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Report on the 2022 Biennial Hooded Plover Population Count

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Summary

The Hooded Plover (*Thinornis cucullatus cucullatus*) Biennial Count, occurring since 1980, rallies hundreds of skilled participants across eastern mainland Australia to survey suitable ocean beach habitat for Hooded Plovers (eastern subspecies) over several weeks in November. During this count, all other species of resident beach-nesting birds, including several tern species, are also recorded, enabling an assessment of the use of ocean beach habitats by these species. Fixed survey routes, first established in 2010, are surveyed during the biennial count so that direct comparisons of species abundance can be made across years. During the 2022 count:

- 2,754 kilometres of suitable coastline (i.e., Hooded Plover habitat) was identified in New South Wales, Victoria, and South Australia, of which 2,589 km (94%) was surveyed.
- A total of 1,664 Hooded Plovers (1,622 adults and 42 juveniles) were counted, comprising approximately 55% of the estimated world population of 3,000 birds (eastern subspecies) and 92% of the estimated mainland breeding population of 1,800 birds.
- Regionally, Hooded Plover numbers were distributed as follows:
    - In Victoria (86% of habitat surveyed): 761 Hooded Plovers (756 adults and 5 juveniles).
    - In South Australia (98% of habitat surveyed): 838 Hooded Plovers (803 adults and 35 juveniles).
    - In New South Wales (98% of habitat surveyed): 65 Hooded Plovers (63 adults and 2 juveniles).

For the first time in the count's history, two regions of Tasmania were also included in the 2022 count. Over 214 kilometres of suitable Hooded Plover habitat was surveyed in North-east Tasmania and Flinders Island. A total of 420 Hooded Plovers (411 adults and 9 juveniles) were counted which constituted 35% of the estimated Tasmanian breeding population of 1,200 birds and 14% of the estimated world population of 3,000 birds (eastern subspecies).

A comparison of numbers in the three mainland states with the 2020 count (1,584 Hooded Plovers; 2,413 km surveyed) revealed there were 80 more Hooded Plovers counted during the 2022 count (2,589 km surveyed). Within regions, there appeared to be a significantly higher number of Hooded Plovers in the regions of Yambuk to Swan Lake (+42 birds), Kangaroo Island (+35 birds), Lorne to Princetown (+11 birds), and NSW Border to Point Hicks (+10 birds). Ten regions experienced an increase of between 1 to 7 birds. Nine regions experienced decreases in recorded Hooded Plover numbers of between 1 to 22 birds, however nearly half of these were associated with a decrease in survey coverage compared with the 2020 count.

The highest densities of Hooded Plovers were recorded in the regions of Warrnambool to Yambuk (2.03 birds/km) in far west Victoria, followed by San Remo to Inverloch (1.75 birds/km) on the Bass Coast, Mornington Peninsula (1.66 birds/km), Wilsons Prom to Waratah Bay (1.60 birds/km) in

South Gippsland, Kangaroo Island (1.51 birds/km), and Yambuk to Swan Lake (1.35 birds/km) in far south west Victoria. Most of these regions have been flagged as having the highest densities in the three previous count years, even if the order of significance has altered slightly.

Introduction

The biennial Hooded Plover (*Thinornis cucullatus cucullatus*) counts began in 1980 after initiation by the Australasian Wader Studies Group and from the 1990s, they were coordinated by Birds Australia, and then BirdLife Australia. The biennial count is a census-style count aimed at occurring over a single weekend in mid-November aimed at providing an accurate estimate of population size and distribution of the mainland Hooded Plover (eastern subspecies) population. The timing of the count coincides with when most Hooded Plovers are firmly established on their breeding territories, minimising the possibility of inaccurate counting due to bird movements. The count has always included Victorian and South Australian coastlines and has expanded in recent years to include most of the southern New South Wales coastline extending as far north as Jervis Bay. The count does not typically include the Tasmanian coastline which is divided into regions and surveyed by members of BirdLife Tasmania over varying timeframes due to lack of participants. However, for the first time in the biennial count's history, two regions in Tasmania – Flinders Island and the North-east - were included in the 2022 count.

This report details the results of the 2022 Hooded Plover biennial count, held on 19th–20th November 2022. The count was successful with many regions experiencing good weather conditions. However, some regions were affected by flooding due to excessive rainfall caused by the La Niña climate pattern. This restricted access to the coastline in some remote regions resulting in decreased survey coverage. A total of 430 participants undertook 642 surveys, totalling approximately 994 hours of surveying (not including travel to and from their designated survey routes) in South Australia, Victoria and New South Wales. In Tasmania, 24 participants undertook 59 surveys, totalling approximately 106 hours of surveying. The number of surveys exceeds the number of established survey routes due to some routes being split and synchronously shared amongst participants for logistical reasons as well as the inclusion of a few ad-hoc routes where Hooded Plovers were recorded. A total of 2,589 kilometres (94%) of suitable coastline habitat was surveyed in the three mainland states, extending from 250 kilometres west of Ceduna in South Australia to just south of Jervis Bay in New South Wales. In Tasmania, a total of 215 kilometres (88%) of suitable coastline habitat was surveyed, encompassing the whole of Flinders Island, and extending from Musselroe Bay to just south of Four Mile Creek in North-east Tasmania.

Currently, the population of the eastern subspecies of the Hooded Plover which occurs in South Australia, Victoria, Tasmania, and New South Wales, is estimated at 3,000 birds, and listed as Vulnerable [Category C1 + 2a (ii)] in The Action Plan for Australian Birds 2010 (Garnett *et al.* 2011). In late 2014, the eastern subspecies was listed as Vulnerable on the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), recognising substantial population declines, and the need for more extensive management measures to improve its conservation status.

Prior to the establishment of fixed survey routes in 2010 as part of standardising biennial count surveys, the Hooded Plover population in Victoria was estimated to be between 450 and 550 birds, based on counts between 2006 and 2010. In New South Wales, the population was estimated to be 50 birds, based on regular surveys during the breeding season (New South Wales National Parks and

Wildlife Service), and in South Australia, estimates of between 600 and 800 birds in the population were made based on data collected from biennial counts and extrapolations made for areas that had not been surveyed.

Methods

Coordination

A part-time (1 day per fortnight) count coordinator based at BirdLife Australia coordinated the biennial count and was primarily responsible for liaising with regional count coordinators, participants, and land managers to ensure that the count occurred within the specified timeframe across all three states. For the third count in a row, this was a paid role through funding from the Australian Government's National Landcare Program. As part of the count coordinator's role, a meeting was held with the regional count coordinators well in advance of the count weekend to plan the count and discuss any potential issues that could impact the delivery of the count. A major task of the count coordinator's role is to ensure that all the data is collected using standardised data sheets, following survey instructions and strict survey routes determined in previous counts. Furthermore, the count coordinator ensures that all collected count data is collated, entered, vetted, analysed, and mapped. The count coordinator then uses this information in compiling the final report. Kasun Ekanayake was the count coordinator in 2022.

Survey design

No changes were made to the well-established survey methods that were followed in 2020. The timing of the count and the time span within which surveys are conducted, are two critical aspects of the biennial count. Bird movements are likely to be minimal since the count is timed to coincide with the peak of the breeding season when territory occupancy is highest (mid to late November), and most pairs are at least on their first nesting attempt for the breeding season. However, if the survey window was to be particularly wide, there is an increased risk of double counting due to possible bird movements (e.g., because of birds not yet settled on a territory or experiencing failed breeding). Therefore, it is important that the bulk of the census is undertaken in as short a time span as possible.

In summary, participants were instructed to survey a predefined section of coastline in mid-November 2022 in suitable weather and tide conditions, recording all observations of beach-nesting birds, including terns. To avoid double-counting, participants were instructed to count birds on survey routes in one direction only. Information on evidence of nesting and the presence of threats and invasive weeds was also collected for each observation where possible.

Smart phone app for recording data

In 2019, the online portal for entering biennial count data was made available in BirdLife Australia's *Birdata* smart phone app on iPhones and Android smart phones, ready for the 2020 count. After the

successful uptake of the phone app in 2020, survey participants were encouraged to input their data directly into the app using the *Beach-nesting Birds Program* survey form in the field for the 2022 count as well. Where this was not possible, participants were supplied with data sheets which were the same as those used in previous counts and then encouraged to enter their data through the smart phone app or website at home. The ability for participants to directly enter their own data into the portal enables a greater efficiency in data collection as well as reduces the likelihood of data entry errors and minimises the time lag between data collection. It also enabled the count coordinator to quickly identify data that had not yet been submitted, so that missing data could be tracked closer to survey participation dates before it was potentially lost or misplaced. Participants were provided with detailed instructions on how to obtain a login to Birdata (note: this is a different system and data collection methodology to the MyBeachBirds data portal) and ongoing support on how to enter their biennial count data.

Development of the Beach-nesting Birds Program survey form within the Birdata app was supported by BirdLife Australia through funding from the Australian Government's National Landcare program and by the generosity of BirdLife Australia supporters.

Use of defined survey routes

Although Hooded Plover biennial counts have been undertaken since 1980, the capacity to compare each count over time has been limited (Glover 2008), particularly because in earlier years there was no determination of the lengths and proportions of suitable habitat surveyed on each count. The 2010 biennial count was the first to report the length of suitable coastline surveyed and to relate this to the density of birds observed. From continuing these methods, it is now possible to make further meaningful interpretations of what bird numbers might mean between years. As described in Ewers *et al.* (2011), it is essential to be able to quantify the length of the coastline surveyed in order to assist with interpretation of bird numbers.

