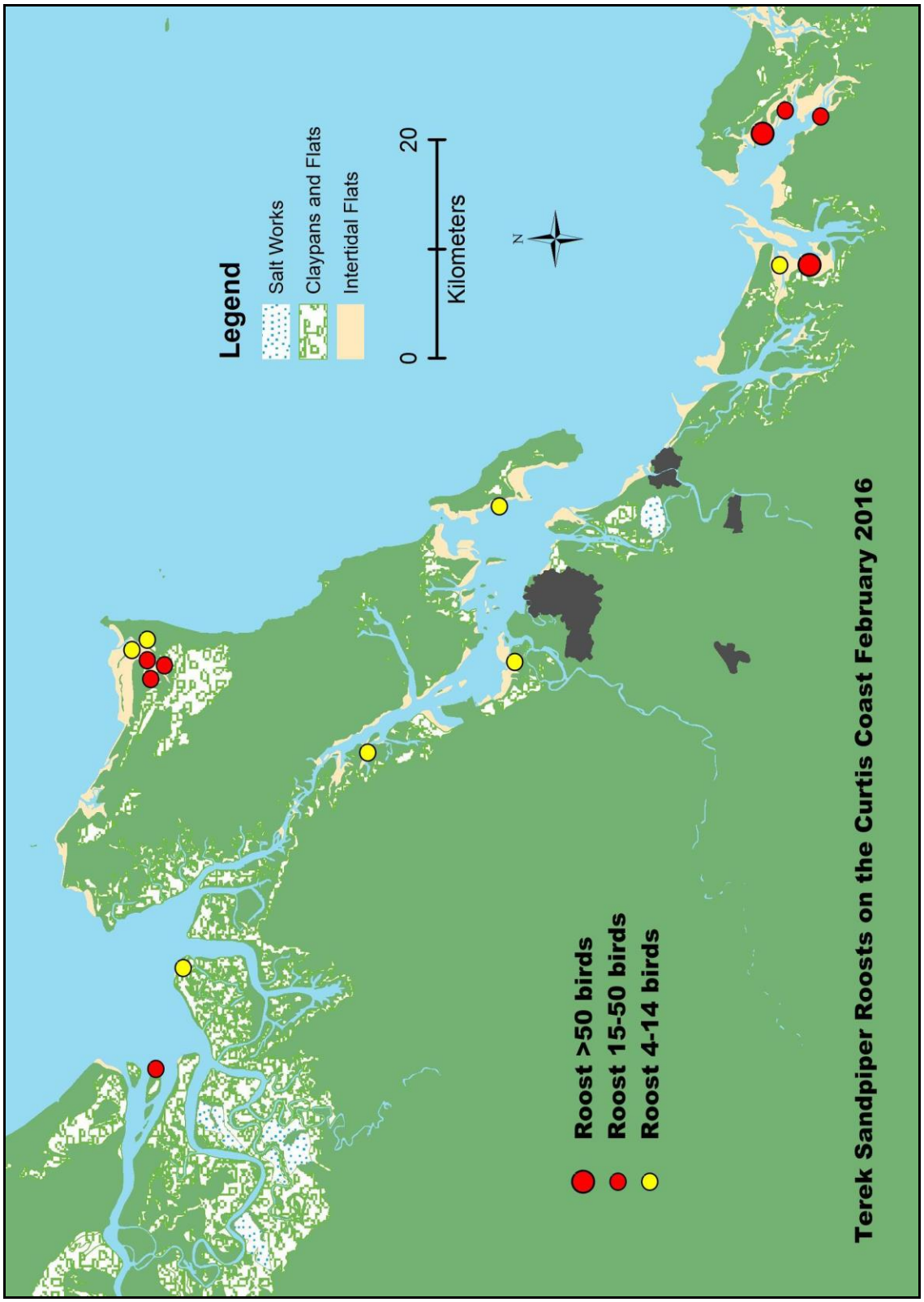


Figure 4-21 Grey-tailed Tattler roosts on the Curtis Coast, February 2016

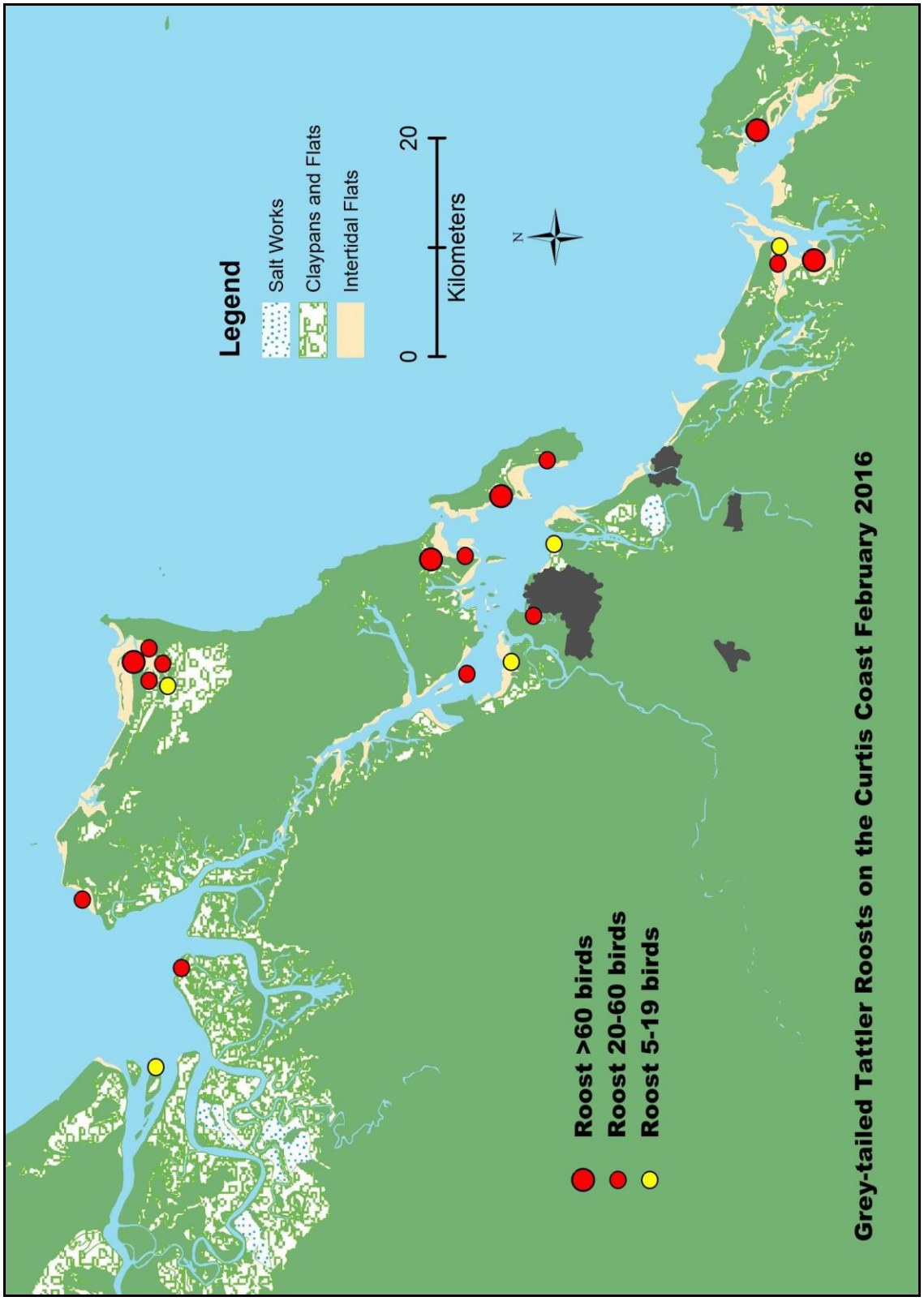


Figure 4-22 Great Knot roosts on the Curtis Coast, February 2016

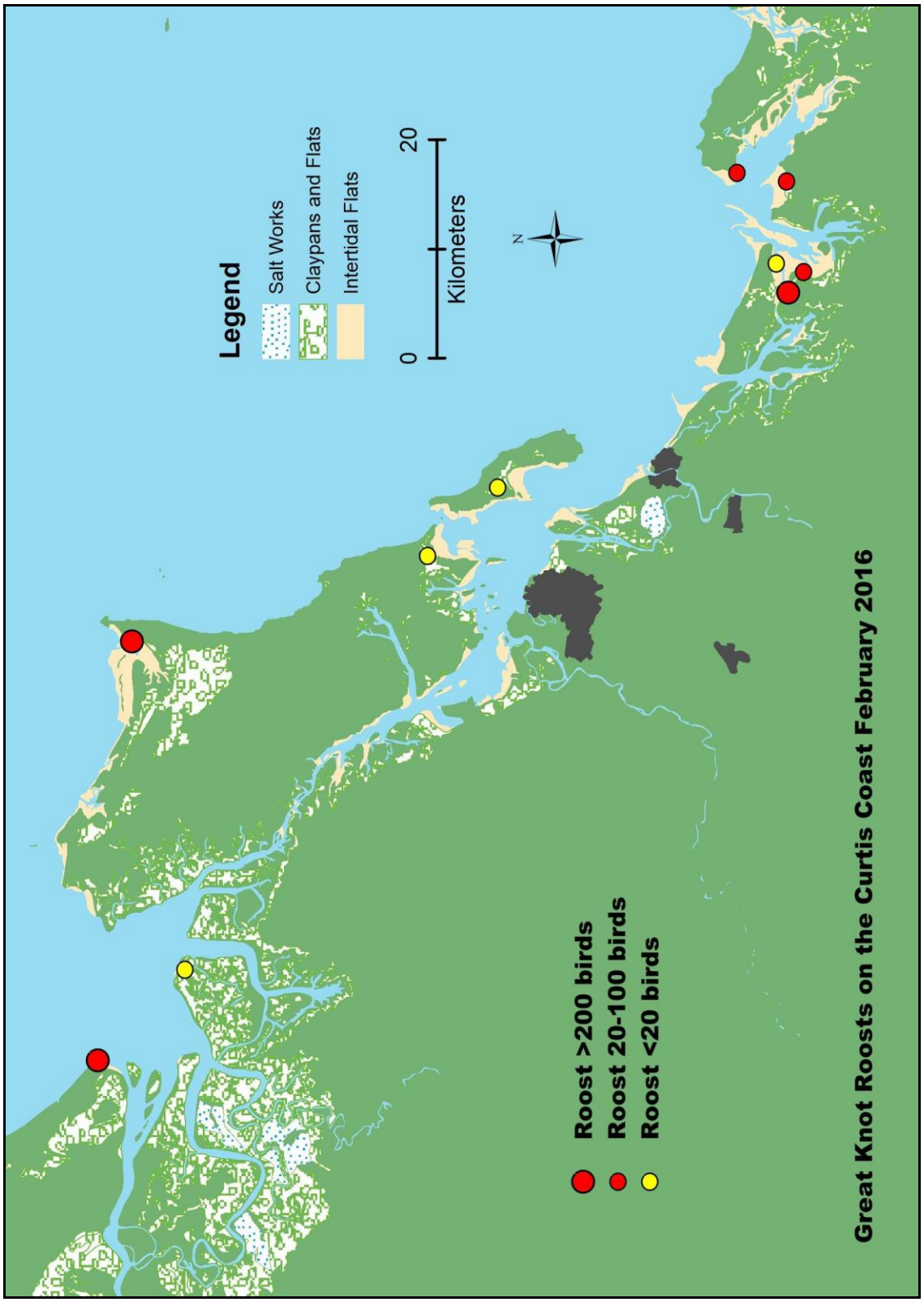


Figure 4-23 **Red-necked Stint roosts on the Curtis Coast, February 2016**

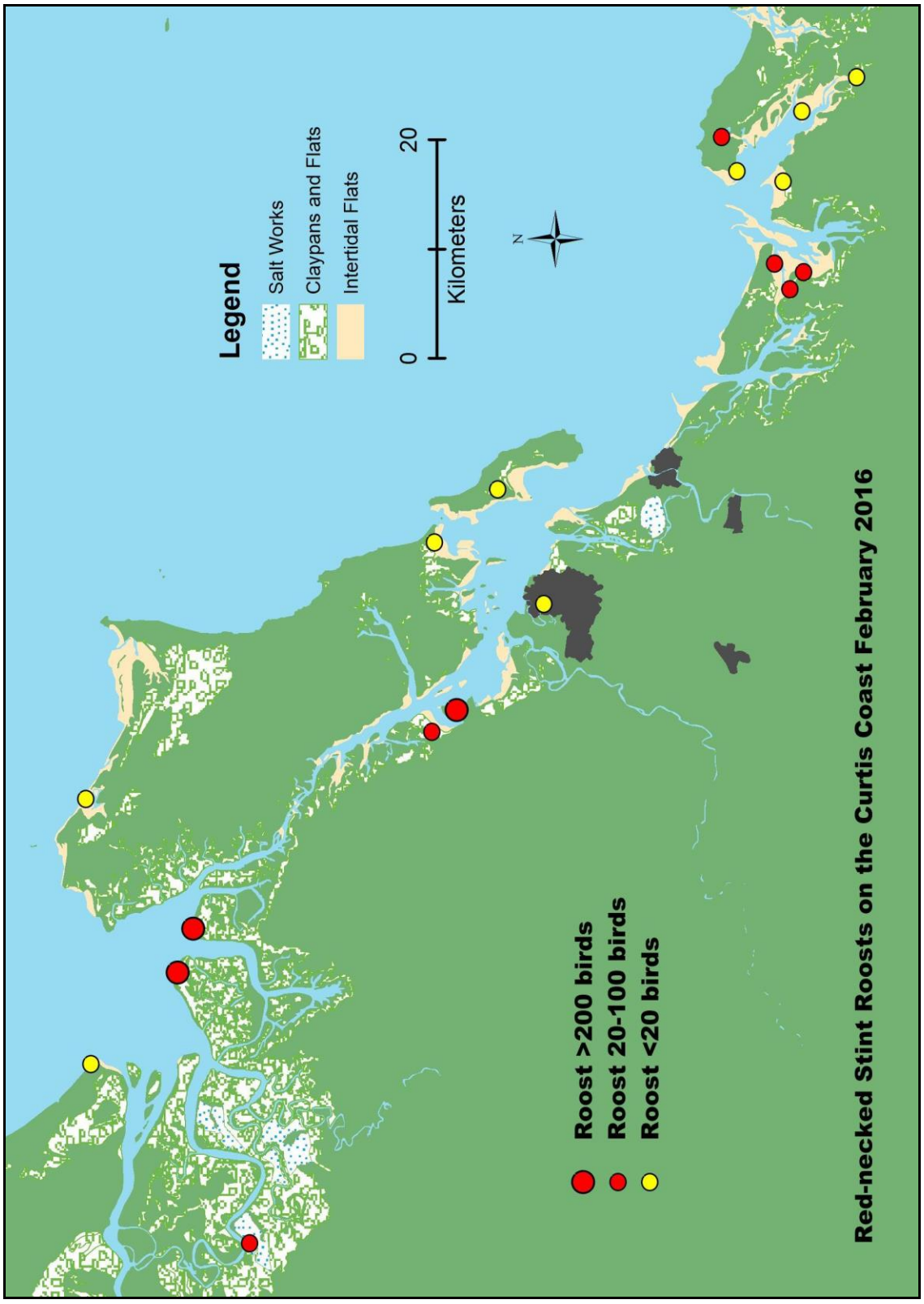


Figure 4-24 Grey Plover roosts on the Curtis Coast, February 2016

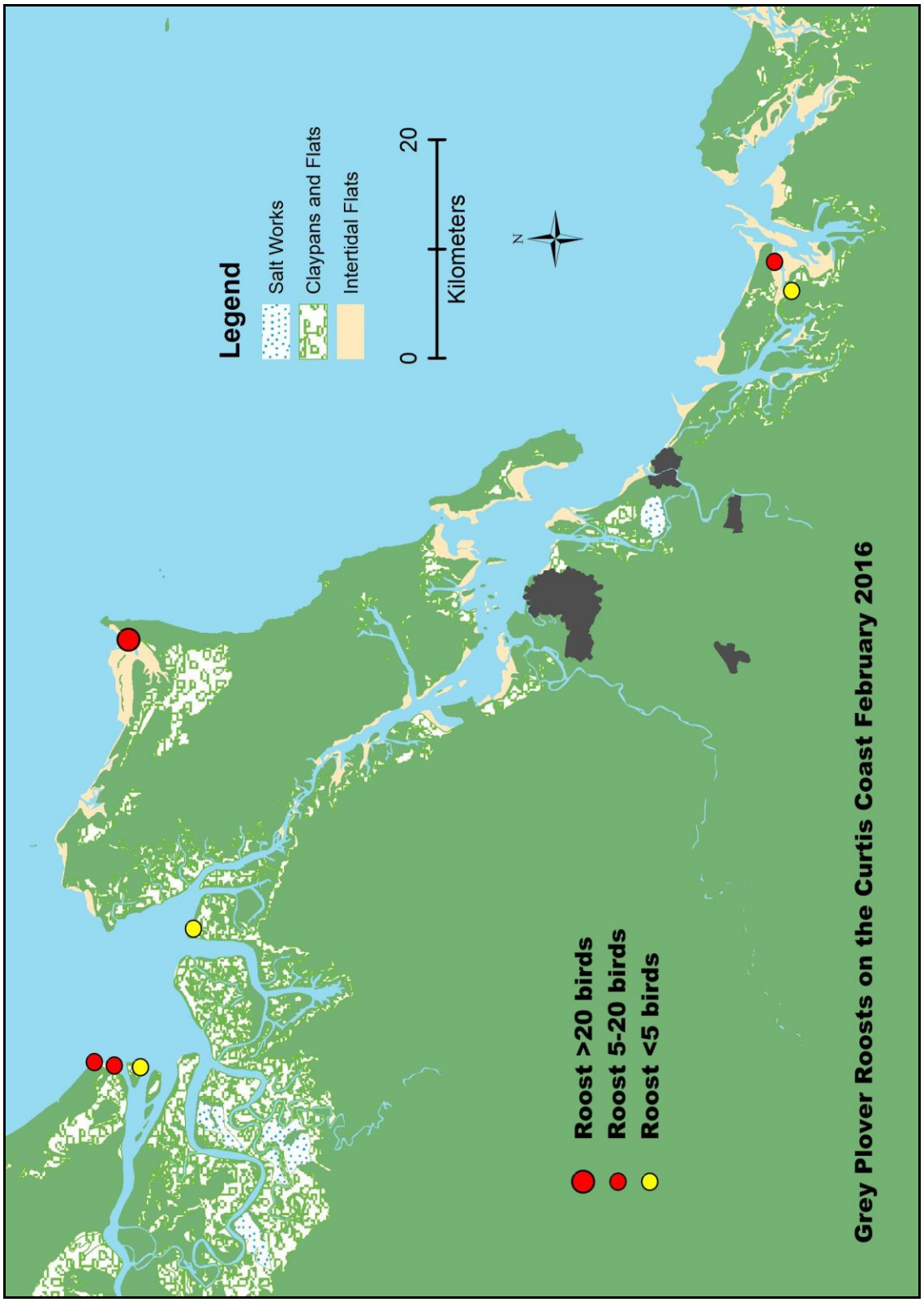


Figure 4-25 Lesser Sand Plover roosts on the Curtis Coast, February 2016

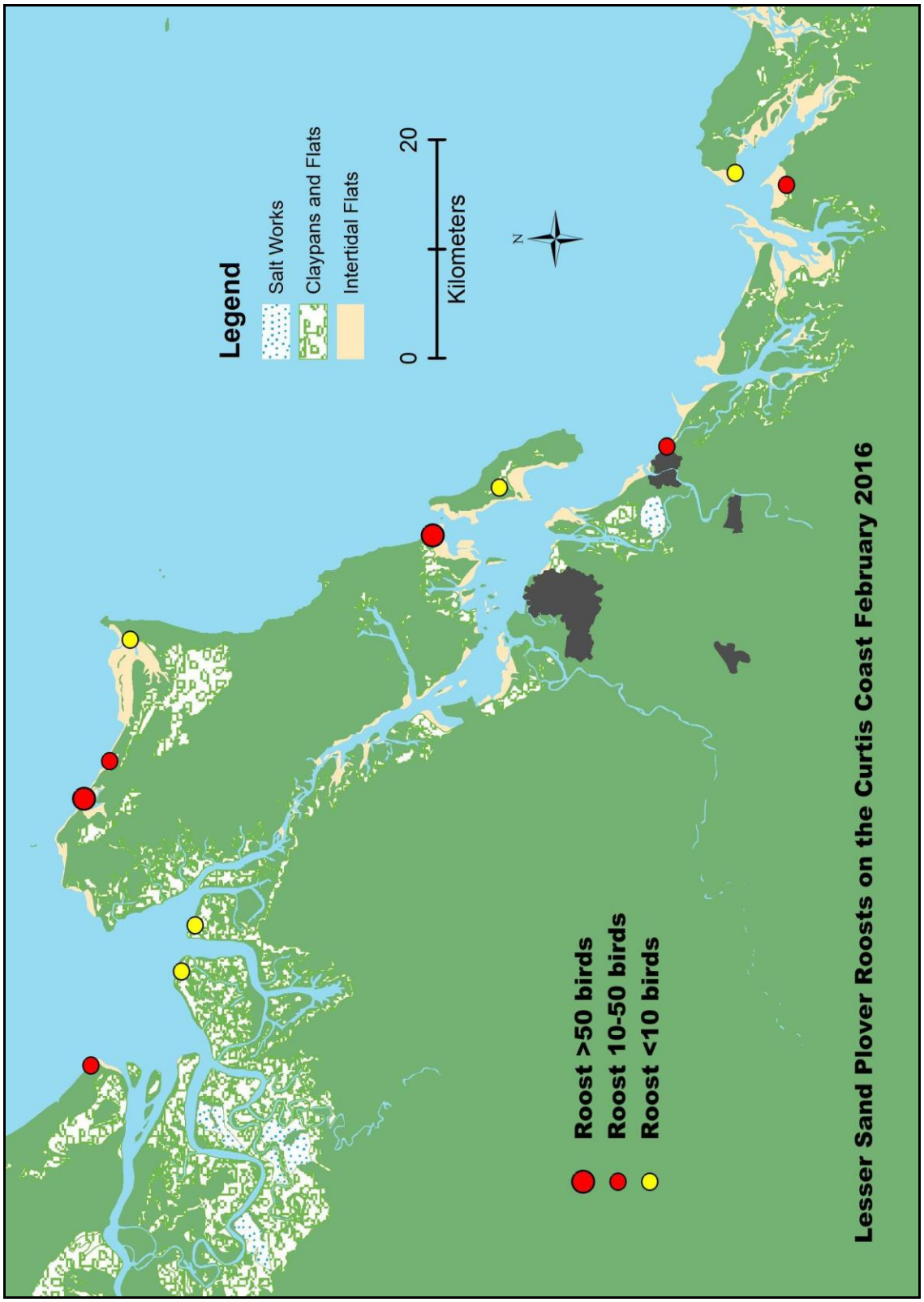


Figure 4-26 Greater Sand Plover roosts on the Curtis Coast, February 2016

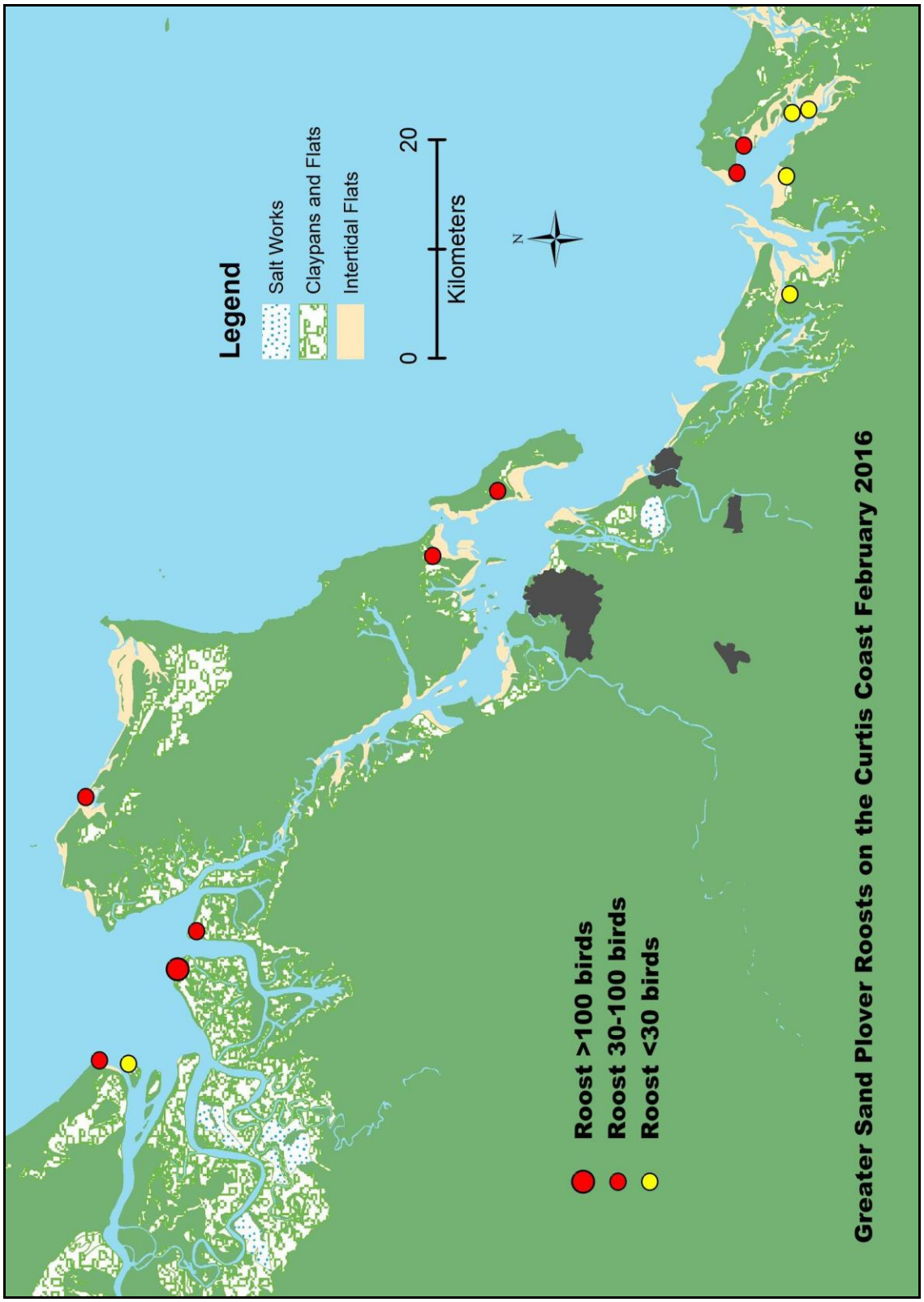


Table 4-15 Summary of low tide foraging counts for migratory shorebirds at each survey location.

Species	PC	FE	NC	M-C	RP	Total
Latham's Snipe	0	0	0	0	0	0
Bar-tailed Godwit	113	145	294	131	108	791
Little Curlew	0	0	0	0	0	0
Whimbrel	32	13	10	43	15	113
Eastern Curlew	40	3	16	36	12	107
Marsh Sandpiper	0	0	0	0	0	0
Common Greenshank	2	0	1	2	0	5
Terek Sandpiper	6	38	3	0	12	59
Common Sandpiper	0	0	0	0	0	0
Grey-tailed Tattler	6	5	0	20	3	34
Ruddy Turnstone	0	0	0	0	0	0
Great Knot	125	13	501	61	2	702
Red Knot	0	0	0	0	0	0
Sanderling	0	0	3	0	0	3
Red-necked Stint	2	563	66	127	24	782
Sharp-tailed Sandpiper	0	0	0	0	0	0
Curlew Sandpiper	0	16	0	0	0	16
Broad-billed Sandpiper	0	0	0	0	0	0
Pacific Golden Plover	0	0	0	12	0	12
Grey Plover	0	1	4	7	0	12
Lesser Sand Plover	0	4	23	7	0	34
Greater Sand Plover	0	85	24	10	0	119
Sand Plover spp.	0	0	1263	1	0	1264
Unidentified large wader	5	1	3	1	0	10
Unidentified medium wader	0	5	0	0	0	5
Unidentified small wader	0	47	13	1	6	67
Total	**331**	**939**	**2224**	**459**	**182**	**4135**
Total species	**8**	**10**	**10**	**11**	**7**	**14**

PC = Port Curtis including the mainland foreshore, FE = Fitzroy Estuary, M-C = Mundoolin Colosseum, RP = Rodds Peninsula

5 DISCUSSION

5.1 Summer 2016 – results in context

