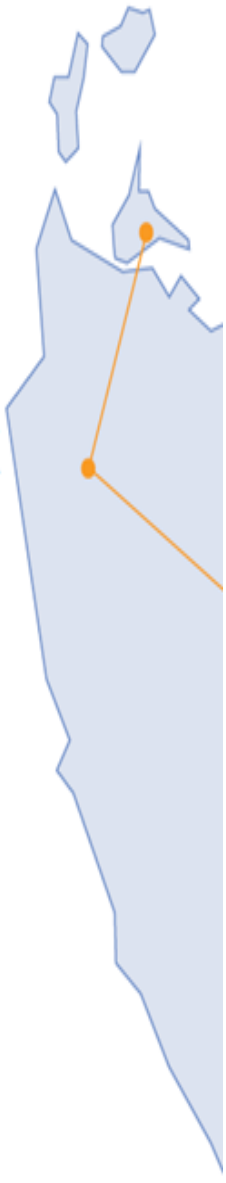
UPC AC Renewables AUSTRALIA

Jim's Plain & Robbins Island
Renewable Energy Parks



Robbins Island Renewable Energy Park

Appendix J

Resident Shorebird and Migratory Shorebird Surveys

UPC Robbins Island Pty Ltd

A survey of the resident shorebirds on Robbins Island, northwest Tasmania, February 2018.

Report to GHD, May 2018.
Dr Eric J Woehler, BirdLife Tasmania

Executive Summary

Robbins Island is a 9900ha island situated just off the northwest coast of Tasmania within the Robbins Passage/Boullanger Bay wetlands. The focal resident shorebirds for the February 2018 survey comprised Hooded and Red-capped Plovers, Australian Pied and Sooty Oystercatchers. In addition, two species of small terns, Fairy and Little Terns were included in the survey as these two seabird species share many ecological requirements of the focal shorebird species, and the threats they face, and have been previously reported from Robbins Island.

Ground-based surveys of resident species of shorebirds were undertaken on 18 - 20 February 2018 and extended for 48.8km of foreshore. A total of 49 breeding territories was mapped during the survey, comprising Hooded (12) and Red-capped Plovers (9), and Pied (16) and Sooty (12) Oystercatchers. No Fairy Terns or Little Terns were observed during the February 2018 survey. Current and historical survey data from the area show Robbins Island to be nationally significant for breeding populations of Hooded Plovers and for Pied and Sooty Oystercatchers, and the known regional breeding population (Anthony Beach, Perkins Island and Robbins Island in Perkins Bay) to be of international significance. The timing of the survey may have under-estimated breeding populations (particularly for Pied Oystercatchers) due to the potential completion of breeding efforts by some individuals and their subsequent absence from their territories during the survey.

It is critical that the Robbins Passage/Boullanger Bay wetlands must be seen and managed as a single ‘unit’, rather than as a series of disconnected foreshore areas used for breeding and feeding by resident shorebirds and small terns to ensure their survival and persistence into the future.

Hooded Plover ©Eric Woehler, BirdLife Tasmania.

Document control:		
Written:	E Woehler	March 2018
Reviewed:	M Newman* R Ashby* A Darby* M Davis GHD M Skerritt UPC	March 2018
Revised	E Woehler	May 2018
Submitted:	M Davis GHD	May 2018

*BirdLife Tasmania

Introduction

Robbins Island is a 9900ha island situated just off the northwest coast of Tasmania. It is Tasmania's seventh-largest island, and is located within the Robbins Passage/Boullanger Bay wetlands. These wetlands are approximately 100km^2 in extent (Ashby 1991), and are now known to support the highest concentrations of migratory shorebirds in Tasmania, and which outnumber all other shorebird sites in Tasmania combined (BirdLife Tasmania, unpubl. data, Hansen et al. 2017, Woehler 2018a). However, many fewer records of resident shorebird species compared to migratory species are known from the Robbins Passage/Boullanger Bay wetlands, and Robbins Island specifically.

BirdLife Tasmania was commissioned by GHD in February 2018 to survey and map with GPS the distribution of breeding territories of nesting resident shorebirds on Robbins Island to (a) provide contemporary data on the distribution of breeding sites, and (b) to establish baseline population data for the resident shorebird species. These data will enable an assessment of the Robbins Island results in a Tasmanian, and national and international contexts.

The focal resident shorebirds for this survey comprised Hooded Plover *Thinornis rubricollis*, Red-capped Plover *Charadrius ruficapillus*, Australian Pied Oystercatcher (hereafter Pied Oystercatcher) *Haematopus longirostris* and Sooty Oystercatcher *H. fuliginosus*. In addition, two species of small terns, Fairy Tern *Sternula nereis nereis* and Little Tern *S. albifrons*, were included in the survey as these two seabird species share many ecological requirements of the focal shorebird species, and the threats they face, and have been previously reported from Robbins Island. The Robbins Island surveys were required to be comparable with similar surveys elsewhere in Tasmania (eg Woehler 2013, 2015, 2018b, Woehler and Ruoppolo 2013a and b, 2014).

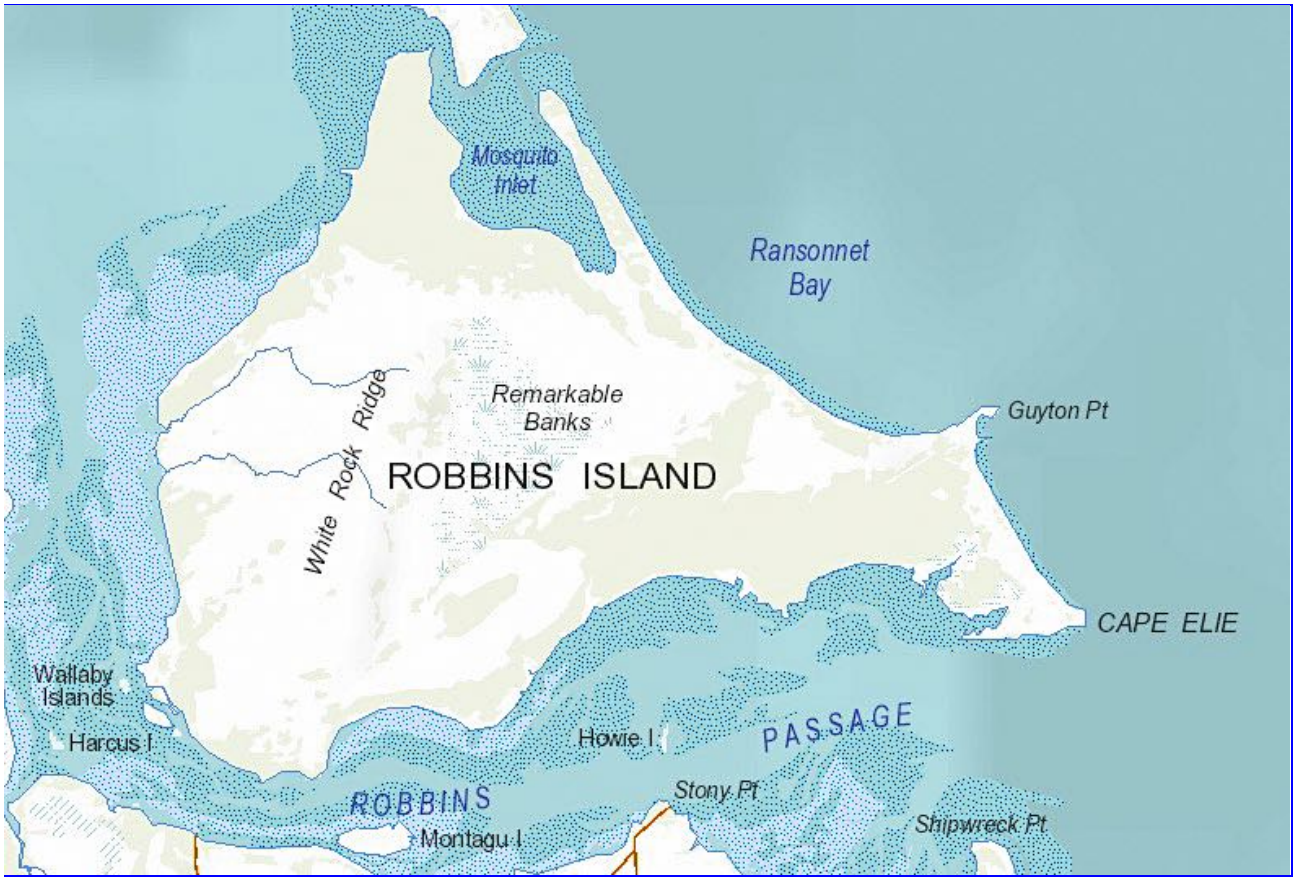


Figure 1. Map of Robbins Island, source map from https://maps.thelist.tas.gov.au/listmap/app/list/map

Methods

a. February 2018 surveys

Ground-based surveys of resident species of shorebirds (waders) were undertaken on 18, 19 and 20 February 2018 (Table 1). All surveys were undertaken by the author.

All GPS data were captured with a Garmin *eTrex* 30 12-channel GPS receiver in real time. The coordinates of breeding territories' centroids and any nests encountered were recorded as UTM coordinates based on the WGS 84 datum and converted to latitude °S and longitude °E for mapping. The linear distances surveyed were calculated by Garmin software for each foreshore survey.

Shorebird surveys followed the standardised survey method used throughout Tasmania – in brief, a linear transect is walked along the foreshore, with the centroids of breeding territories of resident shorebirds mapped as they were encountered. Foreshores were scanned with binoculars at the starting point, then frequently throughout the survey to ensure the location/s of breeding shorebirds and terns was known before their breeding territory was entered to ensure minimal disturbance to breeding shorebirds.

No nest searches were made, but two nests were encountered on the survey route along foreshores as a result of tide height, geomorphology etc, and all efforts were also made to avoid disturbing feeding shorebirds at waters edge. Where nests with eggs or chicks were encountered, the GPS coordinates of the nest were captured in preference to the breeding territory centroid on the foreshore.

Weather conditions during the surveys were recorded at the commencement of each foreshore survey, and any changes in conditions during the surveys were recorded when observed (eg changes in wind strength or direction).

The timing of the surveys coincided with the tail end of the shorebird breeding season (October to March, inclusive) in Tasmania. The Robbins Island surveys will contribute to the ongoing BirdLife Tasmania project that aims to GPS map and census breeding populations of resident beach-nesting shorebirds and small terns state-wide to establish contemporary baseline data on breeding populations of resident shorebirds and small terns, their distribution and population status where comparable historical data exist.

The Robbins Island shorebird surveys meet the *Survey guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the EPBC Act* (available at http://www.environment.gov.au/epbc/publications/survey-guidelines-australias-threatened-birds-guidelines-detecting-birds-listed-threatened)

b. Historical survey data

Breeding season surveys of resident shorebirds around Tasmania have been conducted and coordinated by BirdLife Tasmania (formerly the Bird Observers' Association of Tasmania [BOAT] and Birds Tasmania) between 1982 and 1996, inclusive (Newman and Patterson 1984, Holdsworth and Park 1993, Woehler and Park 1997). Resident shorebirds on adjacent Perkins Island were counted during these early surveys, and these data and other breeding season survey and mapping data from Robbins Island and nearby foreshores have been included in this report to contribute to a regional synthesis of resident shorebird populations for Robbins Passage/Boullanger Bay wetlands.

c. Estimations of breeding populations' significance

There are presently no official guidelines for assessing the level of significance of resident (ie non-migratory) shorebird populations in Australia at international or national levels, beyond their assessment for sites through the application of Ramsar criteria. These criteria use a mixture of percentages of populations and absolute numbers to identify sites of international significance holding populations that meet the criteria, including supporting 1% or more of the global population (Delaney and Scott 2006). See also the *EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (available at http://www.environment.gov.au/epbc/publications/shorebirds-guidelines).

For the present survey, foreshore localities that supported shorebird species at more than 0.1% of their estimated global populations are highlighted as being of national significance and those with 1% or more as of international significance, consistent with the threshold for migratory species (Commonwealth of Australia 2017). Contemporary global population estimates were obtained from Delaney and Scott (2006), Garnett et al. (2011), Wetlands International (2012a, 2012b), Garnett and Franklin (2014), Wetlands International (2014) and Taylor et al. (2014).

Four of the six focal species are listed under the Federal *Environmental Protection and Biodiversity Conservation Act 1999*, they are shown in Table 2, and the EPBC categories under which each species is listed (marine, migratory and threatened), noting that some species are listed under multiple categories. Table 2 also shows the threat category for species listed under the Tasmanian *Threatened Species Protection Act 1995*.

Results

1. Survey effort

Ground-based surveys of resident species of shorebirds (waders) were undertaken on 18, 19 and 20 February 2018, and extended for 48.8km (Table 1). Weather conditions during the three days were favourable for surveys, with winds ≤20 knots and good viewing conditions. High tides occurred during the night, with low tides occurring daily between late morning and early afternoon. A total of 49 breeding territories was mapped during the survey, comprising Hooded (12 territories) and Red-capped Plovers (9), and Pied (16) and Sooty (12) Oystercatchers (Figure 2). No Fairy Terns or Little Terns were observed during the February 2018 survey (Table 1).

Locality - GPS nesting surveys	date	km	HOPL	RCPL	PIOY	SOOY	FATE	LITE
Robbins I - landing point to Cape Elie	18-Feb-18	3.0	0	2	0	1	0	0
Robbins I - East Beach	18-Feb-18	4.4	7	4	0	1	0	0
Robbins I - Guyton Point to Back Banks	19-Feb-18	11.4	5	0	0	1	0	0
Robbins I - Mosquito Inlet	19-Feb-18	11.1	0	1	3	2	0	0
Robbins I - west coast	20-Feb-18	18.9	0	2	13	7	0	0

Table 1. Survey effort, Robbins Island February 2018. The numbers refer to breeding territories located and mapped (Figure 2) for Hooded Plover (HOPL), Red-capped Plover (RCPL), Pied Oystercatcher (PIOY), Sooty Oystercatcher (SOOY), Fairy Tern (FATE) and Little Tern (LITE).

The southern foreshore of Robbins Island between Black Phil's Point and the landing point approximately 3km west of Cape Elie was not surveyed for this project. The southern foreshore may support low(er) numbers of breeding Red-capped Plovers, Pied and Sooty Oystercatchers based on its similarity with the western foreshore of Robbins Island. The length of the unsurveyed foreshore is estimated to be approximately 20km (Figure 2).

2. Distributions and abundances of resident shorebirds' breeding populations

Hooded Plovers were only recorded on the two east-facing sandy beaches (Figure 2a). These were East Beach between Cape Elie and Guyton Point, and "*Seven Mile Beach*" [unofficial place name] between Big Bluff and Back Banks facing Ransonnet Bay. The habitat inside Mosquito Inlet and along the west and south coasts is unsuitable for Hooded Plovers, with fine-grain sediments and relatively low wave-energy foreshores. Hooded Plovers are coastal specialists, typically breeding on high(er) energy sandy oceanic beaches in Tasmania (Bock et al. 2016).

Figure 2a. Map of Robbins Island showing survey effort (red line, 48.8km), and nesting territories of Hooded Plover (n = 12 territories). See Methods for mapping protocol. Base map derived from 1:25,000 Tasmap maps. The unsurveyed extent of the south coast is estimated to be approximately 20km.

Common name	Scientific name	EPBC Thr	EPBC Mar	EPBC Mlg	TSPA 1995
Hooded Plover	*Thinornis rubricollis*	Vulnerable	X		X
Red-capped Plover	*Charadrius ruficapillus*		X		
Pied Oystercatcher	*Haematopus longirostris*				
Sooty Oystercatcher	*Haematopus fuliginosus*				
Fairy Tern	*Sternula nereis nereis*	Vulnerable	X		Vulnerable
Little Tern	*Sternula albifrons*		X	X	Endangered

Table 2. The conservation status of the six focal species under the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) and Tasmanian Threatened Species Protection Act 1995 (TSPA). Species with elevated conservation status are highlighted. "EPBC Mar" and "EPBC Mig" indicates species listed as marine and migratory, respectively.

Red-capped Plover breeding territories were located around much of Robbins Island (Figure 2b) and were absent from "*Seven Mile Beach*" between Big Bluff and Back Banks facing Ransonnet Bay, a sandy beach that appeared suitable for breeding by this species. The reason(s) for their absence on this foreshore during the 2018 survey are presently unknown.

Pied Oystercatchers were the most numerous resident shorebird species recorded during the February 2018 survey, with 16 territories identified of which 13 were on the west coast (Figure 2c). There were no Pied Oystercatchers on "*Seven Mile Beach*" between Big Bluff and Back Banks facing Ransonnet Bay, a sandy beach that appeared suitable for breeding by this species. The reason(s) for their absence on this foreshore during the 2018 survey are presently unknown but may be related to the timing of the survey and the tides during the survey (see Discussion).