For the purposes of organising such an extensive census, the entire coastline of the south-eastern mainland of Australia was divided into 24 regions across three states, and into two regions in Tasmania. These regions are based on historical count regions, and often land management or Natural Resources Management (NRM) regional boundaries. They are not equal in size or availability of suitable habitat.

Each region was assigned one or multiple regional count coordinators (local land managers or volunteers) who organised count participants to survey the routes in their designated region. In many cases, regional count coordinators have fulfilled the same role for several biennial counts, providing much needed local knowledge and consistency across years. Regional count coordinators were instructed to assign people to survey as many of the survey routes in their designated region as possible, and to inform the count coordinator if any routes were not going to be covered prior to the count weekend so alternative arrangements could be investigated.

In 2010, extensive feedback from regional count coordinators was collated to modify survey routes to exclude unsuitable habitat. Using the 2018 set of survey route start and finish points, each regional

coordinator was provided with survey maps for the routes in their region in August for further review to ensure all suitable Hooded Plover habitat was still encapsulated. Each map covered what appeared to be suitable Hooded Plover habitat based on historical range, expert knowledge, and assessment of habitat features (typically high energy/surf beaches backed by dunes). In 2022, the standardised survey route names were included on each survey map to help participants identify their survey route and be able to select the correct route from the drop-down list in Birdata ensuring they were entering their data in the correct survey route. Adjustments were made to 14 routes and 1 route was deleted to better reflect suitable Hooded Plover habitat. Thirty-seven new routes were added to include suitable habitat in the two regions of Tasmania.

This was the seventh count where fixed routes have been used with success. In some areas there is probably a case to be made for removing certain beaches from the standard list or to reduce survey effort in areas with low habitat quality, and/or very low bird densities (see Discussion).

Threat assessments

Of as much value as understanding the abundance and distribution of Hooded Plovers and other beach-nesting bird species on ocean beaches, is understanding the threat levels to which each site is exposed where these birds occur (observation location). Effective conservation management is built around mitigating threats at breeding sites, so it is critical to know what these threats are and how threatened these sites are relative to one another.

While a proportion of the mainland Hooded Plover population is monitored intensively during the breeding season and threats are recorded during each visit using the MyBeachBirds data portal, for other sites that are rarely visited, the biennial count provides an opportunity to assess the range and relative severity of threats that the birds may be encountering there.

Whenever a beach-nesting bird was observed during the count, participants were instructed to note all the key threats present on the beach within a 100 m radius of the observation. This data is used to devise a crude scoring system for threats at sites and to devise heat maps to signal how threatened the birds are at each site.

The threat score was calculated based on the presence and type of threat:

5=	Vehicles/ Horses/Stock	**4=**	Dogs off leash/ Dune use	**3 =**	Dogs on leash/ Evidence of people/Dog prints/Cats/Foxes/Deer

Threat types are scored individually and summed to provide an overall score for a particular observation. For vehicles, for which three subtypes exist (4WD, trail bike, quad bike/ATV), the presence of each of these is scored separately. Similarly, 'evidence of people' consists of two subtypes: presence of human prints above the high tide line and presence of people on the beach.

Threats given a score of higher than 3 are rated as having a greater impact because they:

a. have multiple impacts on the birds, their eggs and chicks as well as their physical habitat;
b. are generally present across a greater cross-section of the birds' habitat (i.e., water's edge, beach and dunes);
c. are more difficult to mitigate (e.g., roaming stock, unregulated horse, or vehicle access); and,
d. are known to inhibit successful breeding.

Five score categories were used, in line with the previous three biennial counts (Driessen and Maguire 2015), ranging from very low threat levels (green) to extreme threat levels (purple, generally only encountered in a suburban beach context or at a recreational hotspot):

- Green, score of 0-3;
- Yellow, score of 4-8;
- Orange, score of 9-13;
- Red, score of 14-23; and,
- Purple, score of 24 or more.

Through grouping the threat scores into fixed categories for each biennial count, approximate trends in threat levels across regions and years emerge. This is useful both as a high-level indicator – i.e., trends in threat levels across different states – as well as a local conservation management aid.

Data entry and analysis

BirdLife Australia's Birdata web portal was used to record and manage the biennial count data using the custom-built Beach-nesting Birds Program survey form. Count data were entered directly into Birdata by either the participant, regional count coordinator or a BirdLife Australia National Office volunteer. The data were then exported into Microsoft Excel for analysis and to produce maps.

Data vetting

There was still a strong need for data vetting in data entered both online and from paper data sheets. Twenty-seven percent of surveys were entered through the website on behalf of the person/people conducting the survey. A common problem when entering data from data sheets is in relation to the recorded Global Positioning System (GPS) coordinates. There are different formats of coordinates that describe a position on a map, and they are available as options on hand-held GPS units. The biennial count instructions and data sheets contained examples of the format of coordinates that should be used for the count. The format "decimal degrees" was preferred (DDD.DDDDD°; e.g. 38.540903°S 145.438145°E) as much of our data is collected using this format to allow for consistency across years. A proportion of the data still came back in the formats of degrees minutes seconds (DDD° MM' SS.SS"; e.g. 38° 32' 27.25"S 145° 26' 17.32"E), degrees and decimal minutes (DDD° MM.MMM; e.g. 38° 32.454'S 145° 26.289'E) and Universal Transverse Mercator (UTM; e.g. 55 H 363882.80m E 5733011.78m S). All of these different formats represent the same spot on a map, but when multiple formats are used, conversion calculators are required to convert locations into

decimal degrees where an element of accuracy is lost during conversion as well as significantly slowing down data processing.

Another error that was detected during vetting was survey data belonging to multiple survey routes being combined and entered as one ad-hoc route instead of several entries in Birdata with each entry relating to a unique survey route. This creation of ad-hoc routes leads to the initial assumption that survey routes have not been surveyed, and eventually resulting in the count coordinator having to manually separate the observations out into their respective survey routes. Another common error when entering data online was creating a separate survey for each individual observation instead of recording each observation within the one survey. Where this occurred, observations had to be consolidated into the one survey. Alternatively, in some instances where no birds were sighted during a survey, the survey was not entered into Birdata. However, it is still important to record that the survey occurred despite no birds being observed.

Birdata uses predefined polygons to encompass each survey route into which participants plot their observations. In the 2022 count, survey participants were able to enter bird observations even if they fell outside of these boundaries (if a sighting fell outside of the boundaries, Birdata would show a warning enabling users to double check their coordinates before submitting their data). These sightings were then manually checked, with the majority falling on extensive sand flats, spits or dunes that are not always captured in the route boundaries due to their dynamic nature over time and variations in satellite imagery. Observations of birds other than of Hooded Plovers that occurred well outside of the route boundaries were excluded from further analyses.

Mapping

All existing survey routes were digitised in a Geographic Information System (GIS) environment, using ArcMap 10.8.2 software. Existing spatial coastline data was used to provide an accurate basis for the complexity of the coastline along each survey route – i.e., each route was digitised in accordance with the layout of the landscape, not 'as the crow flies'. Subsequently all surveyed and non-surveyed routes (or sections thereof) were similarly digitised in ArcMap, providing an overview of regional coverage. Count data (observations) were imported into ArcMap to allow for the creation of maps as well as spatial querying of the dataset.

Results

Results of only the three mainland states - South Australia, Victoria, and New South Wales – are presented in the main body of the report for ease of comparison with previous count reports whereas results of the two Tasmanian regions are presented separately.

Survey timing and effort

The majority of surveys for the 2022 biennial count were undertaken in the third week of November, coinciding with the target count weekend and two days either side of the count weekend (Figure 1). Out of all count data, 34% was collected during the official count weekend. Within four days of the count weekend (the day before to the day after the count weekend), 50% of all data was collected, while 86% of data was collected within 10 days of the count weekend. This outstanding effort from participants across the three states resulted in 98% of all data being collected during November. Less than 1% of all count data was collected outside of November and December due to access limitations related to flooding and remoteness of some survey routes.