Interannual variability in migratory shorebird populations is high and this makes the detection of trends in the data very difficult (DEWHA, 2009b; Wilson et al., 2011; Minton et al., 2012; IMEMS, 2013). In order to address this issue, the Queensland Wader Studies Group funded the University of Queensland to analyse data collected over 16 years at Moreton Bay. The paper which was subsequently published in the peer-reviewed scientific journal *Conservation Biology* describes the problem (Wilson et al., 2011).

"Abundances and estimates of abundances of migratory species may be expected to be particularly variable because the animals are highly mobile, different stages of their life cycle occur in different places, and their wide spatial extent and high abundance create logistical difficulties in coordinating abundance estimation and monitoring (Piersma & Baker, 2000; Piersma, 2007). All these sources of variability make the robust detection of trends difficult because it is challenging to eliminate noise, and unless monitoring or analysis methods account for this variability, changes in abundance may go undetected. When the abundance of different species in an assemblage of both migrants and nonmigrants has different sources of variability, identifying trends can be extremely difficult."

Another paper which addresses the issue was published by the Victorian Wader Studies Group (Minton et al., 2012). At Corner Inlet in Victoria, a 30-year record obtained using a standardised counting procedure showed a 23 percent decline in total migratory shorebird abundance in summer (Appendix 6). The average total abundance was 31,493 birds but the range was 22,065 – 43,041 (79% - 137% of the average). Species abundances also exhibited high variability. For example, the Bar-tailed Godwit had an average summer abundance of 10,080 and a range of 6951 – 13,139 (69% - 130% of the average). Other species which were less abundant at Corner Inlet had even larger fluctuations in numbers throughout the period.