Figure 2b. Map of Robbins Island showing survey effort (red line, 48.8km), and nesting territories of Red-capped Plover (n = 9 territories). See Methods for mapping protocol. Base map derived from 1:25,000 Tasmap maps. The unsurveyed extent of the south coast is estimated to be approximately 20km.

Figure 2c. Map of Robbins Island showing survey effort (red line, 48.8km), and nesting territories of Pied Oystercatcher (n = 16 territories). See Methods for mapping protocol. Base map derived from 1:25,000 Tasmap maps. The unsurveyed extent of the south coast is estimated to be approximately 20km.

Sooty Oystercatchers were recorded during all coastal sectors surveyed (Table 1). Pairs were typically recorded on rocky foreshores or close to rocky outcrops, reefs and rocky islets beyond the inter-tidal zone. The highest numbers were present along the rocky foreshore northward of Bird Point on the far northwest coast (Figure 2d).

Figure 2d. Map of Robbins Island showing survey effort (red line, 48.8km), and nesting territories of Sooty Oystercatcher (12, black). See Methods for mapping protocol. Base map derived from 1:25,000 Tasmap maps. The unsurveyed extent of the south coast is estimated to be approximately 20km.

Based on the results of the February 2018 survey, it is believed that the total breeding populations for the resident shorebirds for Robbins Island in 2017/18 are of the order of 55 – 60 pairs in total (Table 3). The additional breeding pairs of Red-capped Plover, Pied and Sooty Oystercatchers are predicted based on a visual assessment of the southern coast foreshore that was not surveyed on foot. The 20km of foreshore is estimated to support up to 10 breeding territories of these three species, based on the habitats present.

Additional breeding territories may be present on "*Seven Mile Beach*" between Big Bluff and Back Banks facing Ransonnet Bay, a sandy beach that appeared to provide suitable nesting and foraging habitats for Red-capped Plover and Pied Oystercatcher. It is believed that the relatively late timing of the survey and the tidal cycle during the survey may have resulted in breeding territories being missed due to the absence of territorial birds (see Discussion).

Common name	Observed	Predicted
Hooded Plover	12	0
Red-capped Plover	9	2 - 3
Pied Oystercatcher	16	3 - 4
Sooty Oystercatcher	12	3
Fairy Tern	0	0
Little Tern	0	0
Totals	**49**	**est 5 - 10**

Table 3. Minimum estimated additional breeding pairs for the focal species on Robbins Island for the south coast foreshore between Black Phil's Point and the landing point approximately 3km west of Cape Elie (estimated to be approximately 20km) that was not surveyed on foot. These estimates are based on a visual assessment of the foreshore (see Methods).

3. Regional breeding populations

Surveys of the six focal species (see Introduction) have previously been undertaken on Walker Island (3 February 2002), Perkins Island (incomplete survey on 10 October 2006) and Anthony Beach (11 October 2006). Anthony Beach and Perkins Island form the southern extent, and Robbins Island the northwest extent, of Perkins Bay, Figures 3a – 3d. The southwest and south coasts of Perkins Island have not been surveyed to date, and the east and south coasts of Walker Island were surveyed without using GPS.

When combined with the contemporary survey data, these population data provide an initial minimum estimate of the regional breeding populations for Hooded and Red-capped Plovers and for Pied and Sooty Oystercatchers. All surveys were undertaken by the author of the present study using the same survey protocols. Table 4 presents the data from these surveys, and the initial minimum estimate of the regional breeding populations.

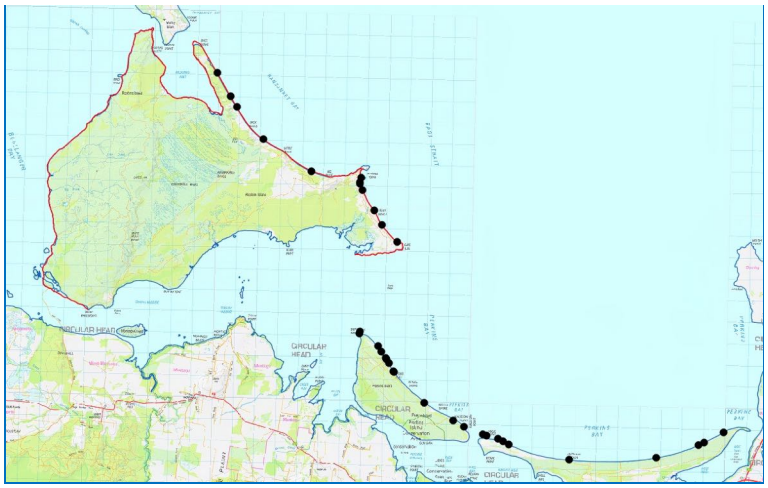


Figure 3a. Map of Perkins Bay and Robbins Island showing nesting territories of Hooded Plover (black symbols). Base map 1:100,000 Tasmap maps. Survey dates and data are shown in Table 4.

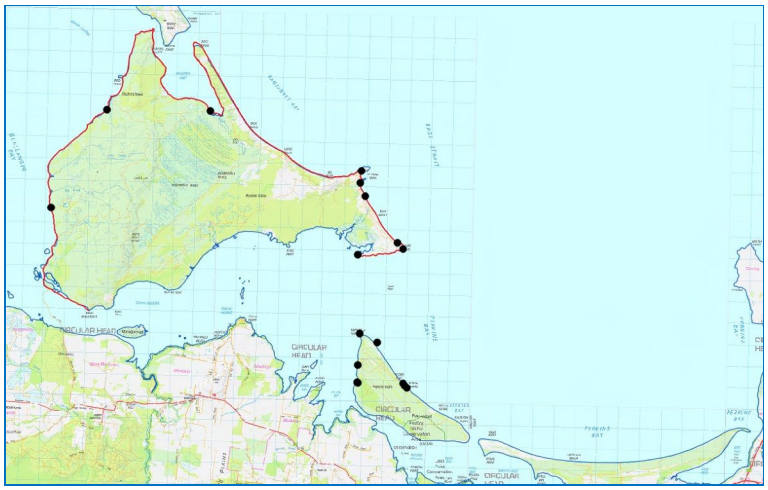


Figure 3b. Map of Perkins Bay and Robbins Island showing nesting territories of Red-capped Plover (black symbols). Base map 1:100,000 Tasmap maps. Survey dates and data are shown in Table 4

Figure 3c. Map of Perkins Bay and Robbins Island showing nesting territories of Pied Oystercatcher (black symbols). Base map 1:100,000 Tasmap maps. Survey dates and data are shown in Table 4.

Figure 3d. Map of Perkins Bay and Robbins Island showing nesting territories of Sooty Oystercatcher (black symbols). Base map 1:100,000 Tasmap maps. Survey dates and data are shown in Table 4.

Locality - GPS nesting surveys	date	km	HOPL	RCPL	PIOY	SOOY	FATE	LITE
Robbins I (this study)	18-20 Feb 2018	48.8	12	9	16	12	0	0
Walker I (incomplete)	3 Feb 2002	6.0	8	1	2	1	0	0
Perkins I (incomplete)	10 Oct 2006	9.7	12	8	15	0	0	0
Anthony Beach	11 Oct 2006	12.3	10	0	17	0	0	0
Totals		**76.8**	**42**	**18**	**50**	**13**	**0**	**0**

Table 4. Estimated regional breeding populations (pairs) for Robbins I (this study), and adjacent Perkins Bay sites. Species codes as per Table 1; see Figures 3a – 3d for maps of the survey data.

4. Historical and recent data

Ashby (1991) provides limited historical numerical data on these species for five localities in the Robbins Passage/Boullanger Bay wetlands in the months of February ('summer') and July ('winter') from 1987 to 1991. Numerical data from summer and winter counts are available for Bird Point, "Five Islets" (unofficial place name), Kangaroo Island, Perkins Island and Montagu Island.

Ashby (1991) described these as the, "five principle (*sic*) known roosts in the vicinity of Robbin's Island", and reported that Hooded Plovers are, "sprinkled thinly" on northeast Robbins Island, but gave no further information on nesting sites for Red-capped Plover, Pied and Sooty Oystercatchers. No quantitative data are known from these studies in the 1980s and 1990s.

Relatively fewer records for the focal species are held by BirdLife Tasmania for Robbins Island (or most other localities in the Robbins Passage/Boullanger Bay wetlands) beyond the annual Summer and Winter Wader Counts that started in the late 1990s (see Woehler 2018a), compared to most coastal areas of Tasmania.

The BirdLife Tasmania records include records of 190 Pied Oystercatchers and up to 180 Sooty Oystercatchers present at Bird Point during winter months. A flock of 56 Fairy Terns was observed at Bird Point in the 2001/02 summer, comparable with the range of recent counts for this species (Table 5). Other records indicate that the results of the February 2018 survey for resident shorebird species are consistent with the limited data set for the island obtained since the 1980s to present.

5. Fairy and Little Terns

The absence of observations of Fairy and Little Terns during the February 2018 survey was surprising in light of their reported abundance in all annual BirdLife Tasmania Summer Wader Counts (SWCs) for Robbins Passage/ Boullanger Bay.

During the most recent SWC held on 30 January 2018, 20 and 30 Fairy Terns were recorded at Back Banks and at Bird Point, respectively (BirdLife Tasmania unpubl. data), and one Little Tern was reported from Back Backs (Table 5). These locations were visited during the February survey. The reason(s) for their absence from the February survey are presently unknown, but both species are particularly sensitive to disturbance and both are migratory. Their annual breeding efforts in Tasmania are highly variable, and the mechanisms responsible are not presently understood.

Summer Wader Count	Fairy Tern			Little Tern		
	Robbins I	RB/BB total	%	Robbins I	RB/BB total	%
2012	45	154	29	4	8	50
2013	0	46	0	0	4	0
2014	81	131	62	12	50	24
2015	1	56	2	0	0	0
2016	1	40	3	0	22	0
2017	30	178	17	0	19	0
2018	70	232	30	1	3	33

Table 5. Counts of Fairy and Little Terns from BirdLife Tasmania Summer Wader Counts (SWCs) for 2012 – 2018 inclusive. Data for all sites on Robbins Island are shown, as are the total counts for the Robbins Passage/Boullanger Bay wetlands (RPBB). The proportion of terns recorded on Robbins Island for each SWC are shown as percentages.

Discussion

1. Robbins Island breeding populations and their national and international significance

The current survey of Robbins Island contributes novel census and mapping data to a broad statewide data set on the distribution and abundance of beach-nesting shorebirds and small terns in Tasmania.

Synthesis reports for similar previous surveys of other coastal shorebird and small tern populations have been prepared for the west coast and King Island (Woehler and Ruoppolo 2013a), northwest coast (Woehler 2015), northeast coast and Flinders Island (Woehler and Ruoppolo 2013b), Moulting Lagoon (Woehler and Ruoppolo 2014) and Pitt Water Orielton Lagoon (Woehler 2013). Surveys have been undertaken for Maria Island (EJ Woehler, unpubl data) and the southeast Tasmanian coast (EJ Woehler, unpubl. data).

These surveys' data have shown clearly that Tasmania *in toto* supports nationally- and internationally-significant populations of resident shorebirds, namely Hooded Plover (eastern sub-species), Pied and Sooty Oystercatchers. Based on current breeding population data, Tasmania supports approximately 40% - 50% of the global populations of these species and sub-species (BirdLife Tasmania unpubl. data and this study, Delaney and Scott 2006, Garnett et al. 2011, Wetlands International 2012a, 2012b, Garnett and Franklin 2014, Hansen et al. 2014, Taylor et al. 2014).

In 2014, the Eastern subspecies of the Hooded Plover *Thinornis rubricollis rubricollis* was listed as Vulnerable under the EPBC Act. The Conservation Advice is available at http://www.environment.gov.au/biodiversity/threatened/species/pubs/66726-conservation-advice.pdf The Conservation Advice identifies an Australian (and global) population of, "3000 mature individuals" decreasing at between 10% and 20% over three generations (see also Garnett et al. 2011); only the eastern subspecies of the Hooded Plover is present in Tasmania.

The 12 breeding pairs of Hooded Plovers present on Robbins Island (Table 2) represent approximately 0.8% of the (2010) estimated population of 3000 individuals. As such, this population is of national significance, and should the estimate for the eastern Hooded Plover decrease from 3000 birds, the Robbins Island population may exceed the 1% threshold for international significance (Garnett et al. 2011).

Based on the available data for Robbins Island and adjacent Perkins Bay localities (Table 4), the regional population on these four localities (estimated 42 pairs) represent 2.8% of the (2010) estimated population of 3000 individuals. As such, the regional Perkins Bay Hooded Plover breeding population is of international significance (Figure 3a).

A similar synthesis cannot be undertaken readily for Red-capped Plover, as the species is a generalist and will readily move inland under a range of conditions. Thus, coastal surveys will likely under-estimate the local abundance of the species. With no comparable survey data for the species on Robbins Island, it is not possible to assess whether the results from the February 2018 survey are representative of the distribution and abundance of Red-capped Plovers on Robbins Island (Figure 3b).

The breeding population of Pied Oystercatchers located on Robbins Island (16 pairs, with a potential maximum of 20 pairs, Table 3) represent 0.3% and 0.4% of the Australian population estimate of between 11,000 and 12,000 birds (Delaney and Scott 2006, Taylor et al. 2014). As such, Robbins Island is of national significance for the species. The regional population on Robbins Island and adjacent Perkins Bay localities (Figure 3c, Table 4, estimated 50 pairs) represents 0.9% of the global population estimate and almost meets the 1% criterion for international significance.

Taylor et al. (2014) calculated a preliminary estimate of the size of the breeding population of the Pied Oystercatcher, based on the proportions of breeding and non-breeding birds in flocks. They estimated that the breeding population was between 4080 and 4760 breeding pairs, representing between 34% and 40%

of the total estimated Australian population. Robbins Island supports an estimated 0.4% - 0.5% of the breeding population (16 – 20 pairs) and the Perkins Bay regional population estimate of 50 pairs is 1.1% of the estimated Australian breeding population (Taylor et al. 2014).

As the Robbins Island and Perkins Bay surveys were primarily undertaken on sandy foreshores, estimates for breeding Sooty Oystercatchers will be conservative and under-estimate their local abundance as individuals of the species typically nest on off-shore islands and on rocky foreshores (Hansen et al. 2014). These habitats are under-represented in the BirdLife Tasmania surveys, so the regional estimates (Table 4, Figure 3d) must be considered as the minimum for the species in the region.

Winter counts of roosting Sooty Oystercatchers obtained during annual counts will provide better regional estimates of the total population but will be unable to provide data on the breeding population, *sensu* Ashby (1991). Hansen et al. (2014) documented the Robbins Passage/Boullanger Bay to support 7% of the southern sub-species *H. f. fuliginosus* in Winter counts and 6% in Summer counts.

At present there are no data available on the relative proportions of breeding and non-breeding Sooty Oystercatchers (Hansen et al. 2014) as there are for Pied Oystercatcher (Taylor et al. 2014), but they are likely to be similar given both species are in the same genus. In light of their breeding habitat preferences and the under-representation of these habitats in the current data set, it is not possible to generate estimates of the Robbins Island and Perkins Bay breeding populations in national contexts.

The south coast of Robbins Island is the most likely area to support nesting by Sooty Oystercatchers, based on a visual assessment at the start of the current survey and the similarity of this foreshore to the western foreshore of Robbins Island (EJW pers. obs). The estimated 20km of foreshore can be surveyed in 2018/19 if required. Based on the visual assessment, the southern foreshore is expected to likely support fewer than 10 breeding pairs of resident shorebirds (Table 3), and this is not expected to alter the results and their interpretation significantly in light of the limitations to the current data set noted above.

The Robbins Island survey was undertaken in mid-February, which is towards the end of the breeding season for resident shorebirds in Tasmania. The distribution of the individuals observed (largely in pairs) and their behaviours (eg territorial defence, wing distraction) indicated that some shorebirds were still on their breeding territories at the time of the survey, so the mapping data reflect the minimum distribution and abundance of resident shorebirds' 2017/18 breeding efforts.

It is believed that the observations of more than 70 Pied Oystercatchers feeding in the shallows and on exposed seagrass meadows in Mosquito Inlet on 19 February (EJW and M Skerritt, pers. obs) includes breeding birds absent from their breeding territories on adjacent foreshores. The absence of Pied Oystercatchers from "*Seven Mile Beach*" between Big Bluff and Back Banks facing Ransonnet Bay, despite suitable nesting habitat being present can be explained by greater food availability in, and/or a feeding preference for Mosquito Inlet. Feeding adult Pied Oystercatchers from adjacent territories will tolerate other birds once the breeding season has established (M Newman, pers. comm.).