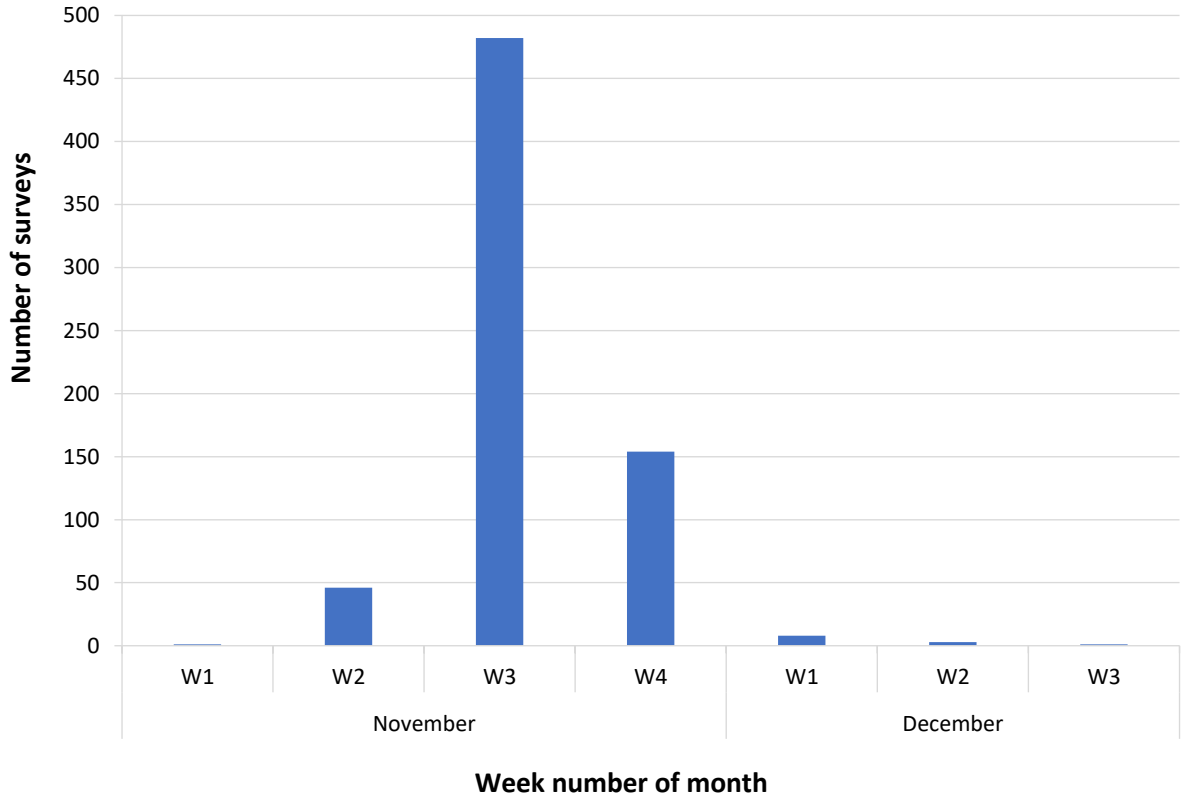


Figure 1. Distribution of the 2022 biennial count surveys in time.

Overall beach-nesting shorebird numbers

A total of 1,664 Hooded Plovers were counted (1,622 adults and 42 juveniles) across 94% of suitable coastline of south-eastern mainland Australia (Table 1; Appendices 1-3). The 2022 biennial count recorded 92% of the estimated number of birds in the mainland population and 55% of the world population (eastern subspecies). In a global context, counts for Hooded Plover, Red-capped Plover (*Charadrius ruficapillus*), Sooty Oystercatcher (*Haematopus fuliginosus*) and Pied Oystercatcher (*Haematopus longirostris*) represent internationally important numbers (Table 1). While the count is not intended to census the populations of the latter three species, it does reveal that ocean beach habitats on the eastern mainland provide important habitat for them. For Pied Oystercatchers in particular, the count surveys a high proportion of their preferred habitat.

Table 1. Overview of the 2022 biennial count results (adults and juveniles) in an international context.

	Hooded Plover	Red-capped Plover	Pied Oystercatcher	Sooty Oystercatcher
Victoria	761	258	610	224
South Australia	838	1,378	1157	713
New South Wales	65	75	82	46
Total	**1,664**	**1,711**	**1,849**	**983**
Global population*	3,000	95,000	11,000	7,500
Importance	**55%**	**2%**	**17%**	**13%**
* estimates from IUCN Red List of Threatened Species (2016) and Wetlands International (2022).				

A regional and state breakdown of total counts reveals that for Hooded Plovers, similar to previous counts, the regions of Yorke Peninsula, Kangaroo Island, and Eyre Peninsula (all in South Australia), and Warrnambool to Yambuk (in Victoria) all support significant numbers of the species (Table 2, Figure 2a). It is important to note that the size of these regions relative to their Hooded Plover populations varies significantly, thus Figure 2b of the density of birds relative to area provides a meaningful depiction of high value sections of coastline.

Juvenile Hooded Plovers made up approximately 2.5% of the total species count. Given the timing of the count within the breeding season, only August to mid-September nesters would have flying juveniles by mid-November. These would be the earliest nesting attempts and so this proportion of juveniles is not unexpected. Interestingly, Eyre Peninsula (7.1% of species count made up of juveniles) and Yorke Peninsula (5.8% of species count made up of juveniles) had a higher proportion of juveniles than other regions. They are the regions in south-eastern Australia where Hooded Plover pairs begin to nest the earliest in the breeding season and the higher proportion of juveniles suggest that these regions have experienced high rates of chick survival in the early part of the season.

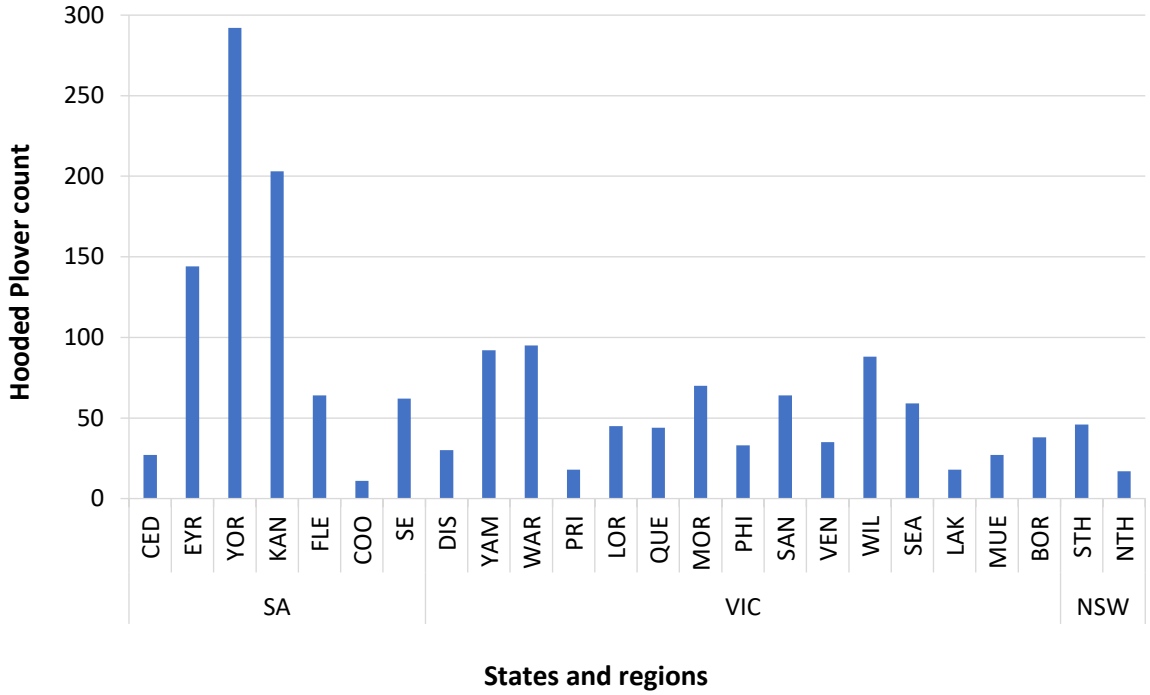
The overall number of Red-capped Plovers on ocean beaches suffered a significant decrease in the 2022 count (41% decrease) compared with the 2020 count. As with previous counts, the number of Red-capped Plovers in South Australia is considerably higher compared with Victorian and southern New South Wales beaches (Table 2, Figures 3a and b). In South Australia, Red-capped Plovers were recorded in large numbers in the Ceduna and West, Eyre Peninsula and Yorke Peninsula regions. Of the total number of Red-capped Plovers recorded for the state, 2.4% were juveniles. In Victoria, the highest number of Red-capped Plovers were recorded in the Seaspray to Corner Inlet and only one juvenile was recorded in the entire state, which was in the Mueller River to Lake Tyers region. Lower numbers of the species were scattered throughout the other Victorian regions surveyed. This species occupies a broad range of habitats that were not surveyed, including low-energy beaches and wetlands. These habitats may instead be the preferred habitat for this species in Victoria.

As with previous counts, relatively large numbers of Pied Oystercatchers were recorded in South Australia, far-western Victoria and Corner Inlet (Table 2, Figures 4a and b). Corner Inlet, Discovery Bay, Coorong, Kangaroo Island, Yorke Peninsula, Eyre Peninsula, and Ceduna and West regions each support internationally important numbers of Pied Oystercatchers (exceeding 1% of the global population). A decrease in the combined total number of Pied Oystercatchers was detected in the New South Wales North and South regions compared with the 2020 count where both regions collectively harboured just over 1% of the global population. Given its Endangered conservation status in New South Wales (fewer than 200 breeding pairs in the state, Office of Environment and Heritage, NSW 2019) and the fact that some of the remote beaches in the south provide important habitat for the species, it may be prudent to closely monitor their numbers.