Despite the difficulties counting shorebirds and detecting changes in abundance there is evidence of migratory shorebird decline in Australia at a continental scale. Analyses of a 30-year-old citizen science dataset spanning the years 1973-2014 showed that of 19 species for which data were available, 12 exhibited continent-wide declines (Clemens et al., 2016). These were (in decreasing order of the magnitude of the decline): Curlew Sandpiper; Lesser Sand Plover; Sharp-tailed Sandpiper; Terek Sandpiper; Black-tailed Godwit; Red-necked Stint; Bar-tailed Godwit; Ruddy Turnstone; Eastern Curlew; Pacific Golden Plover; Grey Plover and Common Greenshank. No change was detected in Red Knot, Marsh Sandpiper, Sanderling, Greater Sand Plover, Whimbrel, Great Knot or Grey-tailed Tattler. A rare piece of happier news was that Grey-tailed Tattler, Great Knot and Whimbrel showed increases north of 27.8°S (i.e. an area which includes the Curtis Coast) over a 15 year subset of the data spanning 1996-2014. Indeed, the change in abundance of migratory shorebirds on the Curtis Coast may not have been as negative as suggested by the 30 year dataset. Another 15 year dataset (1996-2014) consisting of an expanded set of sites showed declines north of 27.8°S in five species (Black-tailed Godwit, Lesser Sand Plover, Terek Sandpiper, Bar-tailed Godwit and Eastern Curlew) and increases in three (Sharp-tailed Sandpiper, Sanderling and Grey-tailed Tattler).

The total abundance recorded for the Curtis Coast February 2016 summer survey was 16 percent fewer than the 2015 survey. While this reduction sounds severe it comes off the highest figure recorded during the project, 13,752 and is well within the range of previous totals. The figure is 4 percent fewer than the summer mean for the project, 12,058. The decrease in total abundance was mainly due to a 42 percent reduction in the number of Red-necked Stints recorded. But other abundant species also showed decreases: Greater Sand Plover (25 percent); Terek Sandpiper (23 percent); Great Knot (18 percent) and Bar-tailed Godwit (8 percent). These decreases were partly offset by a substantial increase in the number of Grey-tailed Tattlers (46 percent) and some

unusually high returns for some of the rarer species such as Common Greenshank, Broad-billed Sandpiper, Sharp-tailed Sandpiper and Pacific Golden Plover.