The low tides daily during the surveys occurred between late-morning and early afternoon, exposing extensive areas of inter-tidal habitat including seagrass meadows in which shorebirds and waterfowl could feed. Observations of more than 350 Black Swan (*Cygnus atratus*), 200 Chestnut Teal (*Anas castanea*), 340 Pacific Gull (*Larus pacificus*) and 200 Silver Gull (*Chroicocephalus novaehollandiae*) feeding in Mosquito Inlet reinforces the significant value of the area as a significant feeding resource to a broad spectrum of birds. Based on the survey data, Mosquito Inlet does not appear to be an important area for nesting by resident shorebirds.

Surveys for breeding territories of resident shorebirds in Tasmania are ideally undertaken in October and November, coincident with the onset and early stages of species' breeding seasons. The late timing of the current survey increases the possibility that some breeding efforts had completed and the birds had moved

off their breeding territories before the February 2018 survey. Thus, the survey results obtained here must be considered conservative, and may have under-estimated the breeding population of Pied Oystercatchers on Robbins Island. It is possible that numbers of Pied and Sooty Oystercatcher breeding territories are higher earlier in the season.

2. Meta-populations and habitat use by shorebirds in the Robbins Passage/Boullanger Bay wetlands complex

The breeding population of the focal species are believed to comprise species-specific meta-populations. A meta-population can be considered a population of populations (Levins 1969) that are spatially separated in a fragmented habitat but interact at some level through processes such as immigration. Dispersion of fledglings is critical for their survival, and the distances between and amongst suitable breeding habitat in the Robbins Passage/Boullanger Bay wetlands for these species would not present barriers to the post-breeding season dispersion in these species.

Four of the focal species utilise the Robbins Passage/Boullanger Bay wetlands for nesting, feeding and roosting (resting) throughout the year. Hooded and-Red-capped Plovers and Pied and Sooty Oystercatchers remain in the wetlands year-round (Spruzen et al. 2008a, 2008b). Breeding shorebirds will remain within their territories during the breeding season but will be more mobile during the non-breeding months as they are less tied to their foreshore territories during the non-breeding season. These species often form winter flocks comprised of breeding and non-breeding adults, and pre-breeding juveniles that can persist over extended periods before the next breeding season commences.

An unknown proportion of the Fairy and Little Terns in the Robbins Passage/Boullanger Bay wetlands migrate north to the Australian mainland and farther, although both species have been reported in WWCs in the wetlands (BirdLife Tasmania unpubl. data). Fairy and Little Terns predominantly use the Robbins Passage/Boullanger Bay wetlands for nesting, feeding and roosting (resting) during the Spring to Autumn months, and the terns present during Winter months will feed and roost in the wetlands between breeding seasons.

The shorebirds and terns present within the wetlands throughout the year will respond to disturbance from vehicles, dogs, livestock and human recreational activities as best they can, depending on the time of year. Leaving a breeding territory with eggs or dependent young will result in breeding failure but can occur. Non-breeding birds are also less restricted in their foraging locations, and may move around adjoining areas as tide conditions influence food availability. Avoiding or minimising exposure to poor weather conditions, particularly during the winter months will see birds moving around seeking shelter in the wetlands.

All focal species are able to disperse or migrate over substantial distances, with maxima recorded for banded individuals comprising Hooded Plover (330km), Red-capped Plover (813km), Pied Oystercatcher (1408km), Sooty Oystercatcher (585km), Fairy Tern (608km) and Little Tern (8641km), (http://www.environment.gov.au/topics/science-and-research/bird-and-bat-banding/banding-data/search-abbbs-database).

Sandy foreshores are used for nesting by five of the six focal species (Sooty Oystercatcher nest on rocky foreshores, Hansen et al. 2014), and sandy foreshores and intertidal areas are used for feeding and roosting by Hooded and Red-capped Plovers and Pied and Sooty Oystercatchers (Spruzen et al. 2008a, 2008b). The distribution, diversity and abundance of invertebrate prey for shorebirds are influenced by a broad spectrum of biotic and abiotic factors, resulting in a heterogenous or patchy distribution of prey in the foreshore and intertidal areas.

Spruzen et al. (2008a) investigated the relationship between resident and migratory shorebirds and their prey at four locations in the Robbins Passage/Boullanger Bay wetlands complex. The two sites closest to Robbins Island were Robbins Passage on the south coast of Robbins Island and Shipwreck Point on

Perkins Island. The other sites were West Beach and East Inlet near Stanley.

The two studies found that resident and migratory shorebirds were distributed non-randomly at the four study sites. There were strong correlations between invertebrate biomass and abundance and shorebird feeding distributions, and that these relationships varied as a function of the spatial scales of the analyses (Spruzen et al. 2008a, 2008b). In the absence of disturbance to foraging behaviour by shorebirds in the complex, the distribution and abundance of resident and migratory shorebirds provide a proxy to the distribution, diversity and abundance of their invertebrate prey (Spruzen et al. 2008a).

Fairy and Little Terns feed in shallow waters close to shore; proximity of feeding sites to colonies ensures higher breeding success by reducing the travel time between their nest site and feeding site.

The various areas of suitable breeding, feeding and roosting habitats in the Robbins Passage/Boullanger Bay wetlands form a network of sites that combine to provide alternatives, options and opportunities for the breeding and non-breeding populations of the focal species to maintain their presence in the wetlands. Successful breeding produces fledglings able to occupy territories if and when they become available. The various alternatives must be present for feeding and roosting sites if the preferred sites are unavailable from disturbance or poor weather conditions etc.

Poor coastal management or the fragmentation and loss of suitable habitat will see the focal species no longer able to breed or feed in the Robbins Passage/Boullanger Bay wetlands. It is critical that the Robbins Passage/Boullanger Bay wetlands must be seen and managed as a single 'unit', rather than as a series of disconnected foreshore areas used by breeding and feeding by resident shorebirds and small terns to ensure their survival and persistence into the future.

3. Important Bird Areas (IBAs)

An international program to identify areas of importance to birds was initiated by BirdLife International using standard, internationally-agreed and internationally-applied criteria for all area assessments. The Important Bird Area (IBA) programme identified, monitors and protects a global network of IBAs for the conservation of the world's birds and other wildlife. Extensive details, maps and additional information are available at http://www.birdlife.org/worldwide/programmes/sites-habitats-ibas-and-kbas

IBAs overlap with Ramsar sites and their criteria for selection, but the IBA selection criteria include all species of birds not just waterbirds. Briefly, the criteria used to identify IBAs are:

1. **Globally threatened species (where the** site is known or thought regularly to hold significant numbers of a globally threatened species, or other species of global conservation concern),
2. **Restricted-range species (where the** site is known or thought to hold a significant component of a group of species whose breeding distributions are constrained, such as endemic species),
3. **Biome-restricted species (where the** site is known or thought to hold a significant component of the group of species whose distributions are largely or wholly confined to one biome), and
4. **Congregatory species (where the site supports >1% or >20,000 individuals of congregatory species of waterbirds, seabirds or terrestrial species).**

To date, approximately 12,000 IBAs have been identified around the World, and they represent the largest global network of important sites for biodiversity. Full details and descriptions are available at http://www.birdlife.org/datazone/info/ibacritglob

The identification of Australian IBAs was undertaken by BirdLife Australia and all state branches, applying the international criteria to existing survey data. Full details of the project are available at http://birdlife.org.au/projects/important-bird-areas As of 2014, 314 IBAs have been identified in Australia, of which 40 are located in Tasmania. Details of the Australian program were published by Dutson et al. (2009), available at http://birdlife.org.au/documents/OTHPUB-IBA-supp.pdf

Data for the three IBAs are available at http://datazone.birdlife.org/site/factsheet/north-west-tasmanian-coast-iba-australia, http://datazone.birdlife.org/site/factsheet/robbins-passage-and-boullanger-bay-iba-australia and http://datazone.birdlife.org/site/factsheet/hunter-island-group-iba-australia

The national and international significances of the Robbins Passage/Boullanger Bay wetlands, including Robbins Island, have been well established for migratory shorebirds since initial analyses of the available population data were undertaken in support of the areas nomination as an Important Bird Area (IBA) in 2009 (Dutson et al. 2009). The nomination included resident species, but with fewer data available and largely based on counts of roosts (resting sites) that comprised breeding and non-breeding individuals.

As the census and survey datasets for the wetlands increases, so there is an emerging recognition that the Robbins Passage/Boullanger Bay wetlands, including Robbins Island, are similarly of national and international significance for breeding populations of resident shorebirds at a finer resolution for the population than in the original nomination. In light of the results of this survey (Figures 2 and 3, Tables 1 and 4), it may be appropriate to include the eastern foreshore of Robbins Island into the Robbins Passage & Boullanger Bay IBA (Figure 4) recognising the need to protect breeding, feeding and roosting habitats in the wetlands. The previous absence of data from Robbins Island at the time of identifying candidate IBAs prevented its inclusion.

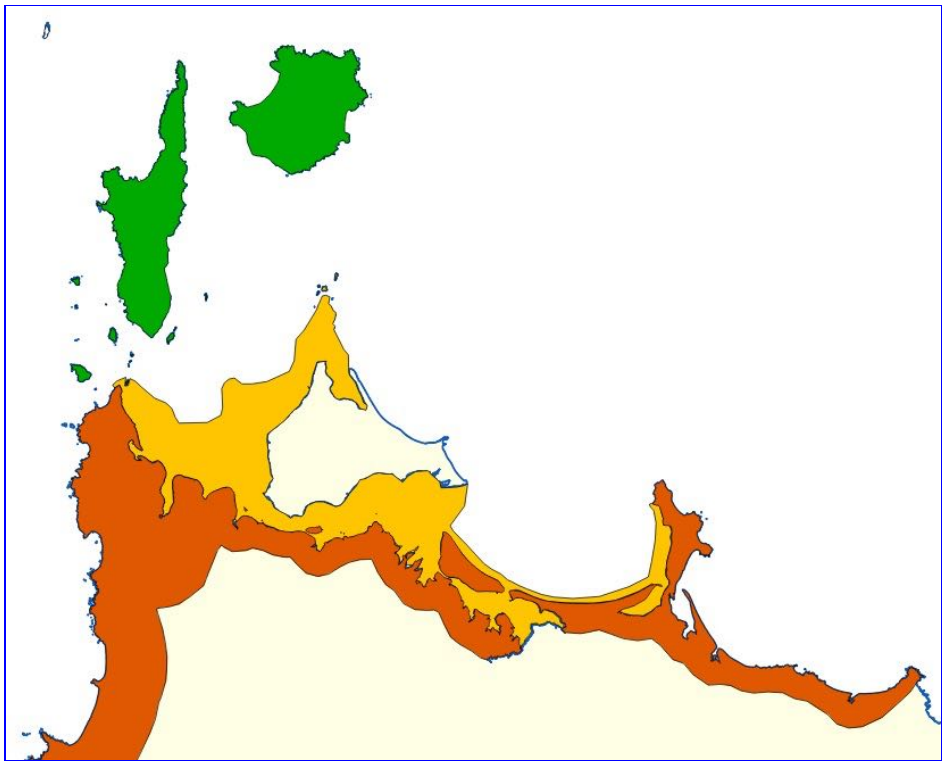


Figure 4. Map showing the three Key Biodiversity Areas (KBAs, formerly Important Bird Areas, IBAs) in northwest Tasmania. They are Hunter Island Group (green), Robbins Passage & Boullanger Bay (yellow) and Northwest Tasmanian Coast (orange).

Acknowledgements

BirdLife Tasmania thanks David Pollington and Madeleine Skerritt (UPC Renewables) for their support for the survey and data syntheses, and Matt Davis (GHD) who commissioned the surveys. Madeleine Skerritt and Matt Davis participated in the field surveys. Hazel Britton provided summaries of the tern data from BirdLife Tasmania Summer Wader Counts. Comments from Richard Ashby and Dr Mike Newman, BirdLife Tasmania improved the earlier draft.

References cited

Ashby R 1991. Waders of far north-west Tasmania. The Stilt 19, 44-49.

Bock A, Phillips MR, Woehler E 2016. The role of beach and wave characteristics in determining suitable habitat for three resident shorebird species in Tasmania. Journal of Coastal Research (Special Issue) 75, 358 – 363

Commonwealth of Australia 2017. *EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species*. Canberra 24pp.

Delaney S, Scott D 2006. *Waterbird population estimates*. 4th Edition, Wetlands International, Wageningen, The Netherlands.

Dutson G, Garnett S, Gole C 2009. *Australia's Important Bird Areas: Key sites for bird conservation*. Birdlife Australia. (RAOU) Conservation Statement 15.

Garnett S, Franklin D (eds) 2014 *Climate change adaptation plan for Australian birds*. CSIRO.

Garnett ST, Szabo JK, Dutson G 2011. *The Action Plan for Australian Birds 2010*. Birds Australia, CSIRO Publishing, Melbourne.

Hansen BD, Minton CDT, Harrison AE, Jessop R 2014. Conservation assessment of the Sooty Oystercatcher *Haematopus fuliginosus*. International Wader Studies 20: 161–172.

Hansen BD, Fuller RA, Watkins D, Rogers DI, Clemens RS, Newman, M, Woehler EJ, Weller DR 2016. *Revision of the East Asian - Australasian Flyway population estimates for 37 listed migratory shorebird species*. Unpublished report for the Department of the Environment, BirdLife Australia, Melbourne, 88pp.

Holdsworth MC and Park P 1993. 1992 survey of the Hooded Plover in Tasmania. The Stilt 22, 37-40.

Levins R 1969. Some demographic and genetic consequences of environmental heterogeneity for biological control. Bulletin of the Entomological Society of America 15, 237–240

Newman OMG and Patterson RN 1984. A population survey of the Hooded Plover (*Charadrius rubricollis*) in Tasmania, October 1982. An Occasional Stint 3, 1-6.

Spruzen FL, Richardson AMM, Woehler EJ 2008a. Influence of environmental and prey variables on low tide shorebird habitat use within the Robbins Passage wetlands, Northwest Tasmania. Estuarine, Coastal and Shelf Science 78, 122-134. http://dx.d:10.1016/j.ecss.2007.11.012

Spruzen FL, Richardson AMM, Woehler EJ 2008b. Spatial variation of intertidal macro-invertebrates and environmental variables in Robbins Passage wetlands, NW Tasmania. Hydrobiologia 598, 325-342. http://dx.doi.org/10.1007/s10750-007-9166-2

Taylor IR, Newman OMG, Park P, Hansen B, Minton CDT, Harrison A, Jessop R 2014. Conservation assessment of the Australian Pied Oystercatcher *Haematopus longirostris*. International Wader Studies 20: 116–128.

Wetlands International, 2012a. Waterbird Population Estimates, Fifth Edition. Summary Report. Wetlands International, Wageningen, The Netherlands https://www.wetlands.org/publications/waterbird-populations-estimates-fifth-edition/

Wetlands International 2012b**.** *Waterbird Population Estimates online database* (http://wpe.wetlands.org/)

Woehler EJ 2013. *Resident shorebirds and seabirds of the Pitt Water Orielton Lagoon Nature Reserve and Ramsar Site*. Report to NRM South and PWS, February 2013. BirdLife Tasmania Technical Report 2013 - 01, 26pp. A public (edited) version of this report was published by NRM South, available at (*http://www.nrmsouth.org.au/uploaded/287/15131893_41residentshorebirdsandse.pdf*) and was subsequently published in Tasmanian Bird Report 36, 40 - 58 (2014).

Woehler EJ 2015. *Resident Shorebirds of Cradle Coast NRM 2014/15, Stanley to Narawntapu*. Report to Cradle Coast NRM. BirdLife Tasmania Technical Report 2015 - 01, 113 pp.

Woehler EJ 2016. *Coastal bird values, Chain of Lagoons to Bicheno: An assessment of the distribution and abundance of resident and migratory shorebirds and terns.* Report to the Great Eastern Trail Project. BirdLife Tasmania Technical Report 2016 – 02, 25pp.

Woehler EJ 2017. *A review of the population status and trends of Hooded Plovers, Little Penguins and Short - tailed Shearwaters on Bruny Island.* Report to Kingborough Council, April 2017. BirdLife Tasmania Technical Report 2017 – 05, 25pp.

Woehler 2018a Migratory shorebirds of the Robbins Passage/Boullanger Bay wetlands complex, northwest Tasmania. Report to GHD, May 2018. BirdLife Tasmania Technical Report 2018 – 07.

Woehler EJ 2018b. *Shorebird values at the Meredith River, Swansea*. Report to Glamorgan Spring Bay Council, BirdLife Tasmania Technical Report 2018-03, 5pp

Woehler EJ, Park P 1997. *Interim report on the status of Hooded Plovers* Thinornis rubricollis *in Tasmania*. Birds Tasmania Technical Report 1997-01, 5pp.

Woehler EJ, Ruoppolo V 2013a. *Shorebird and small tern surveys 2012/13*. Report to Cradle Coast NRM, May 2013. BirdLife Tasmania Technical Report 2013 - 03, 13pp. Subsequently published in Tasmanian Bird Report 36, 22 - 29 (2014).