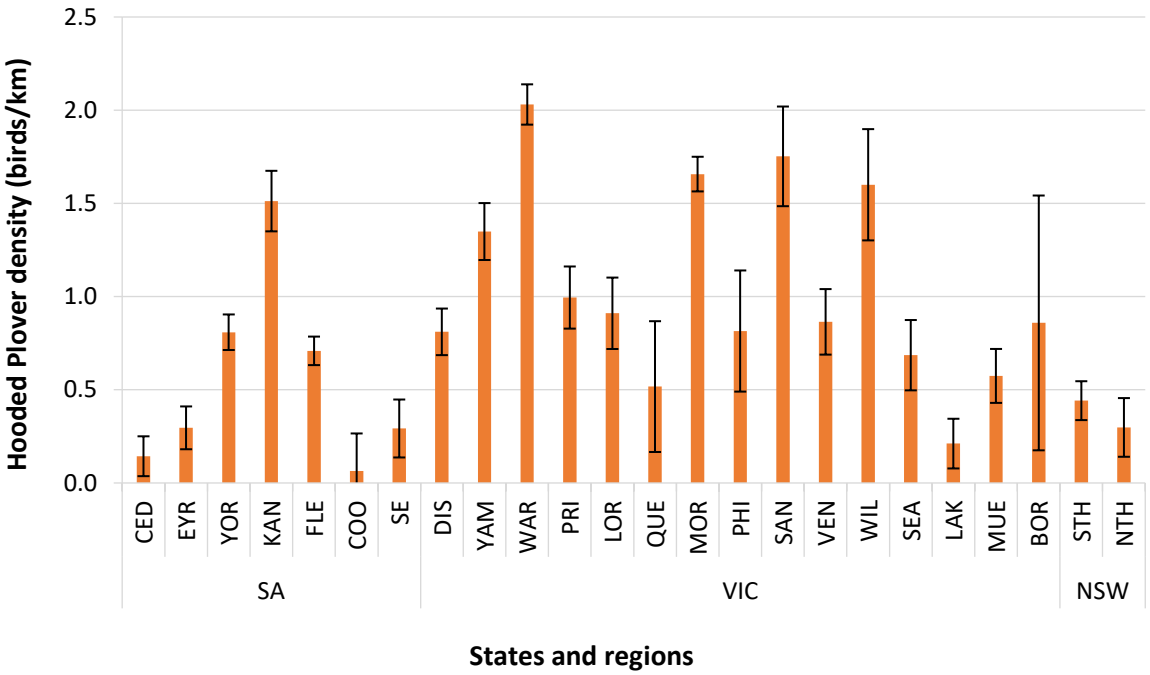
Sooty Oystercatchers were found in relatively large numbers in the Yorke Peninsula, Eyre Peninsula and Ceduna and West regions (all in South Australia) however, densities were quite low (Table 2, Figures 5a and b). This high abundance relative to other parts of the coast may be attributed to the rocky coastline and the presence of offshore islands in these regions, as this is the preferred habitat of the species. The highest number in Victoria was recorded in the Wilsons Prom to Waratah Bay region while the New South Wales North region had the highest recorded numbers in New South Wales (Table 2). By no means does the Hooded Plover biennial count give a reliable indication of the population of Sooty Oystercatchers in the southern mainland of Australia, as the count does not target their prime habitat.

Table 2. Results of the 2022 Hooded Plover biennial count (by state and region).

REGION	Hooded Plover			Red-capped Plover			Pied Oystercatcher			Sooty Oystercatcher		
	Adult	Juv.	**Total**	Adult	Juv.	**Total**	Adult	Juv.	**Total**	Adult	Juv.	**Total**
Victoria												
1. NSW Border to Point Hicks	38	0	**38**	7	0	**7**	21	0	**21**	15	0	**15**
2. Mueller River to Lake Tyers	27	0	**27**	35	1	**36**	64	0	**64**	0	0	**0**
3. Lake Tyers to Seaspray	18	0	**18**	47	0	**47**	60	0	**60**	0	0	**0**
4. Seaspray to Corner Inlet	59	1	**60**	50	0	**50**	151	0	**151**	12	0	**12**
5. Wilsons Prom to Waratah Bay	88	2	**90**	32	0	**32**	6	0	**6**	37	0	**37**
6. Venus Bay	35	0	**35**	4	0	**4**	3	0	**3**	12	1	**13**
7. San Remo to Inverloch	64	0	**64**	2	0	**2**	1	0	**1**	22	0	**22**
8. Phillip Island	33	0	**33**	6	0	**6**	14	0	**14**	35	0	**35**
9. Mornington Peninsula	70	1	**71**	11	0	**11**	2	0	**2**	31	5	**36**
10. Queenscliff to Lorne	44	0	**44**	3	0	**3**	11	0	**11**	9	0	**9**
11. Lorne to Princetown	45	1	**46**	0	0	**0**	0	0	**0**	14	0	**14**
12. Princetown to Warrnambool	18	0	**18**	0	0	**0**	2	0	**2**	3	0	**3**
13. Warrnambool to Yambuk	95	0	**95**	33	0	**33**	31	0	**31**	23	0	**23**
14. Yambuk to Swan Lake	92	0	**92**	17	0	**17**	99	33	**132**	5	0	**5**
15. Discovery Bay	30	0	**30**	10	0	**10**	112	0	**112**	0	0	**0**
VIC Total	**756**	**5**	**761**	**257**	**1**	**258**	**577**	**33**	**610**	**218**	**6**	**224**
South Australia												
16. Southeast South Australia	62	1	**63**	113	0	**113**	79	0	**79**	33	2	**35**
17. Coorong	11	0	**11**	91	8	**99**	116	0	**116**	1	0	**1**
18. Fleurieu Peninsula	64	3	**67**	14	0	**14**	50	1	**51**	19	0	**19**
19. Kangaroo Island	203	1	**204**	25	0	**25**	209	2	**211**	45	0	**45**
20. Yorke Peninsula	292	18	**310**	328	26	**354**	143	2	**145**	174	9	**183**
21. Eyre Peninsula	144	11	**155**	342	4	**346**	300	5	**305**	213	1	**214**
22. Ceduna and West	27	1	**28**	425	2	**427**	250	0	**250**	216	0	**216**
SA Total	**803**	**35**	**838**	**1,338**	**40**	**1,378**	**1,147**	**10**	**1,157**	**701**	**12**	**713**
New South Wales												
23. New South Wales South	46	0	**46**	71	0	**71**	67	0	**67**	18	0	**18**
24. New South Wales North	17	2	**19**	4	0	**4**	15	0	**15**	28	0	**28**
NSW Total	**63**	**2**	**65**	**75**	**0**	**75**	**82**	**0**	**82**	**46**	**0**	**46**
Grand Total	**1,622**	**42**	**1,664**	**1,670**	**41**	**1,711**	**1,806**	**43**	**1,849**	**965**	**18**	**983**

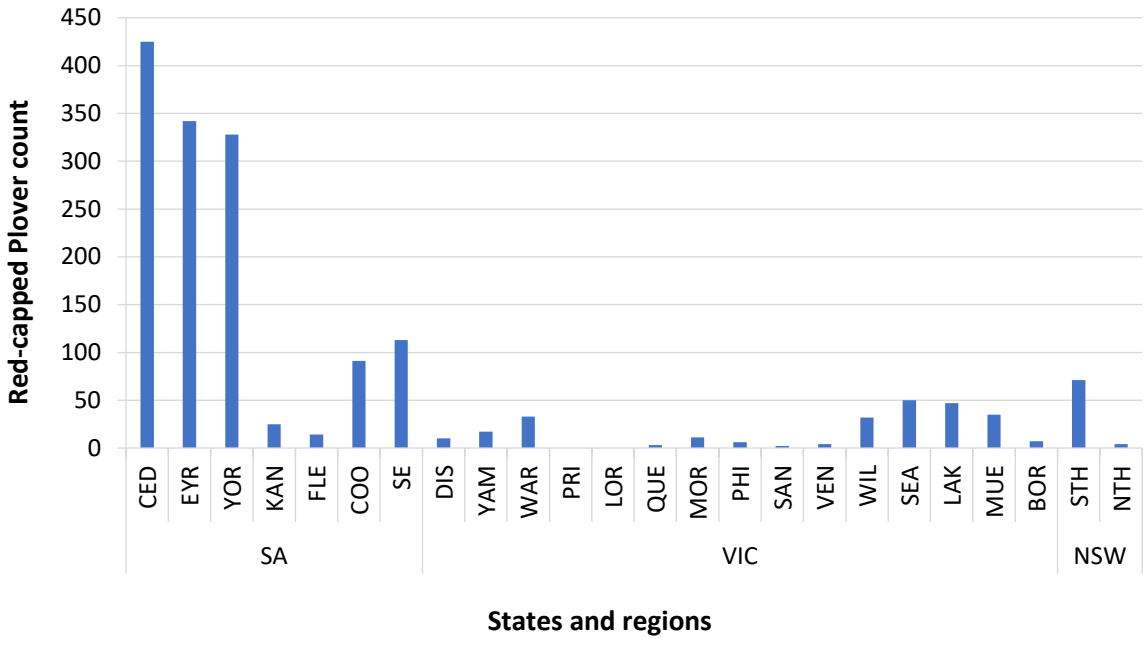


(a)