Conditions for shorebird counting were sub-optimal with strong south-easterly winds predominating. The general effect of windy conditions is to reduce detectability causing a tendency to record fewer birds and fewer species (Rogers et al., 2006a). This can particularly be an issue for differentiating Sand Plovers in large flocks.

Tides during the 2016 survey were at the top of the predicted range for 2016. This meant that a number of roosts which have supported large numbers of birds in previous surveys were inundated. The most important example of this was the Yellow Patch sandbar. In moderate and light winds, the numbers of birds recorded at the roost is in the range 1000-2000 with an instance of 3,959 (GHD, 2011a). Species richness has also been exceptional regularly exceeding 10. The roost is in an exposed location and during strong winds numbers <1,000 have been recorded (Sandpiper Ecological Surveys, 2012b; Wildlife Unlimited, 2015). Due to inundation, the number recorded during the 2016 survey was zero. On the day it was surveyed 700 birds were observed on the sandbar after the roost count had finished, and then during the low tide survey >1500 birds were counted from the roost site – mostly Sand Plover species. Migratory shorebirds normally feed when the opportunity arises at low tide and it is unclear why they were at the roost as foraging opportunities were becoming available. In addition, the estimated total of Sand Plovers from the low tide count of the roost was 1263 birds, a figure which exceeds the total recorded at all high tide roosts for the five days of survey. It would therefore appear that some of the Sand Plovers roosted at an unknown location during the 2016 high tide survey.

Other roost sites which were inundated included Friend Point in Port Curtis, MacKenzie Island North in the Fitzroy Estuary, Upper Seven Mile Creek Inlet and Thornton Creek Island in Mundoolin Inlet.

Figure 5-1 The Upper Thornton Creek Inlet roost was inundated.
The water was deep enough for the boat to go onto the claypan. A total of 46 birds were present on the far bank (Adam Leavesley, Wildlife Unlimited).

Figure 5-2 Thornton Creek Island roost was inundated.
The sandbar that birds often use at high tide is to the right rear of the mangroves. No birds were recorded (Adam Leavesley, Wildlife Unlimited).

5.2 The Effects of Construction on Migratory Shorebirds

The effect of construction in Port Curtis on migratory shorebirds appears to have varied from place-to-place. On the mainland shoreline, migratory shorebirds appear to have declined and this has been attributed to development and disturbance (Sandpiper Ecological Surveys, 2012b; 2012c; Wildlife Unlimited, 2012). Two roost sites have been subject to development. These are site QGC1 where the Wiggins Island Coal Terminal has been constructed (Figure 5-3) and site 32B Clinton Ash Ponds (Figure 5-4). To our knowledge, the Gladstone Marina dredge spoil was deposited in the ponds since February 2015 and earthworks conducted by GPC were underway during the 2016 survey (Figure 5-5). It is assumed that the QGC1 roost no longer supports birds but Clinton Ash Ponds does and the count this year was 45 birds consisting of 42 Sharp-tailed Sandpipers, two Common Greenshanks and 1 Red-necked Stint. In contrast the first survey for this project in January 2011 returned a total of 146 birds consisting of 78 Eastern Curlew, 38 Bar-tailed Godwit and 30 Whimbrel. The two shorebird assemblages differ in two key ways. 1) The original assemblage comprised larger birds (size range = 36cm-66cm) while the changed assemblage comprised mostly smaller birds (size range 16cm – 35cm). 2) The original assemblage consisted of birds that frequently roost in marine environments while the new assemblage consists of birds that will commonly use freshwater ecosystems.

In the Upper Harbour, a gas pipeline was constructed adjacent to the roost at Friend Point shoreline. Prior to construction in January 2011, 188 birds were recorded at the site. In comparison, seven birds were recorded during the 2015 survey and eight during the 2016 survey. While this may suggest a lasting effect of development, it is probable that birds which use Friend Point shoreline also use the nearby Friend Point claypan particularly during the highest tides (Figure 5-6). The roosts at North and South Passage Islands appear to be subject to greatly increased shipping traffic associated with the nearby LNG plants (Figure 5-7, Figure 5-8. The South Passage Island roost returned a count of 235 in January 2011 but only 59 birds in February 2015 and 23 birds in February 2016. In contrast one of the Calliope River roosts directly adjacent to the existing Gladstone Coal Terminal returned a count of 139 birds in 2015 which was the highest count for the roost during this project. The roost is within a few hundred metres of Clinton Ash Ponds and may be the best alternative for the birds that no longer appear to roost at the ash ponds. The February 2016 count at the Calliope River was fewer than 2015 (93 birds) but still a good number for an Upper Harbour site. Roost sites that have been taken over for development constitute a long-term loss of habitat and therefore may lead to a reduction in the shorebird carrying capacity of the study site (DEWHA, 2009b). However, while it appears that proximity to construction activity does disturb migratory shorebirds, the effect is

variable and it remains unclear if the change is permanent. Sources of disturbance for migratory shorebirds in Port Curtis are not limited to recent development (e.g. Figure 5-9) and more detailed investigation is required to better understand what is happening.

Another potential cause of migratory shorebird decline in the upper harbour of Port Curtis is a reduction in foraging habitat. Dredging may cause changes in the distribution of the tidal flats on which shorebirds feed. Hydrological modelling predicts some loss of tidal flats within the Western Basin associated with dredging (GHD, 2011c) and in our view the tidal flats surrounding North Passage Island may have changed (Figure 5-10). A reduction in the area of foraging habitat associated with the Western Basin Dredging and Disposal Project will affect the foraging density estimates produced for this report. Updated estimates of the foraging area are required to maintain confidence in the density estimates.

Differentiating between the various activities associated with construction was difficult because all the specified activities were occurring in the area surrounding the roosts and in close proximity to the intertidal foraging areas. The cessation of the specific construction activities could present an opportunity to assess whether migratory shorebird populations recover, but the likelihood is slim that robust evidence linking changes in migratory shorebird populations to specific construction activities can be obtained using the present methods. Similarly, the present methods offer little scope for determining the relative effects of aspects of construction such as noise compared to light spill or water quality. Conclusions on this topic are therefore likely to be speculative and generalised. In addition, it remains possible that the cause of the reduction in the number of migratory shorebirds recorded in the upper harbour of Port Curtis was habitat alteration (DEWHA, 2009b). An example of habitat alteration would be changes in prey type and abundance or changes in the size and composition of the substrate (Colwell, 2010). Such changes could affect shorebird populations but would not be directly detectable using the *Shorebird 2020* method.

Figure 5-3 A roost on the Calliope River directly adjacent to the WICET, February 2016.
A total of 10 Whimbrel and two Red-capped Plover were recorded (Adam Leavesley, Wildlife Unlimited).

Figure 5-4 Clinton Ash Ponds, February 2016
The site was subject to works in during the 2016 survey (Adam Leavesley, Wildlife Unlimited).

Figure 5-5 Dredge spoil had been deposited in the Clinton Ash Ponds.
The source was believed to be Gladstone Marina. No birds were recorded in this section of the ponds (Adam Leavesley, Wildlife Unlimited).

Figure 5-6 Friend Point Claypan, February 2016
Large birds roost across the claypan, but the main roost was the sandbank in the middle distance. The signs indicate the location of the gas pipeline which supplies the LNG plants on Curtis Island (Adam Leavesley, Wildlife Unlimited).

Figure 5-7 Ships in close proximity to South Passage Island, February 2016
The roost at South Passage Island appears to be subject to greatly increased shipping traffic, but returned a count of 59 birds (Adam Leavesley, Wildlife Unlimited).

Figure 5-8 Shipping traffic in the upper harbour of Port Curtis.
(Adam Leavesley, Wildlife Unlimited)

Figure 5-9 Recreational boat putting migratory shorebirds to flight in Port Curtis, February 2016.
A mixed flock of Grey-tailed tattlers and Terek Sandpipers were disturbed by close approach of a small boat while the survey was in progress. The birds took flight and can be seen to the right of the boat, but immediately returned to the roost (Adam Leavesley, Wildlife Unlimited).

Figure 5-10 The tidal flat at South Passage Island may have changed.
Mapping of the South Passage tidal flat by GHD (2011c) shows a single mass. In February 2016, near to the bottom of the tide, the flat appeared U-shaped, raising the possibility that change may have occurred.

5.3 Survey Coverage and Inference

The geographical coverage and duration of this project appears suitable to meet the primary aim of monitoring the migratory shorebird populations of the Curtis Coast during a major construction phase and in the period of increased human utilisation after. The project area allows for comparison of the main work site in the western basin with the rest of Port Curtis. Assuming no significant change occurs to the conditions for migratory shorebirds on the eastern side of Port Curtis, inference may be drawn about the effects of the construction work and the subsequent increase in human activity in the western basin. Should the increase in port capacity also affect shorebirds in the eastern basin of Port Curtis, the inclusion of Fitzroy Estuary, Mundoolin Inlet, Colosseum Inlet and Rodd's Harbour allows a further comparison to be made because any effects on shorebirds in these locations are expected to be much attenuated. Survey of the wider Curtis Coast also provides baseline information for other areas that may be subject to future development.

The use of the *Shorebird 2020* method allows comparison with other regularly counted sites on the Queensland coast such as Moreton Bay and other sites across Australia, New Zealand and the whole EAAF. This is important because migratory shorebird populations along the EAAF are declining (MacKinnon et al., 2012; Murray et al., 2015). If present estimates of the rate of decline are correct and continue, then by the end of this project in 2020, counts for some of the species on the Curtis Coast may have reduced by 50 percent.

The effects of the various construction activities specified in the Ecological Research and Monitoring Program (Gladstone Ports Corporation, 2011) cannot be easily separated from each other using the present approach (Section 5.2). The reason is that most of the construction work is happening in the same place and at the same time. For the purposes of the present survey and reporting, the Ecological Research and Monitoring Program conditions are interpreted to mean that all effects of the construction work are to be considered. Detailed investigation of habitat utilisation is difficult to achieve using the present method. Conclusions will be limited to what can be determined from broad differences between parts of the study site as discussed in previous reports (GHD, 2011c; Sandpiper Ecological Surveys, 2012b).