Woehler EJ, Ruoppolo V 2013b. *Distribution and abundance of shorebirds of the NRM North region, 2012/13 with estimates of regional breeding populations*. Report to NRM North, May 2013. BirdLife Tasmania Technical Report 2013 - 04, 13pp. Subsequently published in Tasmanian Bird Report 36, 30 - 39 (2014).

Woehler EJ, Ruoppolo V 2014. *Resident and migratory shorebirds of the Moulting Lagoon Game Reserve Ramsar Site*. Report to NRM South and PWS, May 2014. BirdLife Tasmania Technical Report 2014 - 04, 29 pp.

Appendix 1. Breeding territories of resident shorebirds, Robbins Island, February 2018. 'seq' refers to the BirdLife Tasmania reference for the record. The number(s) of individuals are shown for each record, as is the position expressed as latitude and longitude following conversion from UTM coordinates collected in the field (see Methods).

seq	Locality	Date	Species	#	Lat °S	Lon °E
5783	Landing point to Cape Elie	18-Feb-18	Red-capped Plover	2	-40.7170940	145.0425250
5784	Landing point to Cape Elie	18-Feb-18	Sooty Oystercatcher	2	-40.7174480	145.0442786
5785	Landing point to Cape Elie	18-Feb-18	Red-capped Plover	2	-40.7146974	145.0676097
5786	East Beach	18-Feb-18	Hooded Plover	5	-40.7119382	145.0642210
5787	East Beach	18-Feb-18	Red-capped Plover	1	-40.7119382	145.0642210
5788	East Beach	18-Feb-18	Hooded Plover	2	-40.7047298	145.0560613
5789	East Beach	18-Feb-18	Hooded Plover	2	-40.6988672	145.0518763
5790	East Beach	18-Feb-18	Red-capped Plover	1	-40.6924120	145.0467507
5791	East Beach	18-Feb-18	Hooded Plover	2	-40.6901859	145.0450880
5792	East Beach	18-Feb-18	Hooded Plover	2	-40.6876885	145.0438948
5793	East Beach	18-Feb-18	Hooded Plover	2	-40.6868250	145.0439674
5794	East Beach	18-Feb-18	Red-capped Plover	4	-40.6868250	145.0439674
5795	East Beach	18-Feb-18	Sooty Oystercatcher	2	-40.6868250	145.0439674
5796	East Beach	18-Feb-18	Hooded Plover	2	-40.6848971	145.0444853
5797	East Beach	18-Feb-18	Red-capped Plover	2	-40.6818909	145.0446323
5798	Guyton Point to Back Banks	18-Feb-18	Sooty Oystercatcher	2	-40.6828487	145.0410900
5799	Guyton Point to Back Banks	18-Feb-18	Hooded Plover	4	-40.6823115	145.0170145
5800	Guyton Point to Back Banks	19-Feb-18	Hooded Plover	2	-40.6689196	144.9906159
5801	Guyton Point to Back Banks	19-Feb-18	Hooded Plover	2	-40.6554725	144.9757616
5802	Guyton Point to Back Banks	19-Feb-18	Hooded Plover	2	-40.6508982	144.9722690
5803	Guyton Point to Back Banks	19-Feb-18	Hooded Plover	2	-40.6410602	144.9650223
5804	Mosquito Inlet	19-Feb-18	Pied Oystercatcher	1	-40.6356697	144.9546151
5805	Mosquito Inlet	19-Feb-18	Pied Oystercatcher	5	-40.6372873	144.9559256
5806	Mosquito Inlet	19-Feb-18	Sooty Oystercatcher	4	-40.6409213	144.9591967
5807	Mosquito Inlet	19-Feb-18	Pied Oystercatcher	2	-40.6469555	144.9627026
5808	Mosquito Inlet	19-Feb-18	Red-capped Plover	1	-40.6568470	144.9607102
5809	Mosquito Inlet	19-Feb-18	Sooty Oystercatcher	6	-40.6375411	144.9352602
5810	west coast	20-Feb-18	Pied Oystercatcher	4	-40.6232470	144.9257937
5811	west coast	20-Feb-18	Sooty Oystercatcher	4	-40.6232470	144.9257937
5812	west coast	20-Feb-18	Pied Oystercatcher	4	-40.6240945	144.9218306
5813	west coast	20-Feb-18	Sooty Oystercatcher	4	-40.6240945	144.9218306
5814	west coast	20-Feb-18	Sooty Oystercatcher	4	-40.6260263	144.9195599
5815	west coast	20-Feb-18	Pied Oystercatcher	4	-40.6279517	144.9189326
5816	west coast	20-Feb-18	Pied Oystercatcher	4	-40.6300471	144.9182409
5817	west coast	20-Feb-18	Sooty Oystercatcher	5	-40.6317283	144.9175621
5818	west coast	20-Feb-18	Pied Oystercatcher	2	-40.6351045	144.9159673
5819	west coast	20-Feb-18	Pied Oystercatcher	4	-40.6428017	144.9122274
5820	west coast	20-Feb-18	Sooty Oystercatcher	3	-40.6505712	144.9065212
5821	west coast	20-Feb-18	Pied Oystercatcher	1	-40.6513369	144.9060241
5822	west coast	20-Feb-18	Red-capped Plover	2	-40.6562729	144.9035278
5823	west coast	20-Feb-18	Pied Oystercatcher	4	-40.6750521	144.8753373
5824	west coast	20-Feb-18	Sooty Oystercatcher	4	-40.6750521	144.8753373
5825	west coast	20-Feb-18	Pied Oystercatcher	2	-40.6801070	144.8710236
5826	west coast	20-Feb-18	Pied Oystercatcher	4	-40.6920002	144.8721597
5827	west coast	20-Feb-18	Red-capped Plover	2	-40.6972459	144.8728212
5828	west coast	20-Feb-18	Pied Oystercatcher	3	-40.7300892	144.8694662
5829	west coast	20-Feb-18	Pied Oystercatcher	2	-40.7330052	144.8761702

seq	Locality	Date	Species	#	Lat °S	Lon °E
5830	west coast	20-Feb-18	Sooty Oystercatcher	1	-40.7330052	144.8761702
5831	west coast	20-Feb-18	Pied Oystercatcher	2	-40.7374930	144.8875618

Migratory shorebirds of the Robbins Passage/Boullanger Bay wetlands complex, northwest Tasmania.

Report to GHD, May 2018.

Dr Eric J Woehler, BirdLife Tasmania

Executive Summary

This synthesis provides evidence that the Robbins Passage/Boullanger Bay wetlands complex in northwest Tasmania typically support approximately 10,000 - 12,000 migratory shorebirds during the summer months (October to March inclusive), and approximately 2000 - 4400 migratory shorebirds during winter months (April to September, inclusive). The wetlands support 3000 – 4000 resident shorebirds year-round, but these estimates are conservative as the coordinated Summer and Winter Wader Counts are focussed on migratory species' roosts. At least two species of migratory shorebirds are likely under-counted. The wetlands are the most important area for migratory and resident shorebirds in Tasmania, with more shorebirds present than in the rest of Tasmania combined. Based on the current populations of migratory shorebirds, the wetlands support three species at levels of international significance: Double-banded Plover, Red-necked Stint and Ruddy Turnstone. In addition, five species are present at population levels during Summer months significant at the national level (Curlew Sandpiper, Far Eastern Curlew, Grey Plover, Pacific Golden Plover and Red Knot). The wetlands remain of international significance as an Internationally Important Site for the East Asian – Australasian Flyway.

Bar-tailed Godwits and Ruddy Turnstones at Cape Elie, Robbins I, February 2018.

Document control:		
Written:	EJ Woehler	March 2018
Reviewed:	A Darby* M Newman* M Davis GHD	April 2018
Submitted:	M Davis GHD	May 2018

Introduction

The Robbins Passage/Boullanger Bay wetlands off the northwest coast of Tasmania comprise approximately 100km^2 of inter-tidal mudflats (Ashby 1991). Surveys of shorebird roosts on the foreshores of islands during the late 1980s and early 1990s (Ashby 1991) provided the first evidence of the diversity and abundance of migratory and resident shorebirds present in the area. These early counts were constrained by the capacity of a single observer to visit multiple sites but were of sufficient intensity and frequency to establish the diversity of shorebird species present.

In the late 1990s, BirdLife Tasmania (at the time Birds Tasmania) and the Threatened Species Unit of DPIPWE received funding from the Federal Government's *Natural Heritage Trust* for a shorebird program that included a complete census of the Robbins Passage/Boullanger Bay wetlands in the 1998/99 Summer (Park 1999). Summer counts in 1996/97 and 1998/99 provided the first whole-of-wetlands counts from coordinated surveys by members of BirdLife Tasmania experienced in the identification and counting of shorebirds.

These coordinated counts have continued biennially since, in both Summer (nominally February) and in Winter (July) throughout the Robbins Passage/Boullanger Bay wetlands to present (see Methods for details). Annual reports have been published in the *Tasmanian Bird Report* (eg Woehler and Drake 2017) and are subsequently incorporated into national syntheses by the Australasian Wader Studies Group.

The Robbins Passage/Boullanger Bay wetlands have been recognised to be of international significance by being listed as an Internationally Important Site for the East Asian – Australasian Flyway (EAAF: Bamford et al. 2008: https://www.environment.gov.au/system/files/resources/782ebed5-6bdd-4a41-9759-b60273b52021/files/shorebirds-east-asia.pdf), Conklin et al. (2014) (http://awsassets.wwfhk.panda.org/downloads/wwf_prioritization_finalpdf.pdf) and Hansen et al. (2016) (https://www.environment.gov.au/system/files/resources/da31ad38-f874-4746-a971-5510527694a4/files/revision-east-asian-australasian-flyway-population-sept-2016.pdf).

The wetlands are recognised internationally as a Key Biodiversity Area (KBA) under IUCN guidelines (http://datazone.birdlife.org/site/factsheet/robbins-passage-and-boullanger-bay-iba-australia). The area is listed in the Directory of Important Wetlands in Australia (Chapter 10: http://www.environment.gov.au/water/wetlands/publications/directory-important-wetlands-australia-third-edition).

BirdLife Tasmania was commissioned by GHD in February 2018 to collate the available count data with a view to preparing a synthesis of the migratory shorebirds in the Robbins Passage/Boullanger Bay wetlands, based on data for the period 1998 to 2017 (where available). This synthesis will enable an assessment of the migratory shorebirds in the Robbins Passage/Boullanger Bay wetlands in Tasmanian, national and international contexts. Details of the species' conservation status under the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are also provided.

Methods

1. Field counts, Robbins Passage/Boullanger Bay

The shorebird roosts in Robbins Passage/Boullanger Bay (Figures 1 and 2) have been counted during co-ordinated, near-simultaneous high tide counts in Summer (typically January and February) and Winter (June and July) since 1996. These roosts were first identified by Ashby (1991), Table 1. Not every roost site is visited for every count due to logistic, weather and capacity (numbers of counters available) considerations. Ten sites are considered 'primary' and prioritised for all counts (Table 2).

Figure 1. Map of the Robbins Passage/Boulanger Bay wetlands.

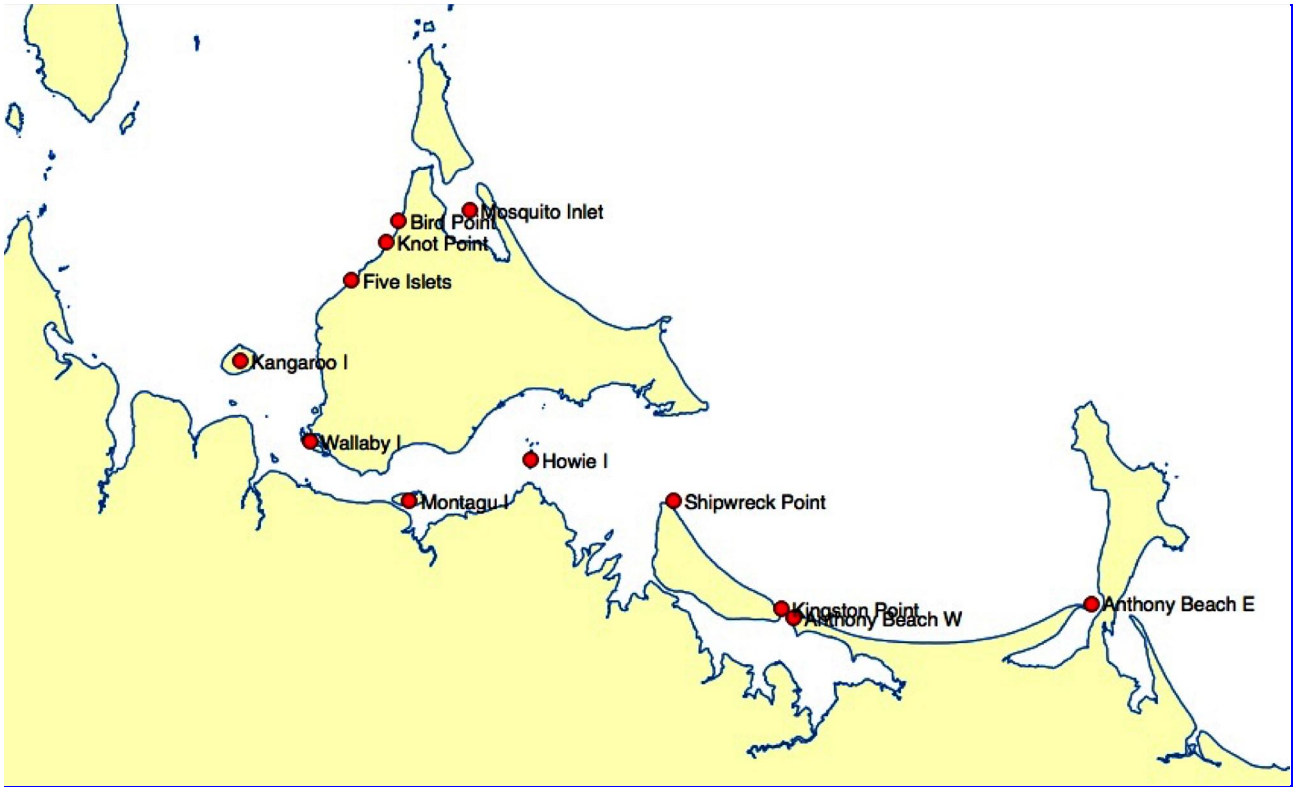


Figure 2. Map of the Robbins Passage/Boulanger Bay wetlands with symbols denoting the locations of 10 primary and two secondary migratory shorebird roosts. See Table 2 for roost coordinates.

Roost	Lat °S	Long °E
Montagu I	-40.7495	144.9178
Kangaroo I	-40.6968	144.8327
Shipwreck Point	-40.7500	145.0501
Wallaby I	-40.7272	144.8676
Anthony Beach W	-40.7942	145.1103
Anthony Beach E	-40.7888	145.2602
Bird Point	-40.6431	144.9125
“Knot Point”	-40.6511	144.9060
“Five Islets”	-40.6657	144.8886
Mosquito Inlet	-40.6392	144.9477
Kingston Point	-40.7907	145.1042
Howie I	-40.7340	144.9787

Table 1. Coordinates of the Robbins Passage/Boullanger Bay wetlands’ roost sites. “Knot Point” and “Five Islets” are unofficial place names (see Figure 2). The upper 10 sites are the primary roost sites, while Kingston Point and Howie I are secondary.

Year	Summer	Winter
1996		
1997	**C**	
1998		
1999	**C**	
2000		
2001		
2002	**C**	
2003	**C**	**C**
2004	**C**	
2005	**C**	**C**
2006		
2007	**C**	
2008		
2009	**C**	
2010	**C**	
2011	**C**	**C**
2012		**C**
2013		
2014		**C**
2015	**C**	**C**
2016	**C**	
2017	**C**	
2018	**C**	
Complete counts	**14**	**6**

Table 2. Co-ordinated counts of the Robbins Passage/Boullanger Bay wetlands’ roost sites, 1996 – 2018 by BirdLife Tasmania. **C** denotes a count of the primary roosts (see Methods and Table 2). There was no count in Winter 1997, and the 2018 Winter Count has not yet been undertaken. All counts are conducted for approximately 2 to 3 hours either side of the selected high tide and are undertaken synchronously at the roosts shown in Figure 2. Complete counts of the complex are deemed to comprise counts at 8 of the 10 primary roosts (Table 1) as used for analyses in this study. Only counts from the 10 primary roost sites were used for analyses.

2. Data collation and syntheses, EPBC status

For most Summer Wader Counts (SWCs) the primary roosts were surveyed, thus obtaining a complete count of the wetlands. Obtaining counts from all roosts during Winter Wader Counts (WWCs) is much more difficult, so fewer complete counts have been obtained in WWCs between 1996 and 2017 inclusive (6 of 21 counts, there was no count attempted in Winter 1997), compared to SWCs between 1996 and 2018 inclusive (14 of 23 counts), Table 2.