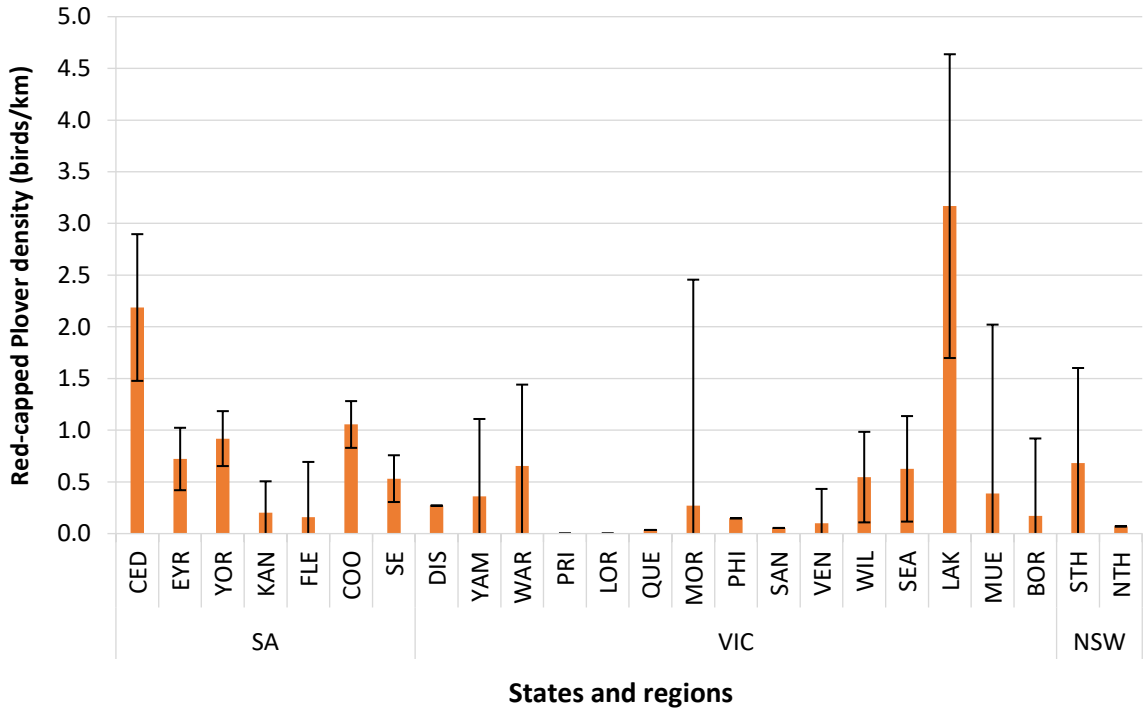


(b)

Figure 2. Adult Hooded Plover counts (a) and densities (b) by region from the 2022 biennial count. Densities are presented with ± standard errors and regions are arranged from west to east for ease of interpretation.

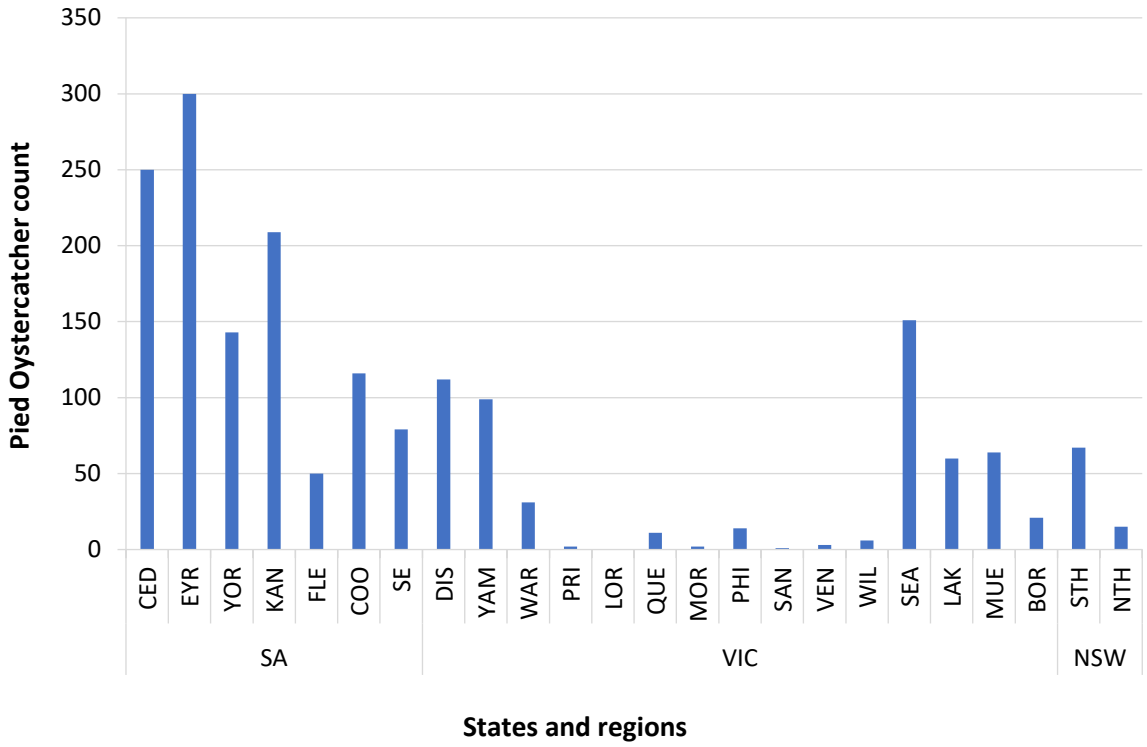


(a)

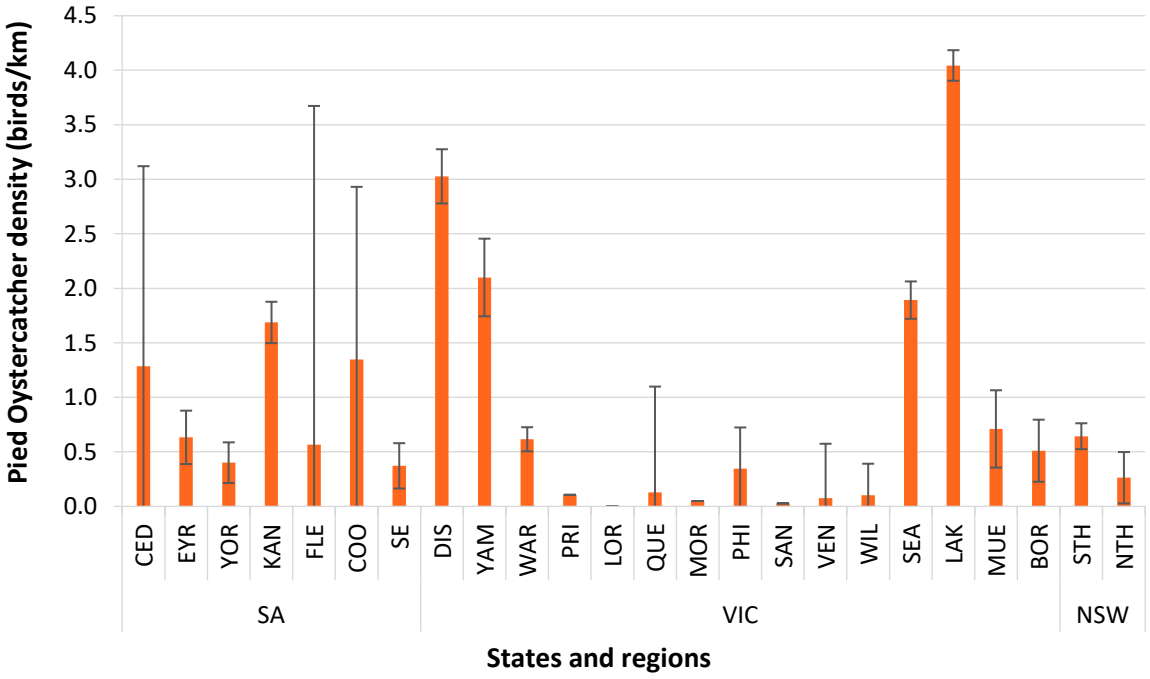


(b)

Figure 3. Adult Red-capped Plover counts (a) and densities (b) by region from the 2022 biennial count. Densities are presented with ± standard errors and regions are arranged from west to east for ease of interpretation.

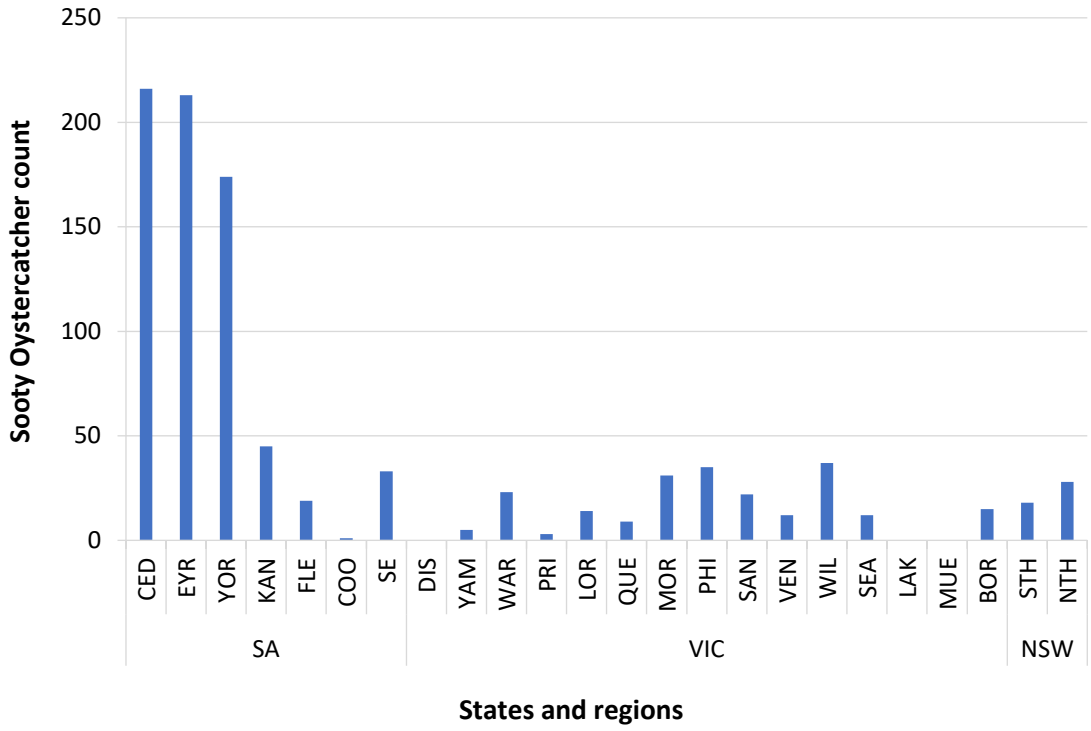


(a)



(b)

Figure 4. Adult Pied Oystercatcher counts (a) and densities (b) by region from the 2022 biennial count. Densities are presented with ± standard errors and regions are arranged from west to east for ease of interpretation.