5.4 The Western Basin Reclamation Area

A total of 327 migratory shorebirds, all Red-necked Stint were recorded at the Western Basin Reclamation Area at high tide. In comparison, three Eastern Curlew recorded during the high tide surveys in 2015. To date the use of the reclamation area by migratory shorebirds has involved small numbers of large birds such as Eastern Curlew and Whimbrel, and Red-necked Stints in a range of flock sizes. Most of the birds have been recorded from the southern ponds. The large birds were all observed roosting; however the stints, when present have been feeding in shallow pools (Figure 5-11, Figure 5-12). Red-necked Stints are more flexible and opportunistic in their habitat use than many other migratory shorebirds (Minton et al., 2012). The use of reclaimed land by migratory shorebirds during the phase of construction when freshly-dredged material in being pumped in has been observed elsewhere (Hollands & Minton, 2012) and was predicted in previous reports (GHD, 2011a; Sandpiper Ecological Surveys, 2012a). However the continued use of the land is unexpected (Wildlife Unlimited, 2013a). The observation suggests that the birds are utilising prey from the site. Red-necked Stints are small with short bills and short legs such that they are not suited to sites with water much deeper than 2-3cm (Colwell, 2010). Presumably the reclamation was designed to be flat, with the result that when the conditions are suitable for stints there is a large area of suitable habitat and the site can support a lot of birds.

The bund wall is similar to a secluded rock structure in the lower harbour adjacent to Queensland Alumina Limited that hosts migratory shorebird roosts (sites 13 & 14 at South Trees Inlet). Regular use of the bund wall could offset the loss of high tide roosts elsewhere in the Western Basin. Given that many species of shorebirds are known to have high site fidelity (Hollands & Minton, 2012; Minton et al., 2012), the identification of new roosts in the Western Basin of Port Curtis will aid understanding of the medium term impacts of the development. Surveys of the bund wall to date have failed to detect shorebirds.

Figure 5-11 Red-necked Stints feeding in the reclamation area in February 2013
A total of 327 stints were recorded at high tide in February 2016; the conditions were similar to the picture (Tamara Leitch, Wildlife Unlimited).

Figure 5-12 Close up of Red-necked Stints feeding in the reclamation area, February 2013
Conditions in the reclamation area were similar this year (Tamara Leitch, Wildlife Unlimited).

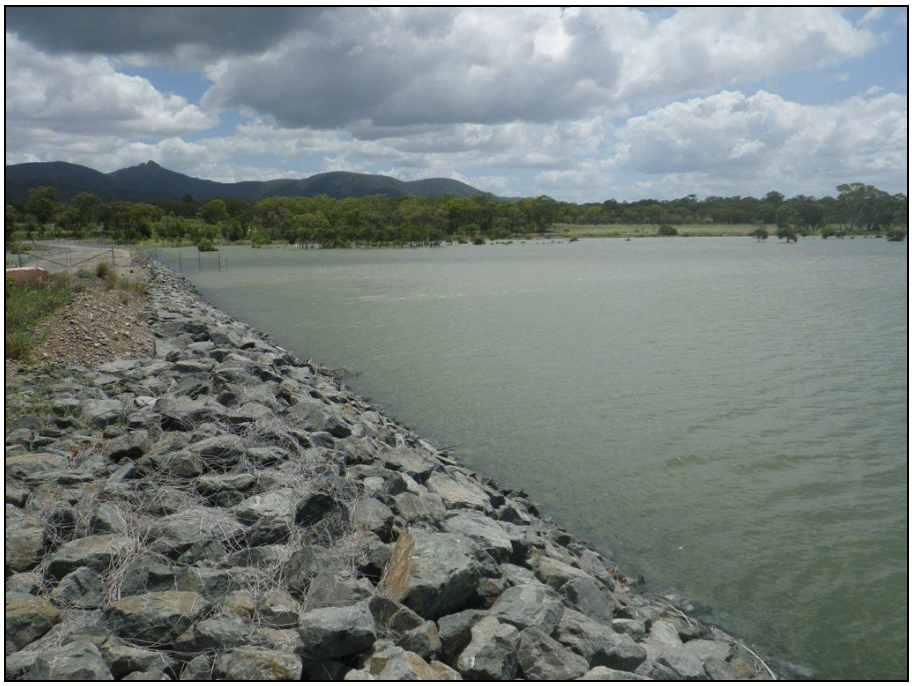


Figure 5-13 The bund wall of the Western Basin Reclamation Area.
The bund wall was surveyed for high tide roosting sites but no birds were detected (Adam Leavesley, Wildlife Unlimited).

5.5 Conclusion

Survey coverage was comparable to February 2015 and previous summer surveys. Therefore the results meet a key objective of the Ecological Research and Monitoring Program that populations of migratory shorebirds across the Curtis Coast are monitored during the Austral summer.

The total abundance of migratory shorebirds does not appear to have declined since the program began in 2011. The program has provided valuable knowledge about the distribution of migratory

shorebirds on the Curtis Coast however population dynamics are not well enough understood to draw any firm conclusions about the trajectories of the constituent species. Many migratory shorebird species on the Curtis Coast have exhibited considerable variation in their distribution in time and space and it is not safe to assume that stability in total migratory shorebird abundance indicates that all migratory shorebird populations are stable.

Shorebird abundance at sites that were subject to construction disturbance generally appeared lower than at the beginning of the project, but this effect was not uniform. It remains unclear whether the Western Basin Dredging and Disposal Project activities have caused significant habitat change or long-term decline to migratory shorebird abundance in the upper harbour. It is also difficult using present methods to determine the differential effects (if any) of the various projects underway in Port Curtis such as WICET, the Curtis Island LNG developments or any other changes in patterns of use of Port Curtis that have occurred since migratory shorebird monitoring began.

The Cheetham Salt Works was surveyed during the mainland shoreline survey on day 5. The survey confirmed that the assemblage of migratory shorebird species present included a number of species that were not common elsewhere on the Curtis Coast.

High tide surveys at the Western Basin Reclamation Area revealed 327 Red-necked Stints feeding on the southern pond. A large area of the pond was under shallow water following a period of heavy rain over the previous fortnight. The southern pond is the site of most of the records of migratory shorebirds obtained from the reclamation area. Surveys targeting the bund wall did not detect any birds.

The site of the Western Basin Dredging and Disposal Project in Port Curtis appears to continue to experience a localised reduction or re-distribution of migratory shorebird numbers similar to that documented in previous reports (Wildlife Unlimited, 2012; 2013a; 2013b; 2014; 2015). Although the total number of birds recorded during surveys for this project has been stable when adjusted for season, considerable variation has occurred amongst the individual species. It is not safe to assume that the relative stability in the total number of birds signals that all the populations are healthy. It is an intriguing question why the total migratory shorebird abundance is apparently relatively stable when the constituent populations appear to vary so much in time and space. Understanding this issue may assist with future management.

5.6 Recommendations

The high tide roost survey was extended to cover the bund wall of the reclamation area in order to determine if the birds were using it to roost. Migratory shorebirds have not been detected on the bund wall however they have been detected on the southern pond. At the same time access to the Cheetham Salt Works has been available for the last two surveys. Time constraints prevent a thorough survey of the mainland shoreline sites, the Western Basin Reclamation Area and the Cheetham Salt Works within the four hour high tide window.

1. Some rationalisation or prioritisation of the mainland shoreline surveys is required in order to complete the schedule within the prescribed four hour high tide window.

2. Following the agreed scheduling guidelines, the next annual summer survey is due on the full moon high tide from Saturday 11 February to Wednesday 15 February 2017.

The Gaslog Skagen, a 98,000t Bermuda registered ship leaves Port Curtis on 8 February bound for Iran.

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Appendix 1 EPBC Act Listed Migratory Shorebirds

Scientific name	Common name	Abbreviation
Scolopacidae		
Gallinago hardwickii	Latham's Snipe	LS
Gallinago stenura	Pin-tailed Snipe	PtS
Gallinago megala	Swinhoe's Snipe	SS
Limosa limosa	Black-tailed Godwit	BltG
Limosa lapponica	Bar-tailed Godwit	BtG
Numenius minutus	Little Curlew	LC
Numenius phaeopus	Whimbrel	W
Numenius madagascariensis	Eastern Curlew	EC
Tringa totanus	Common Redshank	CR
Tringa stagnatilis	Marsh Sandpiper	MS
Tringa nebularia	Common Greenshank	CG
Tringa glareola	Wood Sandpiper	WS
Xenus cinereus	Terek Sandpiper	TS
Actitis hypoleucos	Common Sandpiper	CS
Tringa brevipes	Grey-tailed Tattler	GtT
Tringa incana	Wandering Tattler	WT
Arenaria interpres	Ruddy Turnstone	RT
Limnodromus semipalmatus	Asian Dowitcher	AD
Calidris tenuirostris	Great Knot	GK
Calidris canutus	Red Knot	RK
Calidris alba	Sanderling	San
Calidris ruficollis	Red-necked Stint	RnS
Calidris subminuta	Long-toed Stint	LtS
Calidris melanotus	Pectoral Sandpiper	PS
Calidris acuminata	Sharp-tailed Sandpiper	StS
Calidris ferruginea	Curlew Sandpiper	CuS
Limocola falcinellus	Broad-billed Sandpiper	BbS
Philomachus pugnax	Ruff	R
Phalaropus lobatus	Red-necked Phalarope	RnP
Glareolidae		
Glareola maldivarum	Oriental Pratincole	OPc
Charadriidae		
Pluvialis fulva	Pacific Golden Plover	PGP
Pluvialis squatorola	Grey Plover	GP
Charadrius dubius	Little Ringed Plover	LRP
Charadrius bicinctus	Double-banded Plover	DbP
Charadrius mongolus	Lesser Sand Plover	LSP
Charadrius veredus	Greater Sand Plover	GSP
Charadrius leschenaultii	Oriental Plover	OP