Species		Max SWC	# records SWC	Max WWC	# records WWC
Latham's Snipe	*Gallinago hardwickii*	2	4	-	0
Whimbrel	*Numenius phaeopus*	4	5	3	3
Terek Sandpiper	*Tringa cinereus*	3	6	1	1
Grey-tailed Tattler	*Tringa brevipes*	6	15	2	4
Pectoral Sandpiper	*Calidris melanotos*	1	1	-	0
Lesser Sand Plover	*Charadrius mongolus*	27	13	1	1

Table 3. List of the 6 least-frequently recorded migratory shorebirds species in Summer (SWCs) and Winter Wader Counts (WWCs) in the Robbins Passage/Boullanger Bay wetlands by BirdLife Tasmania, 1996 – 2018. Max SWC and Max WWC show the maximum counts from Summer and Winter counts respectively, and the number of years that each species was recorded from all Summer (n = 23) and all Winter (n = 21) counts are also shown.

Species		EPBC Thr	EPBC Mar	EPBC Mig	TSPA
Bar-tailed Godwit	*Limosa lapponica (baueri)*	Vul	X	X	
Common Greenshank	*Tringa nebularia*		X	X	
Curlew Sandpiper	*Calidris ferruginea*	Cr End	X	X	**
Double-banded Plover	*Charadrius bicinctus*		X	X	
Far Eastern Curlew	*Numenius madagascariensis*	Cr End	X	X	End
Great Knot	*Calidris tenuirostris*	Cr End	X	X	
Grey Plover	*Pluvialis squatarola*		X	X	
Pacific Golden Plover	*Pluvialis fulva*		X	X	
Red Knot	*Calidris canutus*	End	X	X	
Red-necked Stint	*Calidris ruficollis*		X	X	
Ruddy Turnstone	*Arenaria interpres*		X	X	
Sanderling	*Calidris alba*		X	X	
Sharp-tailed Sandpiper	*Calidris acuminata*		X	X	

Table 4. List of the 13 most frequently recorded migratory shorebirds species in Summer and Winter Wader Counts in the Robbins Passage/Boullanger Bay wetlands by BirdLife Tasmania, 1996 – 2018, tabulated under EPBC Threatened, Marine and Migratory status. 'Cr End' is Critically Endangered, 'Vul' is Vulnerable, and 'End' is Endangered. ** Curlew Sandpiper is listed but no threat category has been assigned under the Tasmanian *Threatened Species Protection Act 1995* (TSPA).

Only data from complete SWCs and WWCs were used in the analyses and syntheses detailed here (Table 2). This was to avoid generating spurious results when incomplete, and potentially artificially low count data were included in population trend analyses. Mosquito Inlet (11 counts) and Montagu Island (16 counts) were the two sites in the complex that were visited less frequently. Annual count data for the Robbins Passage/Boullanger Bay wetlands were tabulated by species and year, with separate tables for SWCs and WWCs. Six species of migratory shorebirds were identified as infrequent visitors to the wetlands, based on either low counts and/or infrequent records (Table 3).

The Robbins Passage/Boullanger Bay shorebird roost surveys meet the *Survey guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the EPBC Act* (available at

http://www.environment.gov.au/epbc/publications/survey-guidelines-australias-threatened-birds-guidelines-detecting-birds-listed-threatened).

The 13 most frequently observed species of migratory shorebird reported from Summer and Winter Wader Counts in the Robbins Passage/Boullanger Bay wetlands between 1996 and 2018 inclusive are shown in Table 4. These 13 species are hereafter referred to as the focal species for further examination in this analysis.

All of the species of migratory shorebirds seen in the Robbins Passage/Boullanger Bay wetlands are listed under the *Environmental Protection and Biodiversity Act* 1999, either on the Marine Species List (http://www.environment.gov.au/marine/marine-species/marine-species-list) and the Migratory Species List (http://www.environment.gov.au/cgi-bin/sprat/public/publicshowmigratory.pl). Two of the species are listed under the Tasmanian *Threatened Species Protection Act 1995*.

3. Site significance, population trends and EAAF estimates

Two thresholds were used for assessing the national and international significance of migratory species' numbers in the Robbins Passage/Boullanger Bay wetlands. The thresholds have been adopted nationally to identify important sites for migratory shorebird species in Australia (http://www.environment.gov.au/epbc/publications/shorebirds-guidelines). The thresholds for national and international significance are 0.1% and 1% of the current population estimates for the East Asian – Australasian Flyway (EAAF), respectively.

Note that a site that is internationally significant for a species is also nationally significant for the species.

All contemporary EAAF population estimates were obtained from Hansen et al. (2016) and BirdLife Tasmania unpubl. data. Hansen et al. (2016) is available at http://www.environment.gov.au/biodiversity/publications/revision-east-asian-australasian-flyway-population-2016

Common Name	EAAF population estimate (2016)	1% EAAF population	0.1% EAAF population
Bar-tailed Godwit	325,000	3250	325
Common Greenshank	110,000	1100	110
Curlew Sandpiper	90,000	900	90
Double-banded Plover	19,000	190	19
Far Eastern Curlew	35,000	350	35
Great Knot	425,000	4250	425
Grey Plover	80,000	800	80
Pacific Golden Plover	120,000	1200	120
Red Knot	110,000	1100	110
Red-necked Stint	475,000	4750	475
Ruddy Turnstone	30,000	300	30
Sanderling	30,000	300	30
Sharp-tailed Sandpiper	85,000	850	85

Table 5. East Asian – Australasian Flyway (EAAF) population estimates for the 13 focal species (Hansen et al. 2016), with corresponding 1% and 0.1% thresholds for sites of international and of national significance, respectively (see Methods).

Estimates of the population trends for the migratory shorebirds in the Robbins Passage/Boullanger Bay wetlands followed Clemens et al. (2016). Briefly, annual species' totals from complete SWCs and WWCs were log transformed [ln(x)+0.9 where x is the annual species total]; the slope of the correlation expressed as a percentage provides an approximation to the annual percentage change in the species' population.

The means of species' counts from complete SWCs (and WWCs for Double-banded Plover) for the 1996 – 2018 period were used to assess the proportion of EAAF populations recorded in the Robbins Passage/Boullanger Bay counts. This period was deemed appropriate in light of the longevity of the focal species (see http://www.environment.gov.au/topics/science-and-research/bird-and-bat-banding/banding-data/search-abbbs-database).

Results and Discussion

1. Species' population trends

Surveys of roosts sites in the Robbins Passage/Boullanger Bay wetlands have recorded 19 species of migratory shorebirds (Tables 3 and 4), Hansen et al. (2016), BirdLife Tasmania unpubl. data. Annual population counts of 11 of the 13 focal species (Table 4) are decreasing (Figures 3a – m); five of the species' decreases are statistically significant.

Common Name	r^2	Significance	Annual change RP/BB (%)	Annual change Australia (%)	RP/BB %: Australia %
Bar-tailed Godwit	0.7182	$p < 0.01$	-9.5	-3.2	3.0
Common Greenshank	0.1454	NS	-16.2	-2.0	8.1
Curlew Sandpiper	0.3330	$0.05 > p > 0.01$	-9.3	-9.5	1.0
Double-banded Plover *	0.0924	NS	-7.8		
Far Eastern Curlew	0.7908	$p < 0.01$	-14.9	-3.0	5.0
Great Knot	0.0121	NS	2.4	1.4	1.7
Grey Plover	0.1036	NS	-0.9	-2.0	0.5
Pacific Golden Plover	0.0032	NS	0.7	-2.0	-0.4
Red Knot	0.0291	NS	-0.3	-1.7	0.2
Red-necked Stint	0.5246	$p < 0.01$	-1.9	-3.4	0.6
Ruddy Turnstone	0.6260	$p < 0.01$	-6.4	-3.2	2.0
Sanderling	0.0182	NS	-2.3	0.1	-23.0
Sharp-tailed Sandpiper	0.0162	NS	-0.4	-5.7	0.1
Summer Wader Counts	0.3437	$0.05 > p > 0.01$	-1.4		
Winter Wader Counts (all migratory species)	0.1735	NS	-4.0		
Winter Wader Counts excl Double-banded Plover	0.0102	NS	-1.9		

Table 6. Regression coefficients (r^2) for 13 focal species' population trends based on complete SWCs 1996 – 2018, inclusive (*complete WWCs for Double-banded Plover as this is a Winter visitor to southeast Australia and Tasmania). The coefficient and corresponding statistical significance is given (NS = not significant). The percentage change is the slope of the regression expressed as a percentage (Clemens et al. 2016). The regressions for annual totals from complete SWCs and WWCs are also shown (see also Figures 4, 5a and 5b). The regression data for WWCs excluding Double-banded Plover data reflect changes in migratory species from the Northern Hemisphere.

The only species whose annual totals are increasing are Great Knot and Pacific Golden Plover (see below). There are presently insufficient data for the six species in Table 3 to assess trends. Species-specific comments on the 13 focal species follow below.

Bar-tailed Godwit numbers have decreased by 94% in the Robbins Passage/Boullanger Bay wetlands from the peak count of 500 in the 1996 – 2018 period to current estimates (BirdLife Tasmania unpubl. data). The species' totals are decreasing at 9.5% per annum (Table 6), compared to a decrease of 3.2% per annum Australia wide (Clemens et al. 2016); the Tasmanian rate is approximately three times the national rate of decrease in this species. The regression coefficient for Summer Wader Counts of Bar-tailed Godwit is

statistically significant ($p < 0.01$, Table 6).

The current population in the Robbins Passage/Boullanger Bay wetlands does not meet the criteria for national nor international significance (Table 7), Figure 3a. The species is listed as Vulnerable under the *EPBC Act* 1999, and is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4).

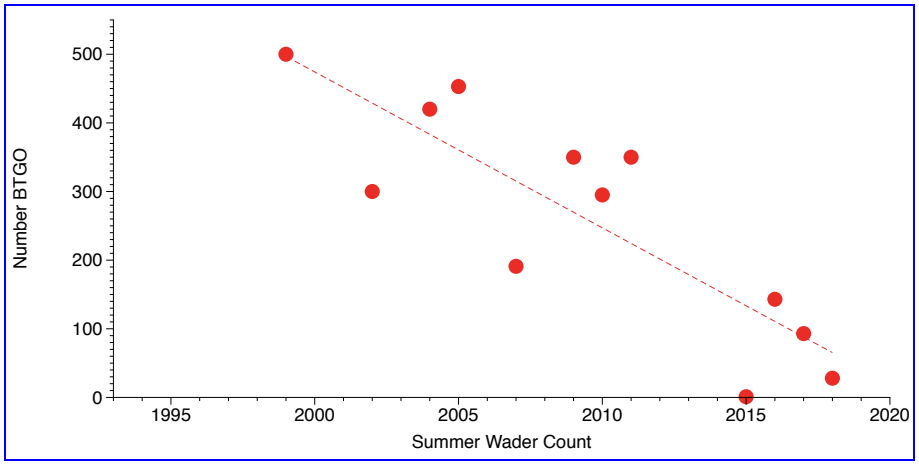


Figure 3a. Plot of Bar-tailed Godwit total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6). The regression coefficient for Summer Wader Counts of Bar-tailed Godwit is statistically significant ($p < 0.01$, Table 6).

Common Greenshank numbers have decreased by almost 100% in the Robbins Passage/Boullanger Bay wetlands from the peak count of 125 in the 1996 – 2018 period to current estimates (BirdLife Tasmania unpubl. data). No Common Greenshanks were seen in the 2018 SWC, and the decrease is 82% based on the 2017 count of 22 (BirdLife Tasmania unpubl. data). The species' totals are decreasing at 16.2% per annum (Table 6), compared to a decrease of 2.0% per annum Australia wide (Clemens et al. 2016); the Tasmanian rate is approximately eight times the national rate of decrease in this species. The regression coefficient for Summer Wader Counts of Common Greenshank is not statistically significant (Table 6).

The current population in the Robbins Passage/Boullanger Bay wetlands does not meet the criteria for national nor international significance (Table 7), Figure 3b. The species is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4).

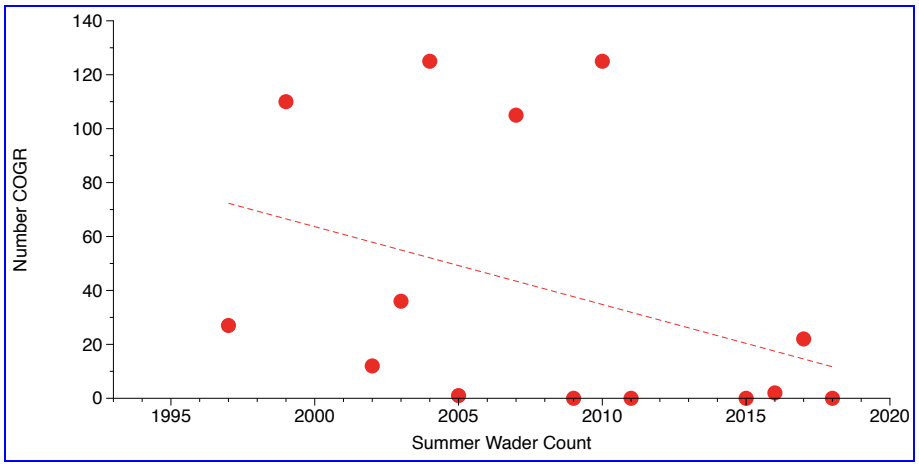


Figure 3b. Plot of Common Greenshank total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6).

Curlew Sandpiper numbers have decreased by 90% in the Robbins Passage/Boullanger Bay wetlands from the peak count of 2311 in the 1996 – 2018 period to current estimates (BirdLife Tasmania unpubl. data). The species' totals are decreasing at 9.3% per annum (Table 6), compared to a decrease of 9.5% per annum Australia wide (Clemens et al. 2016); the Tasmanian rate is approximately the same as the national rate of decrease in this species. The species is listed as Critically Endangered under the *EPBC Act* 1999, and is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4). The regression coefficient for Summer Wader Counts of Curlew Sandpiper is statistically significant ($0.05 > p > 0.01$, Table 6).

The current population in the Robbins Passage/Boullanger Bay wetlands meets the criterion for national significance but not for international significance (Table 7), Figure 3c. Earlier counts of this species in the wetlands met the international criterion (Bamford et al. 2008, Conklin et al. 2014) but the Tasmanian population (statewide) has decreased faster than the national average (BirdLife Tasmania, unpubl. data; see also http://www.environment.gov.au/biodiversity/threatened/species/pubs/856-conservation-advice.pdf).

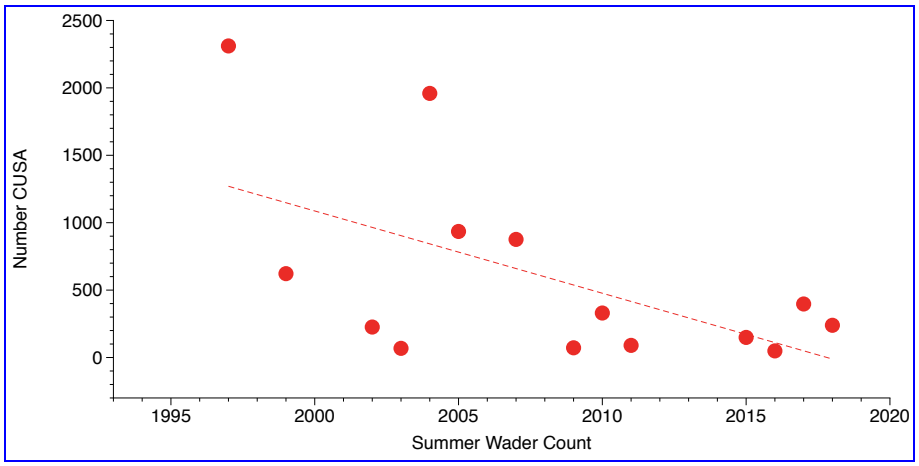


Figure 3c. Plot of Curlew Sandpiper total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6). The regression coefficient for Summer Wader Counts of Curlew Sandpiper is statistically significant ($0.05 > p > 0.01$, Table 6).

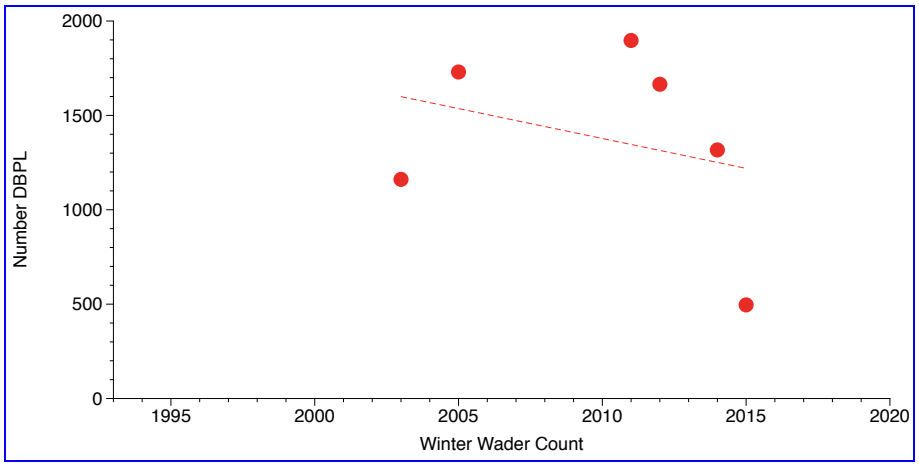


Figure 3d. Plot of Double-banded Plover total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete WWC data only. The regression line is shown (see Methods and Table 6).