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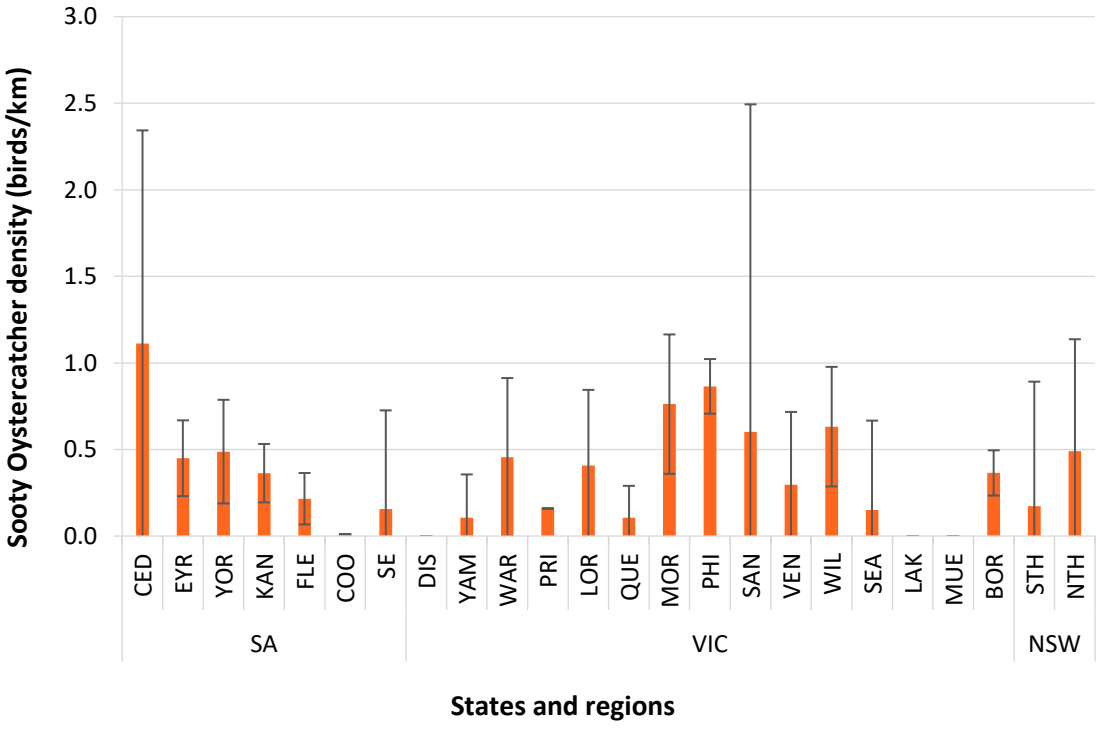

(b)

Figure 5. Adult Sooty Oystercatcher counts (a) and densities (b) by region from the 2022 biennial count. Densities are presented with ± standard errors and regions are arranged from west to east for ease of interpretation.

Banded and flagged birds

Banding and flagging of beach-nesting bird species occurs throughout southern Australia and is undertaken by a number of different study groups including BirdLife Australia's Beach-nesting Birds team, New South Wales National Parks and Wildlife Service (NSW NPWS) staff, Phillip Island Nature Parks (PINP) staff and Friends of Shorebirds South East/Victorian Wader Study Group volunteers. Participants of the biennial count are encouraged to read engraved flags and record the different coloured flag combinations on birds.

During the 2022 count, 296 observations of banded or flagged beach-nesting birds were reported. Of these observations, 198 were of Hooded Plovers, 6 of Red-capped Plovers, 74 of Pied Oystercatchers, 5 of Sooty Oystercatchers, and 13 of Caspian Terns. Reading flag codes, especially on engraved flags, can be difficult for a number of reasons (e.g., bird is too distant, the bird flies off or is moving about, insufficient power of binoculars, etc.). Nearly 82% of total observations of flagged birds comprised fully read flag codes or combinations. This information is invaluable to conservation programs, helping to gain a better understanding of bird survival and movements.

Hooded Plover coverage and densities

As evident in Figures 2-5, when comparing regions, bird numbers are less informative than the density values that can be derived from the bird numbers and the proportion of suitable habitat surveyed. It is also essential that only the adult bird numbers are used in calculating densities as juveniles may disperse from their natal territories hence inflating density values if included in the calculation. Table 3 represents the length of habitat surveyed and the density of Hooded Plovers in each region. Approximately 94% of suitable Hooded Plover habitat was surveyed which is reasonably higher than the 88% coverage achieved in the 2020 count.

The Hooded Plover hotspots on the south-eastern mainland that have had densities exceeding 1 bird per kilometre and 2 birds per kilometre in some cases, in previous biennial counts produced similar results in the 2022 count. The coastline between Warrnambool to Yambuk had the highest density (2.03 birds/km), followed by San Remo to Inverloch (1.75 birds/km) on the Bass Coast, Mornington Peninsula (1.66 birds/km), Wilsons Prom to Waratah Bay (1.60 birds/km), Kangaroo Island in South Australia (1.51 birds/km), and Yambuk to Swan Lake (1.01 birds/km). Significant variation in densities across the coast indicates that habitat for Hooded Plovers is not uniform in quality, and that regions with high densities are likely to reflect high quality habitat. Research into habitat quality and preference reveal that Hooded Plovers are selective of particular habitat features, both terrestrial (amount of dune and foredune habitat) and offshore (amount of intertidal and submerged rocks), as well as food availability which is undoubtedly linked to these features (Cuttriss *et al.* 2015; Ehmke *et al.* 2016).

Table 3. Regional habitat coverage and adult Hooded Plover densities for the 2022 biennial count.

Region	Habitat length (km)	Habitat surveyed (km)	Habitat surveyed (%)	Density (birds/km)
1. NSW Border to Point Hicks	53.9	44.3	82.2	0.86
2. Mueller River to Lake Tyers	121.9	47.0	38.6	0.57
3. Lake Tyers to Seaspray	105.4	85.3	80.9	0.21
4. Seaspray to Corner Inlet	86.1	86.1	100.0	0.69
5. Wilsons Prom to Waratah Bay	62.8	55.0	87.5	1.60
6. Venus Bay	40.5	40.5	100.0	0.86
7. San Remo to Inverloch	36.5	36.5	100.0	1.75
8. Phillip Island	40.5	40.5	100.0	0.82
9. Mornington Peninsula	42.2	42.2	100.0	1.66
10. Queenscliff to Lorne	89.9	85.1	94.7	0.52
11. Lorne to Princetown	49.4	49.4	100.0	0.91
12. Princetown to Warrnambool	19.4	18.1	93.1	0.99
13. Warrnambool to Yambuk	51.5	46.8	90.8	2.03
14. Yambuk to Swan Lake	68.2	68.2	100.0	1.35
15. Discovery Bay	37.0	37.0	100.0	0.81
16. Southeast South Australia	212.2	212.2	100.0	0.29
17. Coorong	173.2	173.2	100.0	0.06
18. Fleurieu Peninsula	90.3	90.3	100.0	0.71
19. Kangaroo Island	135.8	134.2	98.9	1.51
20. Yorke Peninsula	382.9	361.1	94.3	0.81
21. Eyre Peninsula	492.9	486.9	98.8	0.30
22. Ceduna and West	197.8	188.3	95.2	0.14
23. New South Wales South	105.2	104.2	99.1	0.44
24. New South Wales North	58.6	57.1	97.4	0.30
Victoria	**905.2**	**781.9**	**86.4**	**0.97**
South Australia	**1685.0**	**1646.1**	**97.7**	**0.49**
New South Wales	**163.8**	**161.2**	**98.5**	**0.39**
TOTAL	**2754.0**	**2589.3**	**94.0**	**0.63**

Comparison with previous years

From 2010 onwards, we have adjusted survey routes to more accurately reflect potential habitat, and so there have been some changes in densities recorded over the years. In 2014, an additional 469 km (a 25% increase) of habitat were surveyed compared with the 2012 count which largely related to new routes identified in remoter regions such as Eyre Peninsula (Table 4). This inclusion resulted in 135 more Hooded Plovers being recorded, however the substantial increase in coverage

resulted in a lower overall density. The 2016 count saw a further 116 km added to the fixed routes but a 2% decrease in coverage compared with the 2014 count. Remarkably, 178 more Hooded Plovers were recorded causing the overall density to increase significantly. This reflects a genuine increase in population numbers related to a boom breeding season in 2015/16. A further 99 km was added to the fixed routes in the 2018 count which saw a 2% increase in coverage compared with the 2016 count, however the number of Hooded Plovers recorded decreased by 31, with the overall density also decreasing (Table 4). An additional 38 km were incorporated to the fixed routes during the 2020 count, with coverage increasing by 3% compared with the 2018 count. This resulted in 37 more adult Hooded Plovers being recorded however the density decreased (Table 4). In the 2022 count an additional 176 km of habitat were surveyed compared with the 2020 count, resulting in an additional 96 Hooded Plovers. This, however, did not result in an increase in density.

Table 4. Comparison of adult Hooded Plover count totals and densities between 2012 and 2022.