Appendix 2 EAAF Population Estimates

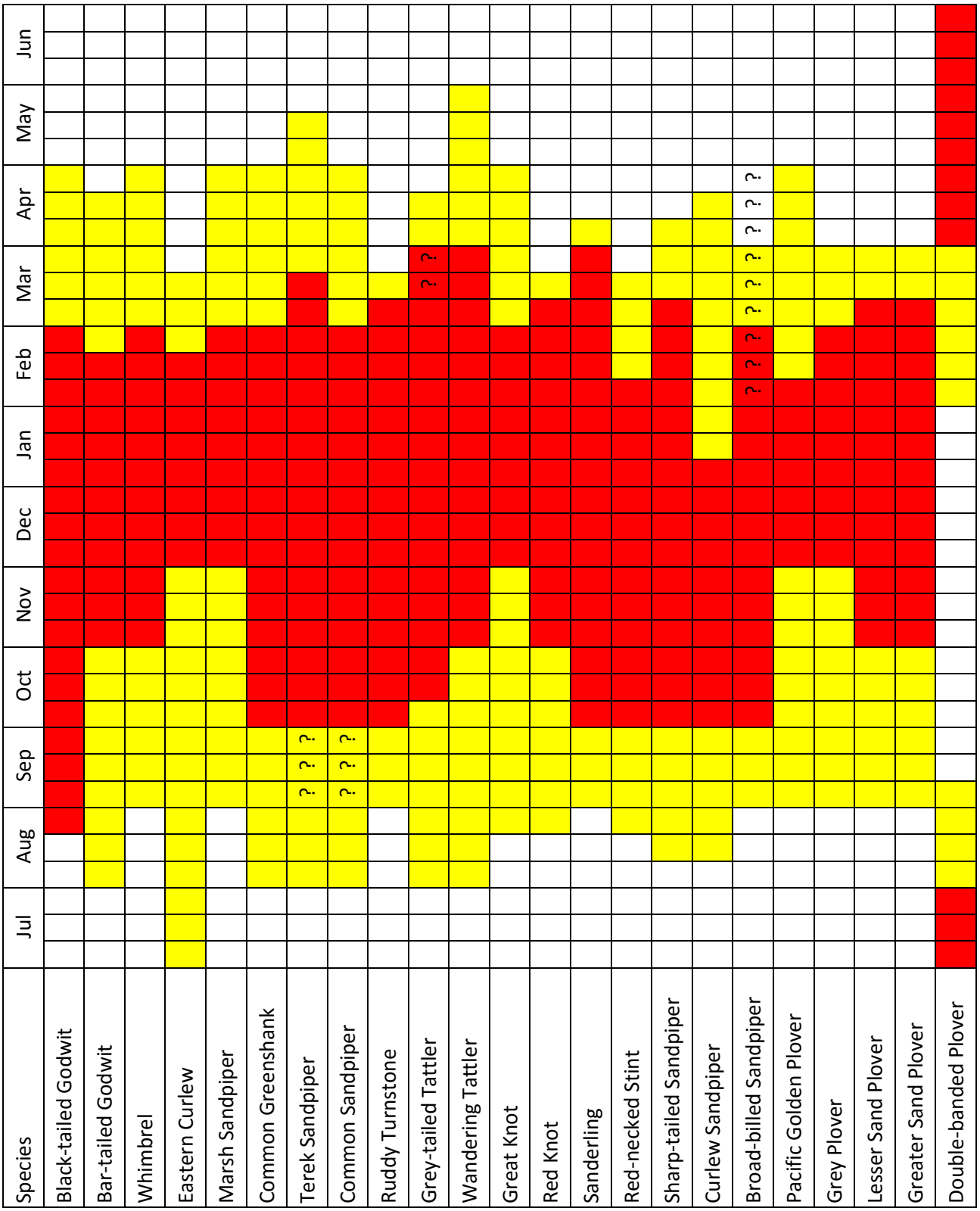
Common name (sub-species)	Bamford *et. al.* 2008	Wetlands International 2015	
Scolopacidae			
Latham's Snipe	36,000	25,000-100,000	Declining
Pin-tailed Snipe	25,000-1,000,000	25,000-1,000,000	Unknown
Swinhoe's Snipe	25,000-100,000	25,000-100,000	Unknown
Black-tailed Godwit	160,000	139,000	Declining
Bar-tailed Godwit (menzbieri)	325,000	146,000	Declining
Bar-tailed Godwit (baueri)		133,000	Declining
Little Curlew	180,000	180,000	Unknown
Whimbrel	100,000	55,000	Declining
Eastern Curlew	38,000	32,000	Declining
Common Redshank	75,000	10,000-100,000	Unknown
Marsh Sandpiper	100,000-1,000,000	100,000-1,000,000	Unknown
Common Greenshank	60,000	100,000	Unknown
Wood Sandpiper	100,000-1000,000	100,000	Unknown
Terek Sandpiper	60,000	50,000	Unknown
Common Sandpiper	25,000-100,000	50,000	Unknown
Grey-tailed Tattler	50,000	44,000	Declining
Wandering Tattler	—	10,000-25,000*	Unknown
Ruddy Turnstone	35,000	28,500	Declining
Asian Dowitcher	24,000	23,000	Declining
Great Knot	375,000	290,000	Declining
Red Knot (piersmai)	220,000	50,500-62,000	Declining
Red Knot (rogersi)		48,500-62,000	Declining
Sanderling	22,000	22,000	Unknown
Red-necked Stint	325,000	315,000	Unknown
Long-toed Stint	25,000	25,000	Unknown
Pectoral Sandpiper	—	1,220,000-1,930,000*	Declining
Sharp-tailed Sandpiper	160,000	160,000	Unknown
Curlew Sandpiper	180,000	135,000	Declining
Broad-billed Sandpiper	25,000	25,000	Unknown
Ruff	—	25,000-100,000*	Unknown
Red-necked Phalarope	100,000-1,000,000	100,000-1,000,000	Declining
Glareolidae			
Oriental Pratincole	2,880,000	2,880,000	Unknown
Charadriidae			
Pacific Golden Plover	100,000-1000,000	100,000	Unknown
Grey Plover	125,000	104,000	Declining
Double-banded Plover (bicinctus)	50,000	50,000	Declining
Double-banded Plover (exilis)		730	Increasing?
Lesser Sand Plover (mongolus)	140,000	25,500	Declining
Lesser Sand Plover (schaeferi)		30,000	Unknown
Lesser Sand Plover (stegmanni)		13,000	Declining
Greater Sand Plover	110,000	79,000	Declining
Oriental Plover	70,000	145,000-155,000	Unknown

* Only a small proportion of the population is present in the EAAF.

Appendix 3 Timing of Migration

Timing of migration for 23 species of migratory shorebirds in central Queensland following Marchant and Higgins (1993) and Higgins and Davies (1996).

Yellow: periods when the population is believed to be in flux; Red: periods when the population is present with numbers potentially at a maximum. ? = migration behaviour described as unclear.



Appendix 4 Species time-series 2011-2014

Monitoring the Curtis Coast Shorebird Populations

After a series of ten surveys on the Curtis Coast, the opportunity arises to assess the patterns of occurrence of the EPBC-listed migratory shorebirds. The short period over which the surveys have occurred means that few firm conclusions may be drawn, but nonetheless the information obtained is likely to be valuable for planning and contextualising future work.

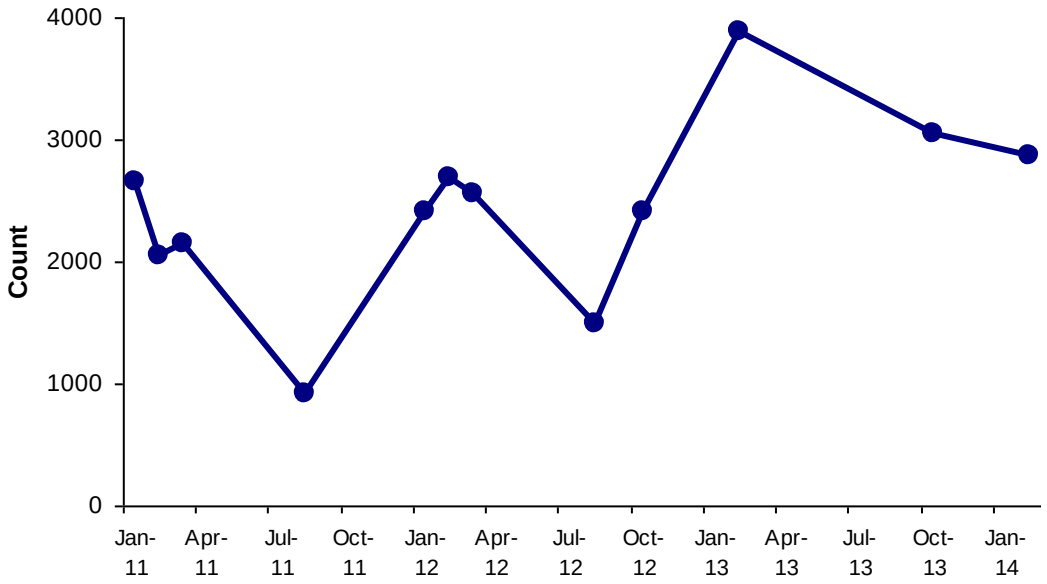
To this point, reports have focussed on the total number of birds present at the study site however this is not the key issue. In a technical sense, the term population applies to a species. It does not apply to a group of species or a community – such as the shorebirds of the Curtis Coast. It is therefore the intent of the conditions set by the regulator in the ERMP, that monitoring address the health of the populations of each of the constituent species of the Curtis Coast migratory shorebird community.

Ten species of EPBC-listed migratory shorebirds are present in sufficient numbers to justify an exploration of the data and speculative characterisation of their population dynamics on the Curtis Coast. These species are: Bar-tailed Godwit, Whimbrel, Eastern Curlew, Terek Sandpiper, Grey-tailed Tattler, Great Knot, Red-necked Stint, Grey Plover, Lesser Sand Plover and Greater Sand Plover.

A set of time-series for these species may potentially shed some light on a number of questions. 1) The size of the population. 2) The variation in the size of the population between years – i.e. the long term trend in numbers. 3) The variation in the size of the population within a season or a year – the timing of migration and the context of figures obtained in particular months.

The single species time-series show that the relatively stable counts obtained for the Curtis Coast are concealing considerable variation from species to species. A stable total count does not signal that the populations of all the constituent species are also stable.

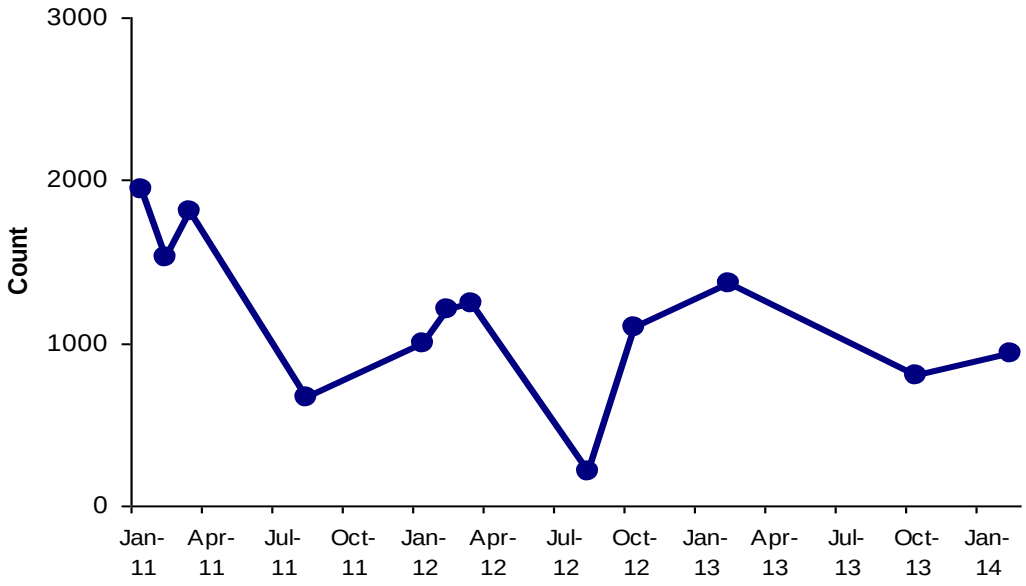
Bar-tailed Godwit



Bar-tailed Godwit time series at the Curtis Coast from January 2011 to February 2014.