Double-banded Plover is a Winter visitor to southeast Australia and Tasmania. Their numbers have decreased by 74% in the Robbins Passage/Boullanger Bay wetlands during WWCs from the peak count of 1897 in the 1996 – 2017 period to current estimates (BirdLife Tasmania unpubl. data). The species' totals

are decreasing at 7.8% per annum (Table 6); compared to a decrease of 3.0% per annum Australia wide (Clemens et al. 2016); the Tasmanian rate is approximately five times the national rate of decrease in this species. The regression coefficient for Winter Wader Counts of Double-banded Plover is not statistically significant (Table 6).

The current population in the Robbins Passage/Boullanger Bay wetlands exceeds the 1% criterion for international significance with more than 6% of the global and EAAF population present in the winter months in the wetlands, and is therefore also of national significance (Table 7), Figure 3d. The species is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4).

Far Eastern Curlew numbers have decreased by 85% in the Robbins Passage/Boullanger Bay wetlands during SWCs from the peak count of 200 in the 1996 – 2018 period to current estimates (BirdLife Tasmania unpubl. data). The species' totals are decreasing at 14.9% per annum (Table 6); no comparable rate is known for the species throughout Australia (Clemens et al. 2016). The regression coefficient for Summer Wader Counts of Far Eastern Curlew is statistically significant ($p < 0.01$, Table 6).

The current population in the Robbins Passage/Boullanger Bay wetlands meets the criterion for national significance but not for international significance (Table 7), Figure 3e. The species is listed as Critically Endangered under the *EPBC Act* 1999, and is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4).

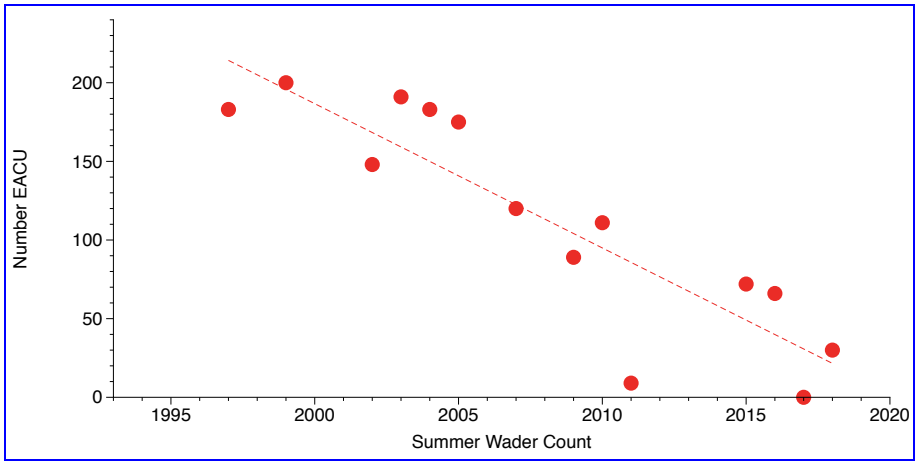


Figure 3e. Plot of Far Eastern Curlew total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6). The regression coefficient for Summer Wader Counts of Far Eastern Curlew is statistically significant ($p < 0.01$, Table 6).

Great Knot numbers have decreased by 63% in the Robbins Passage/Boullanger Bay wetlands from the peak count of 35 in the 1996 – 2018 period to current estimates (BirdLife Tasmania unpubl. data). The species' totals are increasing at 2.4% per annum (Table 6), compared to an increase of 1.4% per annum Australia wide (Clemens et al. 2016); the Tasmanian rate is almost double the national rate of increase in this species. The regression coefficient for Summer Wader Counts of Great Knot is not statistically significant (Table 6).

The current population in the Robbins Passage/Boullanger Bay wetlands does not meet the criteria for national nor international significance (Table 7), Figure 3f. The species is listed as Critically Endangered under the *EPBC Act* 1999 and is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4).

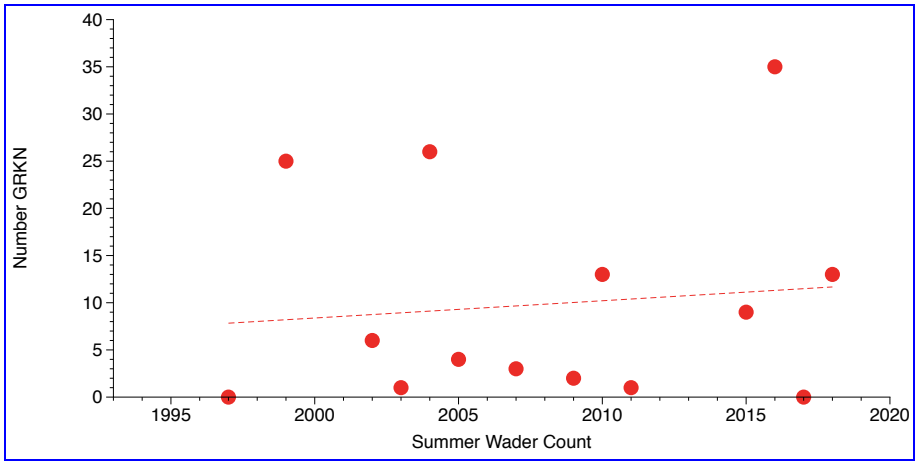


Figure 3f. Plot of Great Knot total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6).

Grey Plover numbers have decreased by 89% in the Robbins Passage/Boullanger Bay wetlands during SWCs from the peak count of 308 in the 1996 – 2018 period to current estimates (BirdLife Tasmania unpubl. data). The species' totals are decreasing at 0.9% per annum (Table 6); compared to a decrease of 2.0% per annum Australia wide (Clemens et al. 2016); the Tasmanian rate is approximately half that of the national rate of decrease in this species. The regression coefficient for Summer Wader Counts of Grey Plover is not statistically significant (Table 6).

The current population in the Robbins Passage/Boullanger Bay wetlands meets the criterion for national significance but not for international significance (Table 7), Figure 3g. The species is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4).

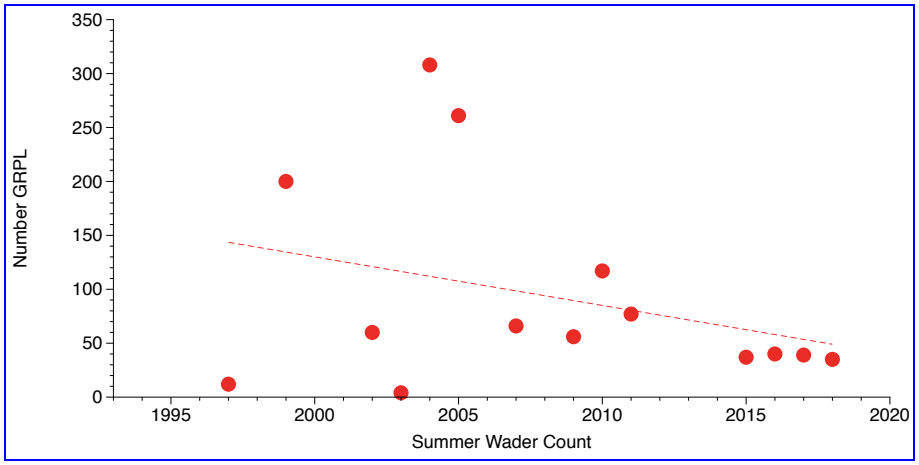


Figure 3g. Plot of Grey Plover total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6).

Pacific Golden Plover numbers have decreased by 14% in the Robbins Passage/Boullanger Bay wetlands during SWCs from the peak count of 521 in the 1996 – 2018 period to current estimates (BirdLife Tasmania unpubl. data). The species' totals are increasing at 0.7% per annum (Table 6); compared to a decrease of 2.0% per annum Australia wide (Clemens et al. 2016). This species is likely to be under-represented in counts as individuals will often roost in dry and flooded vegetation and in pastures, well away from the water and well away from other roosting species (Geering et al. 2007). The regression coefficient for Summer Wader Counts of Pacific Golden Plover is not statistically significant (Table 6).

The current population in the Robbins Passage/Boullanger Bay wetlands meets the criterion for national significance but not for international significance (Table 7), Figure 3h. The species is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4).

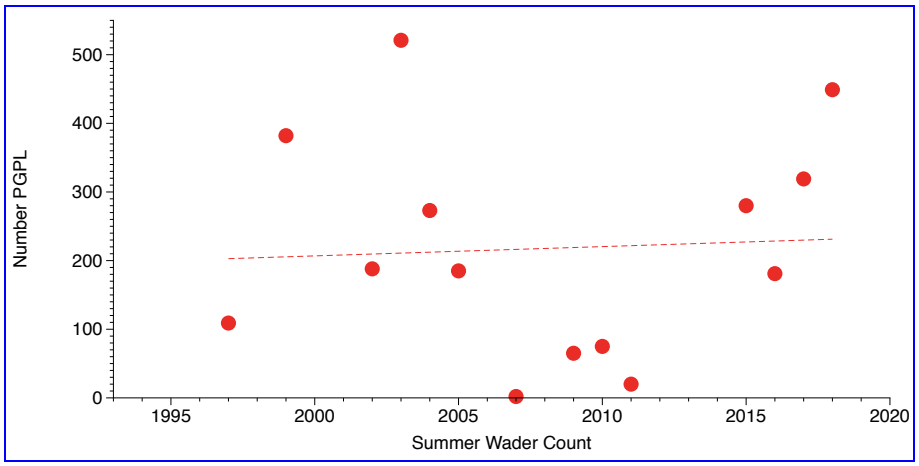


Figure 3h. Plot of Pacific Golden Plover total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6).

Red Knot numbers have decreased by 90% in the Robbins Passage/Boullanger Bay wetlands during SWCs from the peak count of 1920 in the 1996 – 2018 period to current estimates (BirdLife Tasmania unpubl. data). The species' totals are decreasing at 0.3% per annum (Table 6); compared to a decrease of 2.0% per annum Australia wide (Clemens et al. 2016); the Tasmanian rate is approximately one sixth that of the national rate of decrease in this species. The regression coefficient for Summer Wader Counts of Red Knot is not statistically significant (Table 6).

The current population in the Robbins Passage/Boullanger Bay wetlands meets the criterion for national significance but not for international significance (Table 7), Figure 3i. The species is listed as Endangered under the *EPBC Act* 1999 and is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4).

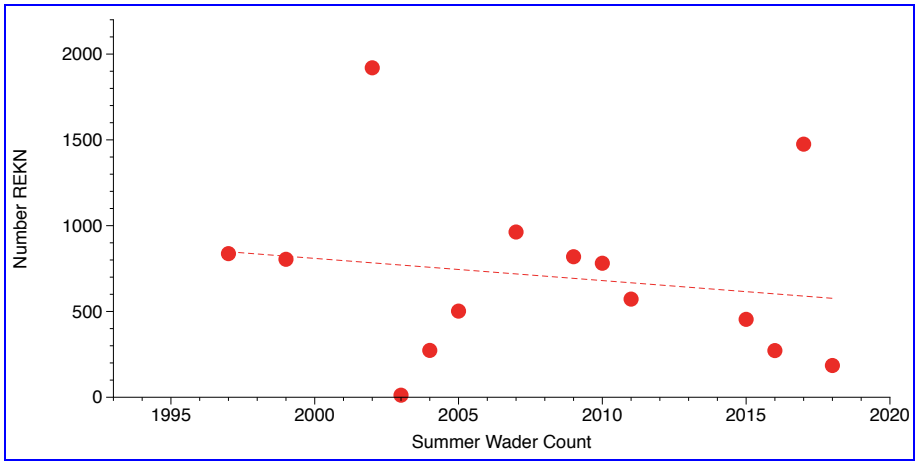


Figure 3i. Plot of Red Knot total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6).

Red-necked Stint numbers have decreased by 58% in the Robbins Passage/Boullanger Bay wetlands during SWCs from the peak count of 13,882 in the 1996 – 2017 period to current estimates (BirdLife

Tasmania unpubl. data). The species' totals are decreasing at 1.9% per annum (Table 6); compared to a decrease of 3.4% per annum Australia wide (Clemens et al. 2016); the Tasmanian rate is approximately 60% of the national rate of decrease in this species. The regression coefficient for Summer Wader Counts of Red-necked Stint is statistically significant ($p < 0.01$, Table 6).

The current population in the Robbins Passage/Boullanger Bay wetlands exceeds the 1% criterion for international significance with more than 1.6% of the global and EAAF population present in the summer months in the wetlands and is therefore also of national significance (Table 7), Figure 3j. The species is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4).

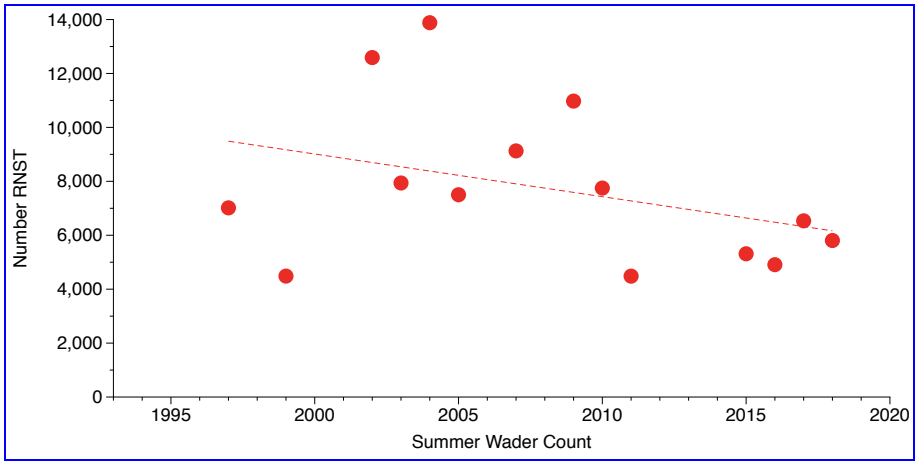


Figure 3j. Plot of Red-necked Stint total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6). The regression coefficient for Summer Wader Counts of Red-necked Stint is statistically significant ($p < 0.01$, Table 6).

Ruddy Turnstone numbers have decreased by 80% in the Robbins Passage/Boullanger Bay wetlands during SWCs from the peak count of 2217 in the 1996 – 2017 period to current estimates (BirdLife Tasmania unpubl. data). The species' totals are decreasing at 6.4% per annum (Table 6); compared to a decrease of 3.2% per annum Australia wide (Clemens et al. 2016); the Tasmanian rate is double the national rate of decrease in this species. The regression coefficient for Summer Wader Counts of Ruddy Turnstone is statistically significant ($p < 0.01$, Table 6).

The current population in the Robbins Passage/Boullanger Bay wetlands exceeds the 1% criterion for international significance with more than 3.6% of the EAAF population present in the summer months in the wetlands, and is therefore also of national significance (Table 7), Figure 3k. The species is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4).

Sanderling numbers had decreased by 95% in the Robbins Passage/Boullanger Bay wetlands from the previous peak count of 55 in the 1996 – 2017 period to the 2017 SWC (BirdLife Tasmania unpubl. data). A flock of 150 Sanderling was observed during the 2018 SWC, which is almost 3 times the previous maximum count; this report of 150 has been excluded from current analyses on the basis of the 150 being treated as a statistical anomaly. Future SWCs will allow for an assessment of the representativeness of the 2018 observation. The regression coefficient for Summer Wader Counts of Sanderling is not statistically significant (Table 6).

The species' totals are decreasing at 2.3% per annum (Table 6), compared to an increase of 0.1% per annum Australia wide (Clemens et al. 2016). The species is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4). The current population in the Robbins Passage/Boullanger Bay

wetlands does not meet the criteria for national nor international significance (Table 7), Figure 3l.