	Total HP	Fixed route length (km)	Actual habitat surveyed (km)	Density (birds/km)
2012	1,207	2,334	1,871 (80%)	0.65
2014	1,342	2,494	2,340 (94%)	0.57
2016	1,520	2,610	2,291 (88%)	0.66
2018	1,489	2,709	2,333 (86%)	0.64
2020	1,526	2,747	2,413 (88%)	0.63
2022	1,622	2,754	2,589 (94%)	0.63
Difference 2012-2014 count	**135**	**160**	**+469 (+25%)**	**-0.08**
Difference 2014-2016 count	**178**	**116**	**-49 (-2%)**	**0.09**
Difference 2016-2018 count	**-31**	**99**	**+42 (+2%)**	**-0.02**
Difference 2018-2020 count	**37**	**38**	**+80 (+3%)**	**-0.01**
Difference 2020-2022 count	**96**	**7**	**+176 (+7%)**	**0.00**

Breaking down the above total density values further to the regional level reveals some major differences between the average densities (2012-2020) compared with the 2022 densities (Table 5). However, since density is a combination of number of birds sighted and length of coastline surveyed, a significant difference in density may be a consequence of change in either of these values, or both. Therefore, separating the density values into their components, and then comparing those directly provides a better insight into why some densities appear to have changed dramatically within ten years (between five counts) while others have remained stable (Table 6). Theoretically, for each count, if all habitat surveyed was equally suitable, the difference in proportions between the coverage and the number of Hooded Plovers should be negligible; in other words, surveying an extra 20% of 'suitable' coastline should yield approximately 20% extra Hooded Plovers counted, leading to a minor discrepancy.

Table 5. Adult Hooded Plover densities from 2012 to 2022, arranged in order of decreasing percentage of difference between the average densities (2012-2020) and 2022 densities.

Zone	Region	Density (birds/km)						Percentage difference (2022 to avg.)
		2012	2014	2016	2018	2020	2022	
1	NSW Border to Point Hicks	0.40	0.54	0.42	0.55	0.46	0.86	81
15	Discovery Bay	0.92	0.24	0.15	0.49	0.81	0.81	55
14	Yambuk to Swan Lake	0.82	0.67	0.72	1.21	1.02	1.35	52
5	Wilsons Prom to Waratah Bay	1.02	0.91	1.00	1.42	1.43	1.60	38
23	New South Wales South	0.34	0.23	0.32	0.34	0.37	0.44	38
2	Mueller River to Lake Tyers	0.59	0.33	0.47	0.43	0.39	0.57	30
4	Seaspray to Corner Inlet	0.30	0.25	0.51	1.17	0.78	0.69	14
18	Fleurieu Peninsula	0.50	0.57	0.68	0.71	0.67	0.71	13
16	Southeast South Australia	0.34	0.21	0.27	0.24	0.33	0.29	5
19	Kangaroo Island	1.67	1.40	1.64	1.28	1.32	1.51	3
6	Venus Bay	0.89	1.04	0.82	0.76	0.72	0.86	2
11	Lorne to Princetown	0.77	0.54	1.08	1.06	1.02	0.91	2
10	Queenscliff to Lorne	0.40	0.51	0.52	0.62	0.49	0.52	2
7	San Remo to Inverloch	1.58	1.63	2.19	2.00	1.64	1.75	-3
22	Ceduna and West	0.14	0.26	0.12	0.05	0.20	0.14	-6
20	Yorke Peninsula	1.05	0.75	0.92	0.80	0.80	0.81	-6
9	Mornington Peninsula	2.41	2.08	2.09	1.88	1.55	1.66	-17
13	Warrnambool to Yambuk	2.26	2.44	2.82	2.49	2.32	2.03	-18
21	Eyre Peninsula	0.37	0.42	0.40	0.34	0.31	0.30	-19
12	Princetown to Warrnambool	1.25	1.14	2.17	1.24	1.01	0.99	-27
8	Phillip Island	1.18	1.19	1.21	1.12	0.89	0.82	-27
24	New South Wales North	0.42	0.46	0.62	0.53	0.35	0.30	-37
17	Coorong	0.13	0.12	0.14	0.16	0.14	0.06	-54
3	Lake Tyers to Seaspray	0.16	0.13	0.22	0.78	1.01	0.21	-54

Table 6. Comparison between coverage and the numbers of Hooded Plovers (adults and juveniles) in 2020 and 2022, by region. The 'Difference in coverage' column shows how much more or less coastline was surveyed in 2022 than in 2020, e.g., a negative value indicates less coverage in 2022. Similarly, the 'Difference in HP total' column compares the 2022 and 2020 totals of Hooded Plovers, e.g., a negative value indicates fewer birds in 2022. The 'Discrepancy' column shows the difference between these two values which should, theoretically, be very small if the routes surveyed in that region are similar in quality. The regions are arranged in order of decreasing 'Discrepancy'.

Zone	Region	State	Difference in coverage (%)	Difference in HP total (%)	Discrepancy (%)
14	Yambuk to Swan Lake	VIC	45	84	39
1	NSW Border to Point Hicks	VIC	8	36	28
2	Mueller River to Lake Tyers	VIC	-48	-23	25
6	Venus Bay	VIC	0	21	21
5	Wilsons Prom to Waratah Bay	VIC	-6	7	13
19	Kangaroo Island	SA	8	21	12
18	Fleurieu Peninsula	SA	2	12	9
9	Mornington Peninsula	VIC	4	11	7
7	San Remo to Inverloch	VIC	0	7	7
10	Queenscliff to Lorne	VIC	0	5	5
23	New South Wales South	NSW	0	2	2
20	Yorke Peninsula	SA	1	2	1
15	Discovery Bay	VIC	0	0	0
21	Eyre Peninsula	SA	3	2	-1
24	New South Wales North	NSW	0	-5	-5
12	Princetown to Warrnambool	VIC	-4	-10	-6
4	Seaspray to Corner Inlet	VIC	8	-3	-11
13	Warrnambool to Yambuk	VIC	-7	-19	-12
16	Southeast South Australia	SA	0	-13	-12
11	Lorne to Princetown	VIC	44	31	-13
8	Phillip Island	VIC	0	-15	-15
22	Ceduna and West	SA	-3	-30	-27
17	Coorong	SA	101	-8	-109
3	Lake Tyers to Seaspray	VIC	475	20	-455
		AVERAGE	**+26**	**+6**	**-21**

Five of the 24 regions had greater than a 20% difference in coverage between the 2020 and 2022 counts – a decrease compared with the 2020 biennial count when seven regions fell into this category. Four of these five regions had 44-475% more coverage than in 2020. For example, in 2022, within the Lake Tyers to Seaspray region, most of the long stretch of beach between Lakes Entrance and Seaspray which was not surveyed in 2020, was surveyed with the help of all-terrain vehicles.

Similarly in the Coorong, the rangers were able to survey the whole stretch of beach of which only half was surveyed in the previous count. The other region had significantly less coverage (48% less) compared with 2020. This included some remote beaches of the Mueller River to Lake Tyers region in East Gippsland which were impacted by access limitations due to flooding. Eight of the 24 regions had greater than a 20% difference in Hooded Plover numbers between the 2020 and 2022 counts which was slightly less than the 11 regions in 2020. Six of these regions recorded increases while the remaining two recorded decreases in observed numbers.

Once the difference in coverage and bird numbers have been considered, large discrepancies (Table 6) can be interpreted as either a real change in the local numbers of Hooded Plovers or unsuitable habitat being surveyed in regions where habitat coverage increased. Large negative discrepancies trigger potential concern and a need to explore our local knowledge and data from these areas. Fewer birds, despite increased coverage, were noted in Coorong (101% more habitat surveyed but 8% fewer Hooded Plovers) and Seaspray to Corner Inlet (8% more habitat surveyed but 3% fewer Hooded Plovers) regions. The decrease in Hooded Plover numbers in the Coorong region flags concern as it could be attributed to the constant disturbance caused by vehicles driven on the beach during spring and summer. Driving on beaches also cause coastal erosion which eventually leads to habitat loss further exacerbating the situation. The decrease in numbers in the Seaspray to Corner Inlet region is negligible (2 birds fewer) thus does not trigger potential concern at this stage.

Overall, the change in numbers compared with survey coverage is a positive result, indicating that the overall population trend is still advancing towards an increase over time (Table 6). It should be noted that not all habitat is the same in quality and that 10 km of coastline will not have the equivalent occupancy across regions. We thus interpret discrepancies cautiously, utilising local knowledge of breeding pairs from other projects. In the regions of Yambuk to Swan Lake, Lorne to Princetown, and Lake Tyers to Seaspray, there was a considerable increase in coverage (45%, 44%, and 475% respectively) which resulted in an increase in Hooded Plover numbers (84%, 31%, and 20% respectively). This is expected as these regions are known to harbour birds in stretches of beach that had not been surveyed in the previous count. A similar pattern, albeit with a much smaller increase in coverage, is evident for NSW Border to Point Hicks (8% coverage, 36% more Hooded Plovers), Kangaroo Island (8% coverage, 21% more Hooded Plovers), Fleurieu Peninsula (2% coverage, 12% more Hooded Plovers), Mornington Peninsula (4% coverage, 11% more Hooded Plovers), Yorke Peninsula (1% coverage, 2% more Hooded Plovers), and Eyre Peninsula (3% coverage, 2% more Hooded Plovers). Kangaroo Island Hooded Plover population experienced successful breeding seasons in 2020/21 and 2021/22 which could account for the increase recorded there in the 2022 count. Conversely, the region of Wilsons Prom to Waratah Bay experienced a 6% decrease in coverage but an increase in six Hooded Plovers. This increase is negligible given that the long stretch at Cotters Beach in Wilsons Prom is a known flocking site which attracts non-breeding flocks of Hooded Plovers even during the breeding season.