Peak numbers of Bar-tailed Godwits appeared to occur in summer. The August 2012 and February 2013 surveys showed an increase from their respective months in the previous year suggesting that the species may have experienced successful breeding seasons (Minton et al., 2012). The northward migration did not appear to make a difference to godwit numbers in March however the possibility that birds moving north were being replaced by others from further south could not be ruled out. Abundance in October 2012 was considerably lower than February 2016 suggesting that godwits may not have staged at the Curtis Coast during the southward migration. However the October 2013 figure was greater than the February 2014 figure, suggesting that staging may have occurred.

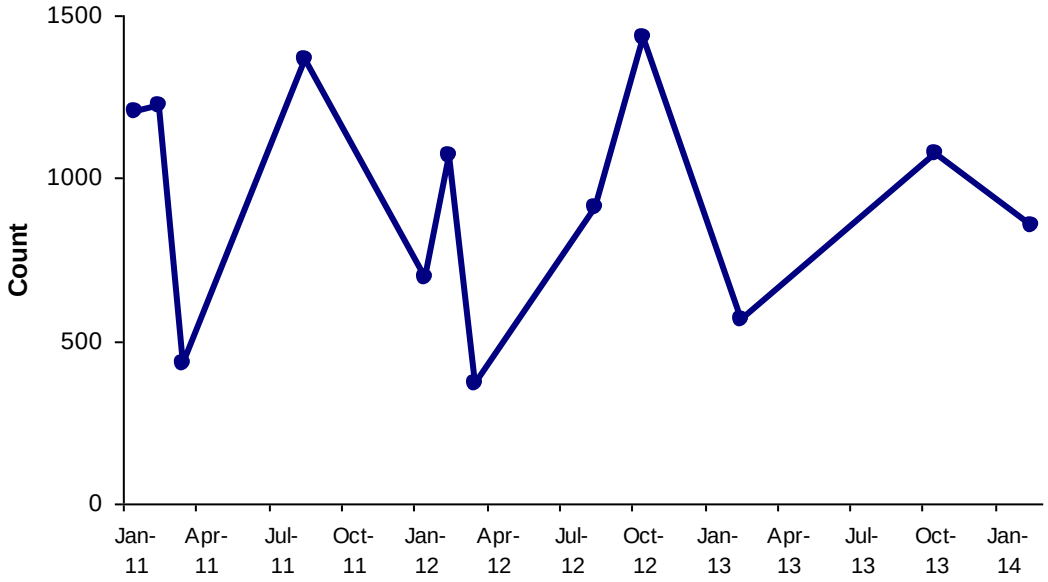
Whimbrel



Whimbrel time series at the Curtis Coast from January 2011 to February 2014.

Whimbrel numbers appeared to peak on the Curtis Coast in the Austral summer and during the study period, the summer figure was reasonably stable. Migration did not appear to make a difference to Whimbrel numbers in March however this did not rule out that birds moving north were being replaced by others from further south. October abundances were consistently lower than the February abundances. The decrease in numbers between August 2011 and August 2012 may have reflected a poor 2011 Arctic breeding season.

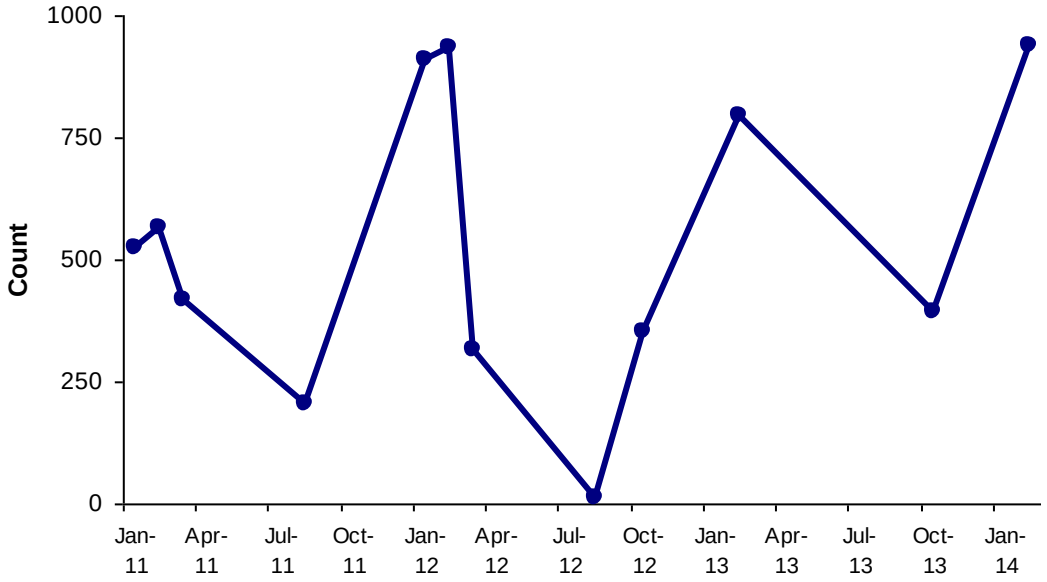
Eastern Curlew



Eastern Curlew time series at the Curtis Coast from January 2011 to February 2014

Eastern Curlew showed an atypical annual pattern of abundance. Numbers were unusually high in August and this may have been due to the movement of young birds north along the Australian coast during the Austral winter (Wilson, 2000; Minton et al., 2011). These birds are then believed to migrate south again during the Austral summer. Numbers were considerably lower in March than they were in January and February. This may reflect the commencement of the northward migration by breeding birds that would appear to have begun in mid-February. This is consistent with Higgins and Davies (1996) but appears to contradict more recent work (Minton et al., 2011). The high counts in October compared to February suggests that birds may have staged through the Curtis Coast on the southward migration.

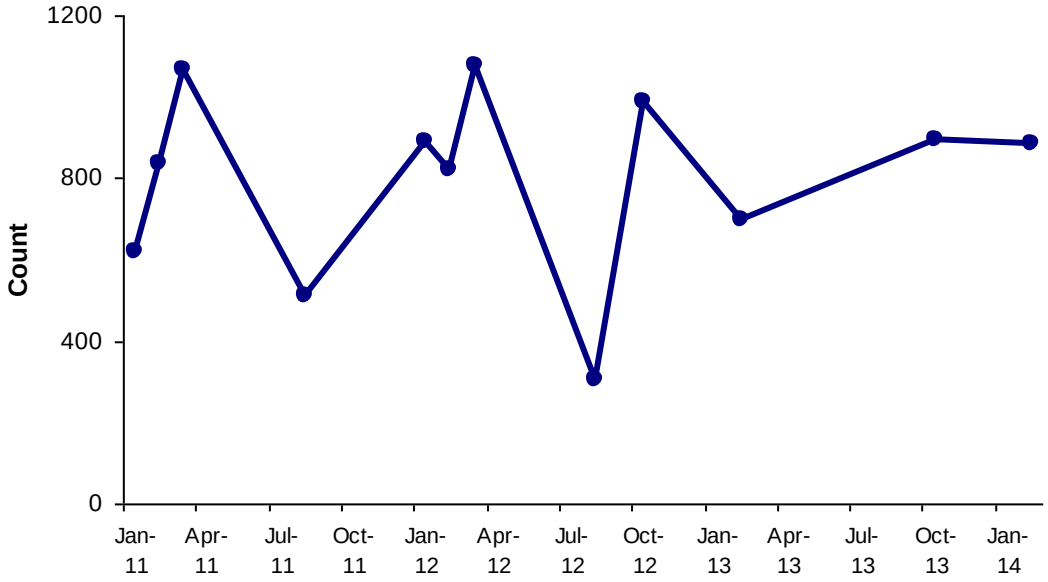
Terek Sandpiper



Terek Sandpiper time series at the Curtis Coast from January 2011 to February 2014

The peak abundance for Terek Sandpiper appeared to be January and February. Numbers declined in March suggesting that birds may have commenced the northward migration sometime in the second half of February. The relatively low counts in October compared to February suggested that numbers were still building throughout October. It may also indicate that the species did not stage through the Curtis Coast during the southward migration. The August 2012 count appeared considerably lower than the August 2011 count which may indicate that the 2011 Arctic breeding season was not very successful.

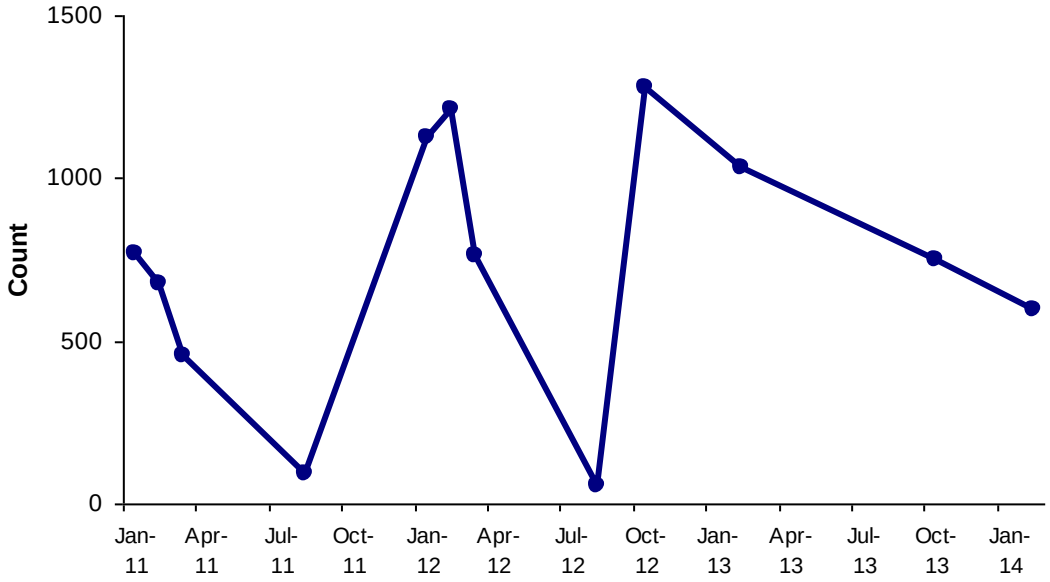
Grey-tailed Tattler



Grey-tailed Tattler time series at the Curtis Coast from January 2011 to February 2014

Grey-tailed Tattler showed an increase in numbers from January and February to March. This may indicate that birds moved into the Curtis Coast from further south at a greater rate than the summer residents were departing. The high figures in October compared to February 2014 may indicate that the Curtis Coast was used as a staging area for the southward migration.