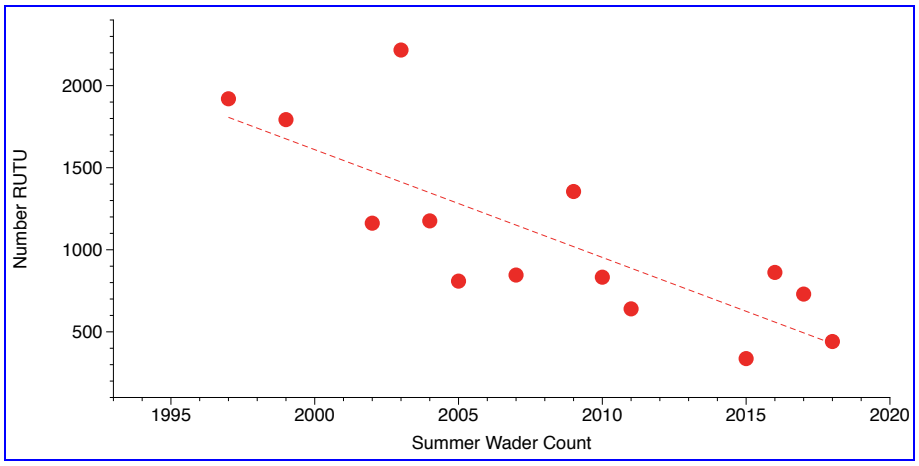


Figure 3k. Plot of Ruddy Turnstone total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6). The regression coefficient for Summer Wader Counts of Ruddy Turnstone is statistically significant ($p < 0.01$, Table 6).

Sharp-tailed Sandpiper numbers have decreased by approximately 100% in the Robbins Passage/Boullanger Bay wetlands from the peak count of 184 in the 1996 – 2018 period to current estimates (BirdLife Tasmania unpubl. data). No Sharp-tailed Sandpipers were seen in the 2018 SWC, and the decrease is 84% based on the 2017 count of 30 (BirdLife Tasmania unpubl. data).

The species' totals are decreasing at 9.5% per annum (Table 6), compared to a decrease of 3.2% per annum Australia wide (Clemens et al. 2016); the Tasmanian rate is approximately three times the national rate of decrease in this species.

As with Pacific Golden Plover, this species is likely to be under-represented in counts as individuals will often roost in dry and flooded vegetation and in pastures, well away from the water's edge (Geering et al. 2007). This species is widespread in Australia, including inland areas, and moves to coastal areas in times of drought conditions. The role of this intra-continental movement in this species in relation to records in Tasmania has not yet been investigated.

The species is on the EPBC Marine Species List and on the EPBC Migratory Species List (Table 4). The current population in the Robbins Passage/Boullanger Bay wetlands does not meet the criteria for national nor international significance (Table 7), Figure 3m. The regression coefficient for Summer Wader Counts of Sharp-tailed Sandpiper is not statistically significant (Table 6).

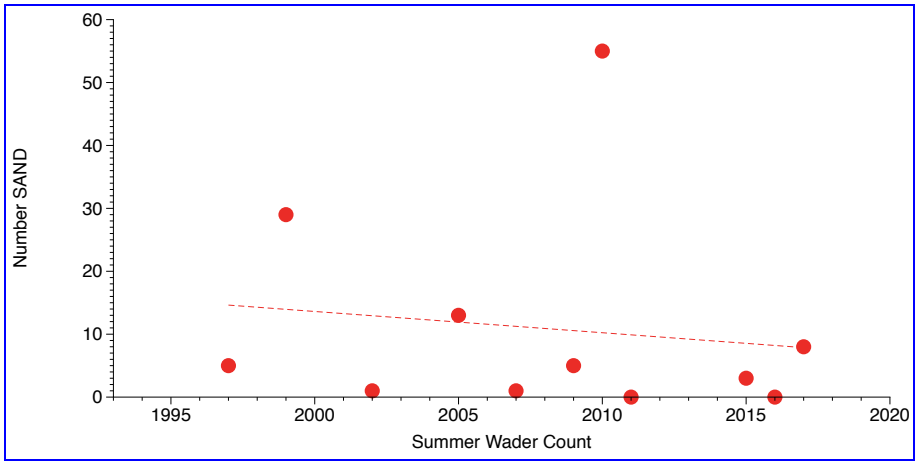


Figure 3l. Plot of Sanderling total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6).

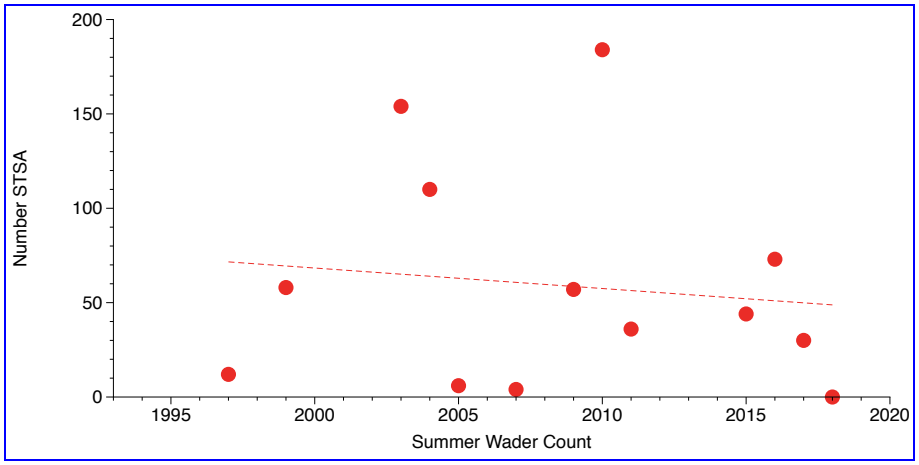


Figure 3m. Plot of Sharp-tailed Sandpiper total counts, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive, using complete SWC data only. The regression line is shown (see Methods and Table 6).

2. Trends in Summer and Winter Counts

The regression for the complete SWCs' totals for the 13 focal species is statistically significant ($0.05 > p > 0.01$: Table 6, Figure 4). The totals for complete SWCs in the Robbins Passage/Boullanger Bay wetlands decreased at 1.4% per annum over the 1996 – 2018 period.

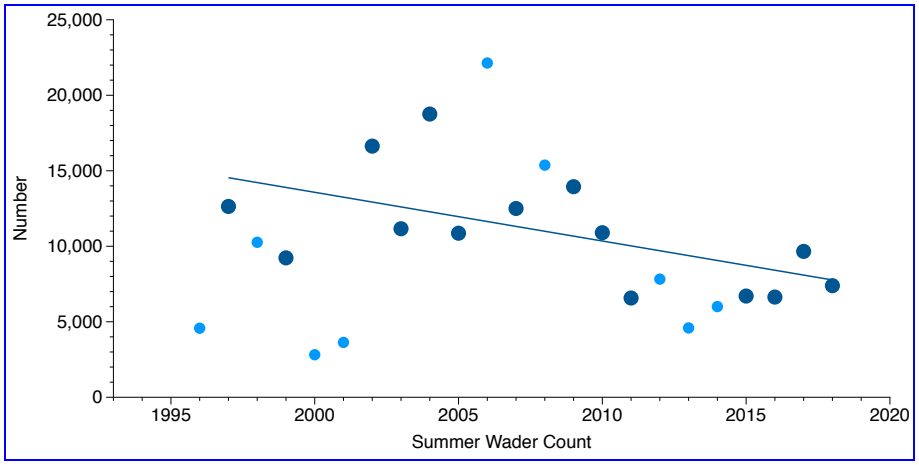


Figure 4. Plot of SWC annual totals, Robbins Passage/Boullanger Bay wetlands, 1996 – 2018 inclusive. Complete SWC data are shown in dark blue symbols, incomplete counts in pale blue. The regression line is based on complete SWC data (see Methods and Table 6) and is statistically significant ($0.05 > p > 0.01$).

There are presently too few data points for complete WWCs (n = 6) to generate a statistically significant regression (Table 6, Figures 5a and b). The annual rate of decrease for all migratory species is presently estimated to be 3 times that of the summer rate (Table 6), but this appears to be an artefact driven by the very low total for the 2015 WWC (Figure 5a), which is the last complete WWC for the wetlands. Additional complete WWCs are required to provide a more accurate regression and concomitant estimate of the annual rate of decrease for migratory shorebirds in the Robbins Passage/Boullanger Bay wetlands since 1996.

Excluding the WWC data for Double-banded Plover (Table 6, Figure 5b) provides an indication of the decrease in Northern Hemisphere migratory species in the Robbins Passage/Boullanger Bay wetlands. Double-banded Plovers migrate between New Zealand and southeast Australia, and are present in the wetlands during Winter.

Northern Hemisphere species have decreased at 1.9% per annum, but the regression coefficient is not statistically significant ($p > 0.05$). Numbers of Northern Hemisphere migratory shorebirds in Australia reflect the recruitment of juveniles into the population, providing an indicator to the inter-annual variability in breeding success (Minton et al. 2005, 2010, 2015), Rogers and Gosbell (2006), Neman and Woehler 2016.

Populations of many migratory species of shorebirds in the EAAF are presently decreasing rapidly (Conklin et al. 2014, Clemens et al. 2016, Studds et al. 2017, Murray et al. 2018). Species with greater reliance on the Yellow Sea are exhibiting the greatest rates of population decrease. The loss of an estimated 65% of critical foreshore feeding areas at a major Flyway staging area has resulted in population decreases approaching 8% per annum over time scales similar to the present study.

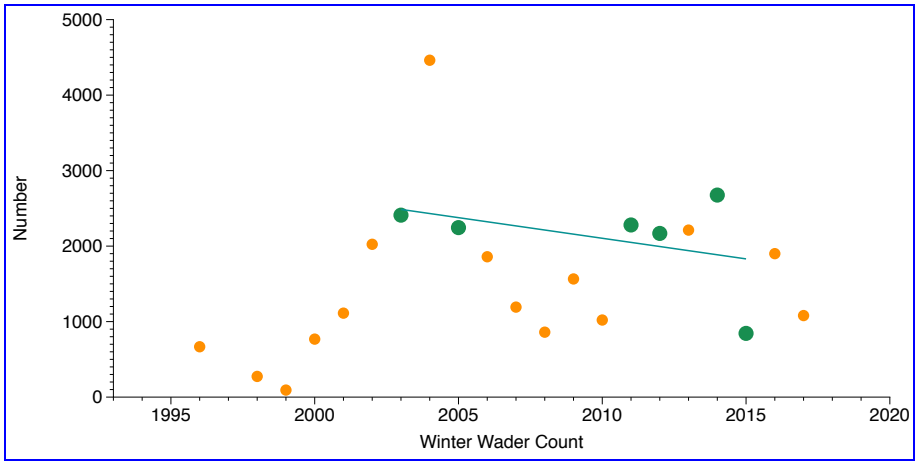


Figure 5a. Plot of WWC annual totals, Robbins Passage/Boullanger Bay wetlands, 1996 – 2017 inclusive. Complete WWC data are shown in dark green symbols, incomplete counts in orange. The regression line is based on complete WWC data (see Methods and Table 6).

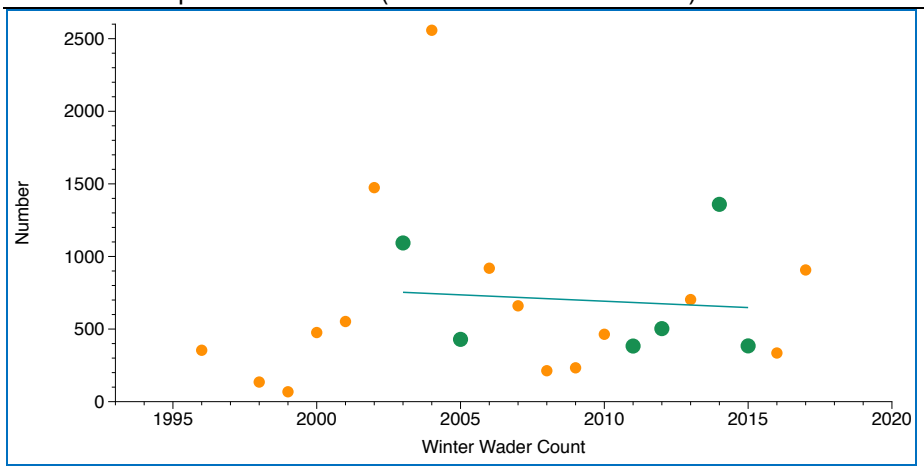


Figure 5b. Plot of WWC annual totals, Robbins Passage/Boullanger Bay wetlands, 1996 – 2017 inclusive, excluding count data for Double-banded Plover. Complete WWC data are shown in dark green symbols, incomplete counts in orange. The regression line is based on complete WWC data (see Methods and Table 6).

3. National and International significance of Robbins Passage/Boullanger Bay wetlands

A number of smaller roost sites are known within the wetlands (Ashby 1991, BirdLife Tasmania unpubl. obs), and it is likely that a low number of other, currently unknown roost sites are present within the wetlands. This premise is based on (a) occasional observations of large flocks flying into roost sites during coordinated counts that are not reported elsewhere during the same count, and (b) of birds known to be in the area before and/or after a coordinated Summer or Winter count that were not observed during the coordinated counts. An example is the observation of 150 Sanderling arriving at a roost during the 2018 SWC (see above).

To address the state of incomplete knowledge of shorebirds in Tasmania, Hansen et al. (2016) applied species-specific and site-specific multipliers to account for unsurveyed roosts in suitable habitats around the state, comprising sites on the West Coast, Northeast Tasmania, King Island, the Furneaux Group and other coastal wetlands.

For the Robbins Passage/Boullanger Bay wetlands complex, existing SWC data for the 10-year period 2006/07 to 2015/16 were multiplied by 1.3, Ruddy Turnstone (x4) and Sanderling (2x) and WWC data for

Double-banded Plover for the same 10 years were multiplied by 3 to obtain estimates for the complex (Hansen et al. 2016, Appendix 9). These revised estimated were used to calculate estimates of total migratory shorebird populations in Tasmania. Applying these multipliers to the means used in the analyses in this report increases the estimated populations present in the Robbins Passage/Boullanger Bay wetlands complex but does not alter the species' populations significance (Table 7).

Within the context of the other long-term shorebird surveys elsewhere in Tasmania, the Robbins Passage/Boullanger Bay wetlands continue to be recognised as the most important area for migratory and resident shorebirds in Tasmania (Spruzen et al. 2008a, Conklin et al. 2014, Hansen et al. 2016), with more shorebirds of more species present at any time of the year in these wetlands than in the rest of Tasmania combined.

Other migratory shorebird roost complexes for which long-term monitoring data are available in Tasmania are known from the Derwent – PittWater in the southeast, George Town and Cape Portland in the northeast. All three have data sets extending for more than 35 years (Thomas 1968, 1970, Clemens et al. 2016, Newman and Woehler 2016). Other sites in Tasmania have been monitored for varying periods with variable effort since the 1980s. These include Georges Bay (St Helens), Port Sorell and Moorland Point at Devonport, (Woehler and Drake 2017).

Bamford et al. (2008) identified Robbins Passage/Boullanger Bay as the highest-ranked internationally important site for migratory shorebirds in Tasmania. More recently, Conklin et al. (2014) identified Robbins Passage/Boullanger Bay as an internationally important site for two EAAF priority shorebird populations (Curlew Sandpiper and Ruddy Turnstone).

Extensive long-term (30 year or greater) time series for migratory shorebird populations in Australia were examined by Clemens et al. (2016), including Tasmania. The study showed the extensive, and in many cases, rapid decreases of migratory species throughout Australia. Some decreases showed latitudinal trends, others longitudinal. The results in Clemens et al. (2016) have been supported by findings in other studies (eg Studds et al. 2017, Murray et al. 2018).

The decreases in the migratory species present in the Robbins Passage/Boullanger Bay wetlands complex are in broad agreement with the decreases reported for Australia, differing only in their magnitude for 11 of the 13 focal species (Table 6), with the Robbins Passage/Boullanger Bay trends typically greater than the national trends. The greater magnitudes of the decreases from the Robbins Passage/Boullanger Bay complex reflects Tasmania's status as the end-point on the EAAF that is believed to provide an indication of future population trends (Newman and Woehler 2016).

Based on the data and analyses presented here, BirdLife Tasmania presently believes that the Robbins Passage/Boullanger Bay wetlands regularly hold approximately 10,000 to 12,000 migratory shorebirds during the summer months (October to March inclusive), and approximately 2000 to 4400 migratory shorebirds during winter months (April to September, inclusive. These numbers vary inter-annually as different species' populations migrate to the wetlands or elsewhere in southeast Australia including Tasmania.

The role of drought and the loss of water at inland water bodies on the Australian mainland was briefly examined by Clemens et al. (2016), albeit largely for resident species. Intra-continental movements of migratory species such as Sharp-tailed Sandpipers, which will move to coastal areas in times of drought conditions, may contribute to the variability in the species observed in the Robbins Passage/Boullanger Bay wetlands complex. However, the role of this intra-continental movement in relation to migratory shorebird species in Tasmania has not yet been examined (Alcorn et al. 1994).

Based on the data and analyses presented here, BirdLife Tasmania presently believes that the Robbins Passage/Boullanger Bay wetland complex also support 3000 – 4000 resident shorebirds year-round, but these estimates are conservative as the coordinated counts are focussed on migratory species' roosts rather than on resident species whose breeding populations are best surveyed during their breeding season (eg Woehler 2018).

The EAAF is the most species diverse of the world's nine migratory flyways (Conklin et al. 2014), and the Flyway's diversity is reflected in the diversity of migratory and resident shorebirds in the Robbins Passage/Boullanger Bay wetlands.

The total number of migratory shorebirds in the Robbins Passage/Boullanger Bay has decreased since the peak counts of the early 2000s (Bamford et al. 2008, Hansen et al. 2016, BirdLife Tasmania unpubl. data), Figures 3 to 5, Table 6. These decreases mirror the trends observed in many species of shorebirds in the EAAF (Clemens et al. 2016, Studds et al. 2017, Murray et al. 2018). Banding and other marking studies have shown strong site fidelity in many species of migratory shorebirds in Australia and Tasmania, with individuals returning to the same locations from one summer to the next (eg Alcorn et al. 1994, Harris 1983, 1984, Newman and Fletcher 1981, Newman and Woehler 2016).

Despite these long-term decreases in migratory shorebird numbers, based on existing survey data reported here, it is clear that the Robbins Passage/Boullanger Bay wetlands continue to meet criteria for inclusion on the list of Important Sites for EAAF priority shorebird populations (Bamford et al. 2008, Conklin et al. 2014), and nomination for Ramsar listing. The high number of migratory species, species with conservation status, and large populations of shorebirds using the wetlands all satisfy Ramsar criteria.

Based on the current populations of migratory shorebirds (Table 7), the wetlands support three species at levels of international significance: Double-banded Plover (Winter – 6% global population), Red-necked Stint (Summer – 1.6% Flyway population) and Ruddy Turnstone (Summer – 3.6% Flyway population). In addition, five species are present at population levels during Summer months significant at the national level (ie > 0.1% of flyway populations: Curlew Sandpiper, Far Eastern Curlew, Grey Plover, Pacific Golden Plover and Red Knot), Table 7.

Thus, the wetlands remain of international significance as an Internationally Important Site for the East Asian – Australasian Flyway (Conklin et al. 2014 and Hansen et al. 2016).

The wetlands meet the IUCN Important Bird Area (IBA) criteria (now known as Important Bird and Biodiversity Areas: http://datazone.birdlife.org/site/ibacriteria). These criteria are broadly similar to the criteria for assessing wetlands for Ramsar listing but are applied to non-wetland species. The wetlands were nominated and adopted as a Tasmanian IBA within the joint BirdLife Australia – BirdLife International project in 2006 (Dutson et al. 2009). The wetlands are also listed on the Tasmanian Inventory of Nationally Important Wetlands (http://www.environment.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands).

While it may be tempting to rank individual sites within the wetlands in an effort to identify the, "most important" roost or feeding or nesting sites etc, it is highly inappropriate to do so. Individual sites could be ranked by the number of birds recorded during a count, the species diversity at a roost site or numbers breeding along a stretch of beach, or even the numbers of birds feeding in an area. However, all such approaches ignore the biological reality of the wetlands, and the shorebirds' uses of them.

Common Name	Mean count, 1996 – 2018 SWCs*	1% EAAF population	0.1% EAAF population	% EAAF population estimate	RP/BB significance
Bar-tailed Godwit	243	3250	325	0.07	
Common Greenshank	40	1100	110	0.04	
Curlew Sandpiper	595	900	90	0.66	National
Double-banded Plover*	1194*	190	19	6.28	International
Far Eastern Curlew	113	350	35	0.32	National
Great Knot	11	4250	425	< 0.01	
Grey Plover	94	800	80	0.12	National
Pacific Golden Plover	218	1200	120	0.18	National
Red Knot	705	1100	110	0.64	National
Red-necked Stint	7736	4750	475	1.63	International
Ruddy Turnstone	1080	300	30	3.60	International
Sanderling	23	300	30	0.08	
Sharp-tailed Sandpiper	59	850	85	0.07	

Table 7. Robbins Passage/Boullanger Bay survey data, East Asian – Australasian Flyway (EAAF) population estimates from Hansen et al. (2016), with corresponding 1% and 0.1% thresholds for sites of international and of national significance, respectively. *The mean count for Double-banded Plovers is from Winter Wader Counts (WWCs), when the species is present in SE Australia.

Spruzen et al. (2008a, b) are the only studies to examine the use of the Robbins Passage/Boullanger Bay wetlands by resident and migratory shorebirds. The study examined the foraging behaviours of shorebirds at four sites and found significant differences in their distribution and abundance that was related to feeding behaviour and prey species. Given the extent of the intertidal area within the complex (approximately 100km^2), it is not possible to extrapolate from the four study sites to the entire complex. Further research is required to quantify the spatial and temporal variabilities in shorebird foraging in the complex, and to assess the extent of habitat preference or selection by the shorebird species present.

It is critical to view the Robbins Passage/Boullanger Bay wetlands holistically, in that the wetlands comprise an inter-connected network or complex of feeding, roosting (and for some species, nesting) sites among which the birds move in response to changes in tides, weather, wind speeds and direction, time of day and night, time of year and other factors such as disturbance. It is incorrect to treat each site in isolation, and ranking sites effectively treats each site independently of all others.

4. Other sites of international significance for migratory shorebirds in Tasmania

Bamford et al. (2008) and Conklin et al. (2014) detail the sites of international significance for migratory shorebirds in Australia, including Tasmania, for the EAAF. The seven sites comprise Robbins Passage/Boullanger Bay (significant for four species), Logan Lagoon, Flinders Island (2 species), Blanche Point (St Helens), the Derwent Estuary and PittWater, King Island, Ocean Beach (Strahan) and Cape Portland (all important for one species of migratory shorebird).

Australia supports 118 sites of international significance for migratory shorebirds in the EAAF, representing 30% of the 397 sites in the 23 countries within the EAAF. These sites are located throughout all states and territories (Watkins et al. 2008). Tasmania's seven sites represent 6% of the Australian total, and 2% of the internationally-significant sites' total for the flyway. The recent revision of EAAF migratory shorebird populations' estimates by Hansen et al. (2016) will be used in a future re-assessment of these sites in Australia.

5. Summary of existing threats to roost sites within the wetlands

As with ranking sites, it is appropriate to initially assess threats to the wetlands in a holistic manner, rather than a site by site inventory of threats. Every threatening process in operation within the wetlands complex is contributing to the cumulative impact of all threats to all sites within the wetlands, not just the shorebird sites. The primary threats identified for the wetlands are habitat loss and fragmentation (eg the loss of productive inter-tidal seagrass areas due to vehicles), human disturbance (eg vehicular traffic), introduced vertebrate predators such as feral cats and dogs, and invasive coastal plants such as Sea Spurge *Euphorbia paralias*.

The shorebirds need and use all of the coastal sites within the wetlands (Spruzen et al. 2008b). Roosts will differ between resident and migratory species, and between breeding and non-breeding seasons for resident species. Breeding individuals will forage within their territories during the summer but may be more widely distributed along foreshores in the non-breeding season. Disturbance at roosts will displace roosting birds to relocate to another location that is available. Adverse weather conditions such as strong winds will see roosting and feeding birds seek alternative feeding and roost area, if available.

The loss or fragmentation of any site presently used for feeding, roosting or breeding will have an impact to the shorebird community as a whole. It is critical to view the Robbins Passage/Boullanger Bay wetlands as a single complex or unit for management, conservation and planning purposes. Failure to do so will impact on the values present at national and at international levels.

Conclusions and recommendations

This review is based upon data provided over more than 20 years by BirdLife Tasmania counters who have volunteered many hundreds of hours of their time in order to provide a unique, decadal-scale dataset for the Robbins Passage/Boullanger Bay wetlands complex.

The limitations of the few complete winter counts have already been noted, but the available WWC data have identified the international significance of the wetlands for Double-banded Plovers wintering in the Robbins Passage/Boullanger Bay wetlands complex from their New Zealand breeding grounds. Further analyses of the WWC data would be limited to the two most numerous of the migratory species, Red-necked Stint and Ruddy Turnstone, and would be further limited due to the relatively few complete WWCs (Table 2). Greater efforts to obtain complete WWCs in the future would facilitate meaningful analyses.

The analyses of the SWC data set herein provide the first holistic assessment of the Robbins Passage/ Boullanger Bay wetlands since Ashby's (1991) initial assessment of the complex. The repeat counts spanning three decades for the shorebird community at the same roosts have identified an obvious and significant pattern of losses for many species that are greater in magnitude and more rapid than the species' trends throughout Australia at continental scales (Clemens et al. 2016).

Studies to date have identified critical habitat loss at stopover feeding sites in the EAAF (Iwamura et al. 2013, Studds et al. 2017, Murray et al. 2018). There have been very few studies undertaken to identify decreases in migratory shorebirds at sites in Australia and the factor(s) responsible (but see Nebel et al. 2008, Wilson et al. 2011) for initial efforts. The pivotal role of the Yellow Sea as a feeding and staging area for migratory shorebirds in the EAAF has been shown by the strong correlation between its use by species and the rates of decrease in the flyway, including Australia (Studds et al. 2017).

The location of the Robbins Passage/Boulanger Bay complex at the southern end of the EAAF makes the results of the current study highly significant as the flyway losses are likely to be first observable at the extremes (Newman and Woehler 2016).

Acknowledgements

BirdLife Tasmania thanks David Pollington and Madeleine Skerritt (UPC Renewables) for their support for the wetland data synthesis, and Matt Davis (GHD) who commissioned the analyses. Comments from A Darby and M Newman improved an earlier draft.

References cited

Alcorn M, Alcorn R, Fleming M 1994. Wader Movement in Australia. *RAOU Report* No. 94.

Ashby R 1991. Waders of far north-west Tasmania. The Stilt 19, 44-49. Available at http://awsg.org.au/stilt/Stilt-19.pdf

Bamford MJ, Watkins DG, Bancroft W, Tischler G (2008) *Migratory shorebirds of the East Asian---Australasian Flyway: Population estimates and important sites*. Wetlands International, Oceania. Available at https://www.environment.gov.au/system/files/resources/782ebed5-6bdd-4a41-9759-b60273b52021/files/shorebirds-east-asia.pdf

Clemens RS, Rogers DI, Hansen BD, Gosbell K, Minton CDT, Straw P, Bamford M, Woehler EJ, Milton DA, Weston MA, Venables W, Weller D, Hassell C, Rutherford W, Onton K, Herrod A, Studds CE, Choi C - Y, Dhanjal - Adams KL, Skilleter G, Fuller RA 2016. Continental - scale decreases in shorebird populations in Australia. Emu 116, 119 - 135 http://dx.doi.org/10.1071/MU15056

Conklin JR, Verkuil YI, Smith B 2014. *Prioritizing migratory shorebirds for conservation action on the East Asian-Australasian Flyway*. WWF-Hong Kong, Hong Kong, 128pp. Available at http://awsassets.wwfhk.panda.org/downloads/wwf_prioritization_finalpdf.pdf

Dutson G, Garnett S, Gole C 2009. *Australia's Important Bird Areas: Key sites for bird conservation*. Birdlife Australia. (RAOU) Conservation Statement 15. Available at http://www.birdlife.org.au/documents/OTHPUB-IBA-supp.pdf

Garnett ST, Szabo JK, Dutson G 2011. *The Action Plan for Australian Birds 2010*. Birds Australia, CSIRO Publishing, Melbourne. Available at http://www.birdlife.org.au/documents/OTHPUB-IBA-supp.pdf

Geering A, Agnew L, Harding S 2007.*Shorebirds of Australia*. CSIRO Victoria, xii + 242pp.

Hansen BD, Fuller RA, Watkins D, Rogers DI, Clemens RS, Newman, M, Woehler EJ, Weller DR 2016. *Revision of the East Asian - Australasian Flyway population estimates for 37 listed migratory shorebird species*. Unpublished report for the Department of the Environment, BirdLife Australia, Melbourne, 88pp. Available at http://www.environment.gov.au/biodiversity/publications/revision-east-asian-australasian-flyway-population-2016

Harris K 1983. Mortality Rates of Red-necked Stint determined by rocket-net catches. Occasional Stint 2, 56-64.

Harris K 1984. Mortality Rates of Curlew Sandpiper (*Calidris ferruginea*) determined by rocket net catches. Occasional Stint 3 41-44.

Iwamura T, Possingham HP, Chadès I, Minton C, Murray NJ, Rogers DI, Treml EA, Fuller RA 2013. Migratory connectivity magnifies the consequences of habitat loss from sea-level rise for shorebird populations. Proceedings of the Royal Society of London B: Biological Sciences 280, 2013.0325. http://dx.doi.org/10.1098/rspb.2013.0325

Minton C, Jessop R, Hassell C 2010. Wader breeding success in the 2009 arctic summer, based on juvenile ratios of bird which spend the non-breeding season in Australia. Stilt 57, 63-66. Available at http://awsg.org.au/stilt/Stilt-57.pdf

Minton C, Jessop R, Hassell C 2015. Wader breeding success in 2014 Arctic summer. Tattler 37, 13-14. Available at http://awsg.org.au/tattler/Tattler-37.pdf

Minton C, Jessop R, Collins P, Gosbell K 2005. Monitoring wader breeding productivity by the proportion of first year birds in wader populations in S.E. Australian non-breeding areas. In P Straw (ed). *Status and Conservation of Shorebirds in East Asian-Australian Flyway*. Proceedings of the Australian Shorebirds Conference 13-15 December 2003, Canberra, Australia. Wetlands International Global Series 18, International Wader Studies 17, Sydney, Australia pp 73-85.

Murray NJ, Marra PP, Fuller RA, Clemens RS, Dhanjal - Adams K, Gosbell KB, Hassell CJ, Iwamura T, Melville D, Minton CDT, Riegen AC, Rogers DI, Woehler EJ, Studds CE 2018. The large-scale drivers of population declines in a long - distance migratory shorebird. Ecography 40, 001-009 http://dx.doi.org/10.1111/ecog.02957

Nebel S, Porter JL, Kingsford RT 2008. Long-term trends of shorebird populations in eastern Australia and impacts of freshwater extraction. Biological Conservation 141, 971-80. http://dx.doi.org/10.1016/j.biocon.2008.01.017

Newman OMG, Fletcher AWJ 1981. Fluctuations in Hobart area wader populations 1964 to 1981. Tasmanian Bird Report 10, 4-11.

Newman M, Woehler EJ 2016. Red - necked Stint in South - east Tasmania: Part 1 Population trends and juvenile recruitment. The Stilt 69 - 70, 7 – 19. Available at http://awsg.org.au/stilt/Stilt-69-70.pdf

Park P 1999. Summer and Winter Wader Counts, 1999. Tasmanian Bird Report 28, 19-22.

Rogers KG, Gosbell K 2006. Demographic Models for Red-necked Stint and Curlew Sandpiper in Victoria. Stilt 50, 205-214. Available at http://awsg.org.au/stilt/Stilt-50.pdf

Spruzen FL, Richardson AMM, Woehler EJ 2008a. Spatial variation of intertidal macro-invertebrates and environmental variables in Robbins Passage wetlands, NW Tasmania. Hydrobiologia 598, 325-342 http://dx.doi.org/10.1007/s10750-007-9166-2

Spruzen FL, Richardson AMM, Woehler EJ 2008b. Influence of environmental and prey variables on low tide shorebird habitat use within the Robbins Passage wetlands, Northwest Tasmania. Estuarine, Coastal and Shelf Science 78, 122-134 http://dx.d:10.1016/j.ecss.2007.11.012

Studds CE, Kendall BE, Murray NJ, Wilson HB, Rogers DI, Clemens RS, Gosbell K, Hassell CJ, Jessop R, Melville DS, Milton DA, Minton CDT, Possingham HP, Riegen AC, Straw P, Woehler EJ, Fuller RA 2017. Reliance on the Yellow Sea predicts shorebirds' population collapses in a migratory flyway. Nature Communications 8:14895 http://dx.doi.org/10.1038/ncomms14895.

Thomas DG 1968. Waders of Hobart. Emu 68, 95-125.

Thomas DG 1970. Fluctuations of numbers of waders in south-eastern Tasmania. Emu 70, 79-85.

Wilson HB, Kendall BE, Fuller RA, Milton DA, Possingham HP 2011. Analyzing variability and the rate of decline of migratory shorebirds in Moreton Bay, Australia. Conservation Biology 25, 758-66. http://dx.DOI.org/10.1111/j.1523-1739.2011.01670.x

Woehler EJ, Drake S 2017. 2016 Summer and winter wader counts (incorporating corrected tables for 2015 summer counts). Tasmanian Bird Report 38, 44-53.

Woehler EJ 2018. A survey of the resident shorebirds on Robbins Island, northwest Tasmania, February 2018. Report to GHD, May 2018. BirdLife Tasmania Technical Report 2018-06, 20pp