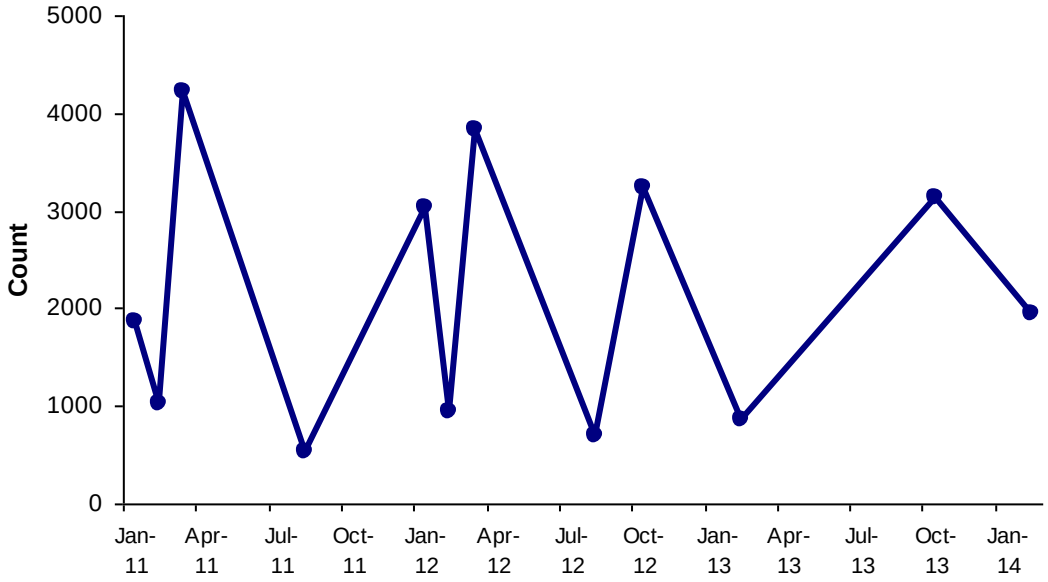
Great Knot



Great Knot time series at the Curtis Coast from January 2011 to February 2014

The annual peak in abundance for the Great Knot appears to be January and February. Numbers declined in March suggesting that birds may commence the northward migration sometime in the second half of February. The relatively high counts in October compared to February suggests that birds may stage through the Curtis Coast on the southward migration. Numbers in August were low in both years suggesting that few birds winter on the Curtis Coast.

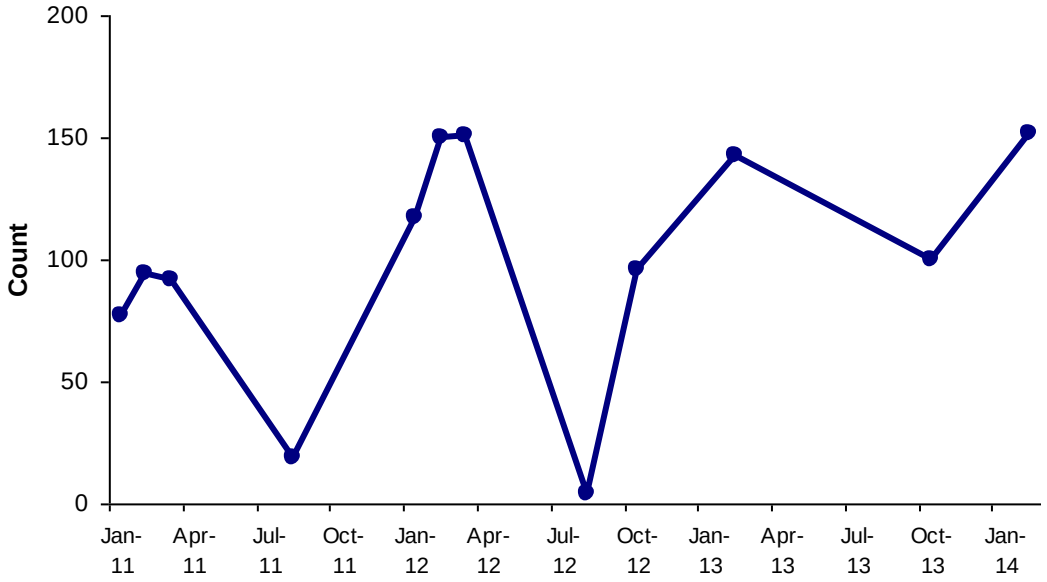
Red-necked Stint



Red-necked Stint time series at the Curtis Coast from January 2011 to February 2014

Red-necked Stint showed a rapid intra-annual rise and fall in numbers on the Curtis Coast. Maximum numbers were recorded in March suggesting that birds stage through the Curtis Coast on the northward migration. Another smaller peak occurred in January, but three of the four February surveys returned relatively low numbers. A potential explanation for this pattern is that stints may migrate northward in two groups perhaps determined by age or sex. One group appeared to leave the Curtis Coast in the second half of January or early February, while the second group staged through the region in March. The estimates from October were relatively high compared to the following February. This may indicate that stint numbers approach their summer maximum in October or perhaps stage through the Curtis Coast during the southward migration. No October-January comparison was collected and that would be useful. Records from the Cheetham Salt Works which were collected at a higher frequency than this survey are consistent with the staging suggestion (Houston et al., 2012).

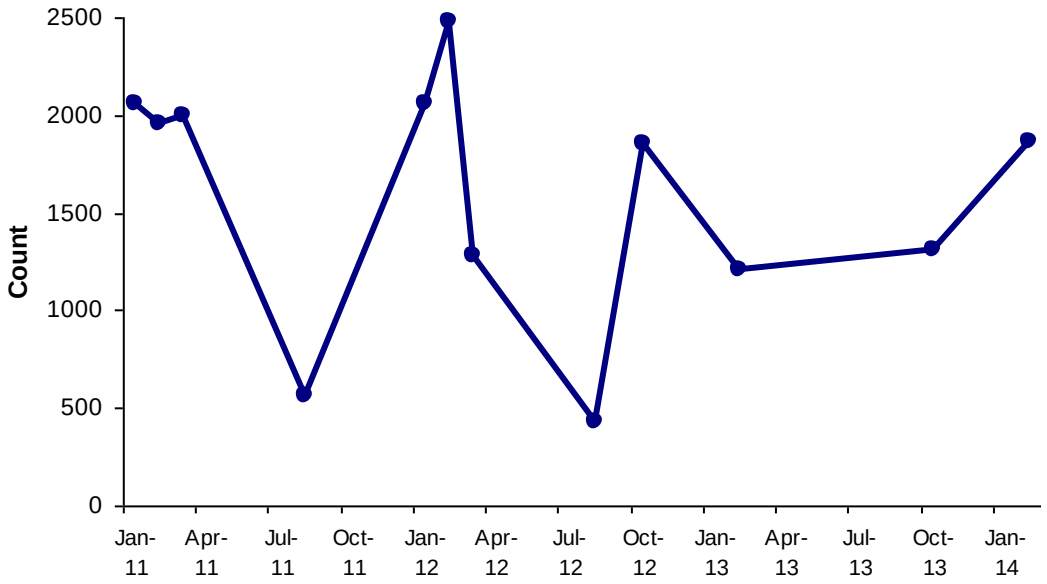
Grey Plover



Grey Plover time series at the Curtis Coast from January 2011 to February 2014

The numbers of Grey Plover on the Curtis Coast may not be sufficient to generate a consistent pattern over a longer time period. For the present however, numbers appeared to peak in February and March. This may indicate that the Grey Plover northward migration did not occur until April, or alternatively, that as the summer residents migrate northward, their numbers were replaced by birds from further south. The August surveys recorded very few birds and the October surveys returned a figure considerably lower than that recorded the following February. This suggests that the southward migration may have still been underway in October.

Sand Plover species



Sand Plover species time series at the Curtis Coast from January 2011 to February 2014

Sand Plover numbers were inconsistent across the Curtis Coast during the study period. The first two years suggested a January-February annual peak in abundance however the October 2012 survey returned a higher figure than the February 2013 survey, which suggested that southward staging may have occurred. The following year, the October abundance estimate was lower than the February estimate. The timing of the northward migration in 2012 was also inconsistent. The 2011 data suggested a late March departure but the 2012 data suggested a late February departure. Potential reasons for the inconsistencies were: 1) the birds may not follow a strict timetable; 2) the apparent effects may have been an artefact of the survey timing; 3) the combination of two species may have confounded the pattern; and 4) the floods in January 2014 associated with TC Oswald may have affected the abundance of one or both species on the Curtis Coast. The information obtainable will be improved if the proportion of birds not identifiable to species level is reduced.

Appendix 5 Non-migratory Shorebirds

Scientific name	Common name	Abbreviation
Burhinidae		
Burhinus grallarius	Bush Stone-curlew	BSc
Esacus magnirostris	Beach Stone-curlew	BeSc
Haematopodidae		
Haematopus longirostris	Australian Pied Oystercatcher	APO
Haematopus himantopus	Sooty Oystercatcher	SO
Charadriidae		
Erythrogobus cinctus	Red-kneed Dotterel	RkD
Charadrius ruficapillus	Red-capped Plover	RcP
Elseyornis melanops	Black-fronted Dotterel	BfD
Vanellus miles	Masked Lapwing	ML
Recurvirostridae		
Himantopus himantopus	Black-winged Stilt	BwS
Recurvirostra novaehollandiae	Red-necked Avocet	RnA

Appendix 6 Variation in Summer Migratory Shorebird Counts at Corner Inlet, Victoria

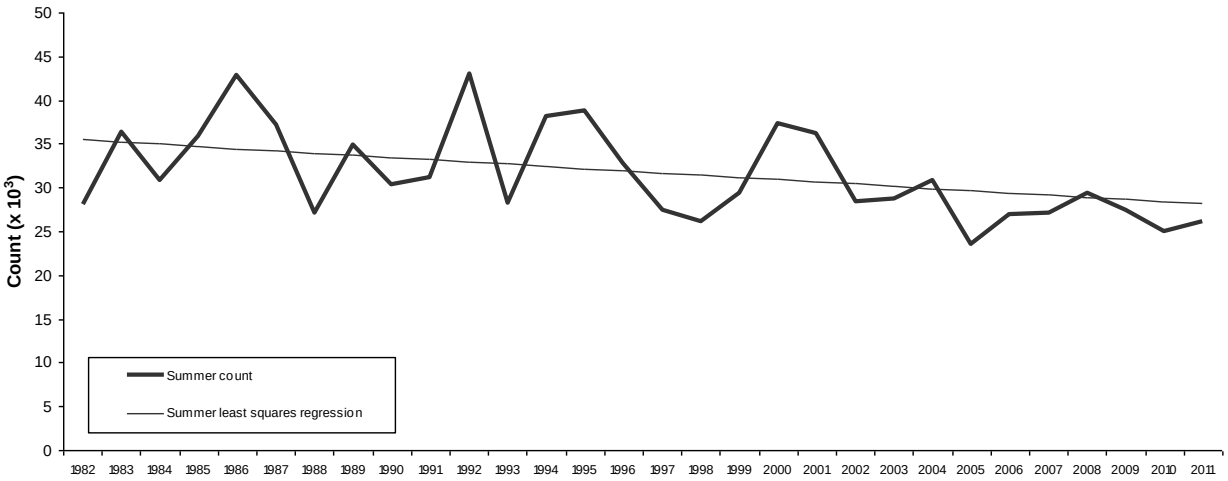


Figure A6.1 Migratory Shorebird Count at Corner Inlet from 1982-2011, reproduced from Minton *et al*. (2012). A standardised method was used throughout the period.