Small decreases in the number of Hooded Plovers where there was no change in habitat coverage were detected in the regions of Southeast South Australia and Phillip Island (nine and six Hooded Plovers respectively). Conversely, small increases in Hooded Plover numbers despite no change in habitat coverage were recorded in the regions of Venus Bay, San Remo to Inverloch, Queenscliff to

Lorne, and New South Wales South (six, four, two, and one Hooded Plover respectively). Remarkably the Discovery Bay region produced the same number of Hooded Plovers as the 2020 count with no changes in habitat coverage.

Evidence of breeding

Count participants were requested to record evidence of breeding when it was observed. Evidence of breeding was recorded in 27% of the Hooded Plover observations made during the count (a considerable decrease from the 36% in 2020). As well as direct evidence of breeding, several people noted adult behaviour that suggested breeding (e.g., leading and distraction displays). Fewer chicks (45% less) were observed in 2022 than during the 2020 count which indicates poor hatching success in the early part of the 2022/23 breeding season (Table 7). A high proportion of nests failed especially during the start of the of breeding season due to tidal inundation caused by storm surges arising from unsettled weather.

Count data are seldom useful for accurately assessing breeding activity, as Hooded Plovers are adept at hiding their nests and chicks, and because count participants must cover a lot of ground during the survey, there is little spare time for participants to spend watching the birds' behaviour and search for nests. Nest monitoring is not an essential task of the biennial count and is typically carried out by trained nest monitors within various organisations (e.g., BirdLife Australia, volunteers of Friends of the Hooded Plover, Phillips Island Nature Parks, and New South Wales National Parks and Wildlife Service) who embark on regular monitoring of breeding pairs in Victoria, South Australia and New South Wales. As part of the established monitoring program, Hooded Plover pairs are visited regularly and over time, trained citizen scientists become proficient at recognising breeding behaviour of Hooded Plovers. The data collected through this method of monitoring enables us to quantify breeding success, to devise more accurate threat profiles based upon multiple visits to breeding sites, and for us to make comparisons of breeding output between regions, guiding us in our conservation efforts for the species.


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Table 7. Evidence of Hooded Plover breeding recorded in each region during the 2022 biennial count. Values represent the number of observations recorded within each nesting stage. *Scrape:* a small depression in the sand which does not contain eggs; *Suspect nest:* based on adult behaviours (leading, false brooding), a nest with eggs is suspected but never sighted; *Nest with eggs:* scrape containing eggs; *Suspect chicks:* based on adult behaviours (distraction displays, aggression), presence of chicks is suspected but never sighted; *Chicks:* chicks between 1-35 days old sighted.

Region	Scrapes	Suspect nests	Nests with eggs	Suspect chicks	Chicks
Victoria					
1. NSW Border to Point Hicks	-	3	-	-	-
2. Mueller River to Lake Tyers	3	-	2	-	-
3. Lake Tyers to Seaspray	-	1	-	-	-
4. Seaspray to Corner Inlet	4	4	-	-	-
5. Wilsons Prom to Waratah Bay	-	3	2	-	-
6. Venus Bay	2	-	-	-	-
7. San Remo to Inverloch	2	1	8	-	-
8. Phillip Island	-	-	1	-	-
9. Mornington Peninsula	4	1	8	1	2
10. Queenscliff to Lorne	-	2	2	1	-
11. Lorne to Princetown	4	-	-	-	-
12. Princetown to Warrnambool	-	-	1	-	1
13. Warrnambool to Yambuk	7	3	2	-	1
14. Yambuk to Swan Lake	6	-	1	-	2
15. Discovery Bay	2	-	1	-	-
Total	**34**	**18**	**28**	**2**	**6**
South Australia					
16. Southeast South Australia	1	-	2	-	-
17. Coorong	-	-	-	-	-
18. Fleurieu Peninsula	1	1	11	-	1
19. Kangaroo Island	3	14	4	1	6
20. Yorke Peninsula	5	26	6	3	3
21. Eyre Peninsula	1	6	6	1	3
22. Ceduna and West		1			
Total	**11**	**48**	**29**	**5**	**13**
New South Wales					
23. New South Wales South	2	-	1	-	3
24. New South Wales North	-	3	6	1	-
Total	**2**	**3**	**7**	**1**	**3**
Grand Total	**47**	**69**	**64**	**8**	**22**

Threat Assessments

Of all observations of beach-nesting birds (including terns), 83.3% of sightings included threat assessments. Out of the 2,157 observations of beach-nesting birds where threat data was collected, no threat of any kind was observed at 37% of these (800 observations). Seventy percent of sightings with no threats detected were recorded in remote areas in South Australia (Kangaroo Island, Yorke Peninsula and Eyre Peninsula) and a further 29% were recorded in relatively inaccessible areas in Victoria (parts of Wilsons Promontory National Park and the Corner Inlet sand islands). A summary of the percentage of sites in the three states falling within the different threat score categories reveals that in all three states, there were more sites with green threat scores than any other threat score category. However, sites with orange threat scores were only slightly lower than sites with green threat scores in New South Wales (Table 8).

Table 8. The percentage of sites (observations) with beach-nesting birds falling within each threat score category in 2022, by state.

	Green (0-3)	Yellow (4-8)	Orange (9-13)	Red (14-23)	Purple (24+)
VIC	64.2	19.2	11.1	4.9	0.6
SA	54.2	26.9	11.2	7.0	0.7
NSW	31.8	24.2	28.8	15.2	0.0
ALL SITES	56.8	24.3	11.7	6.5	0.6

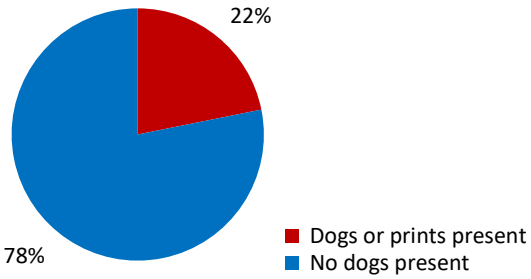
Maps depicting threat score categories have been made for each of the 24 surveyed regions (see Appendices 1-3). Since the 2010 count, these maps have revealed a similar pattern of distribution of threat score categories where sites with orange, red, or purple (high level) threat scores being generally located near population centres or areas of high recreational use, while sites with green (low level) threat scores being typically located away from these busy areas.

A comparison of the spread of sites with different threat score categories between the 2020 and 2022 counts, indicates an increase in the number of sites with low level (green) and moderate level (yellow) threat scores, and a decrease in the number of sites with moderate level (orange) and high level (red) threat scores (Table 9). The number of sites with the highest threat level (purple) appears to have decreased slightly but is largely stable. At a state level, the most significant change of threat score distribution has occurred in South Australia, where there has been an increase in sites with green threat scores with a corresponding decrease in orange, red, and purple threat scores which is encouraging. There has been significant investment in South Australian site protection, which aligns with this lowering of threat scores. Interestingly, in New South Wales, there has been a decrease in sites with green and orange threat scores and a corresponding increase in yellow and red threat scores.

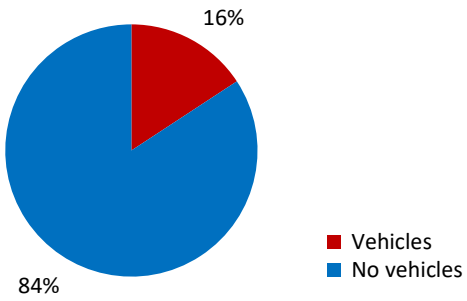
Table 9. The percentage difference between spread of threats of sites between 2020 and 2022, by state.

	Green (0-3)	Yellow (4-8)	Orange (9-13)	Red (14-23)	Purple (24+)
VIC	0.2	5.7	-3.4	-2.9	0.4
SA	9.1	3.4	-6.0	-5.4	-1.2
NSW	-3.5	3.7	-3.6	3.4	0.0
ALL SITES	6.6	4.0	-5.6	-4.4	-0.6

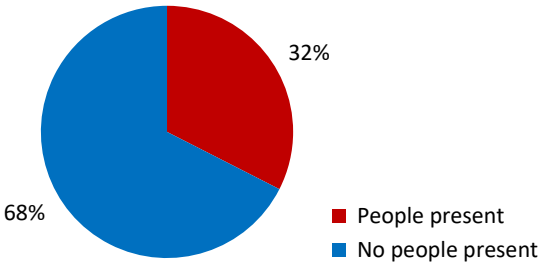
Based on the 2022 count data, around a quarter of all beach-nesting bird species observations (including terns) recorded the threats of dogs and introduced mammalian predators during the breeding season (Figures 6a and d). The threat of vehicles was recorded in 16% of observations and 32% had evidence of people presence (Figures 6b and c). When examining data of just Hooded Plover observations, it is clear that there is substantial pressure from threats on the species. Considering the size of the mainland population (eastern subspecies) – around 1,650 adult birds as detected in this survey – it is particularly concerning that 63% of all Hooded Plover observations recorded during the 2022 biennial count showed evidence of people and/or dogs within 100 metres radius, which is within the buffer of disturbance (Figures 6e and g). This is particularly meaningful given this is a snapshot of threats that will be experienced, and it is likely to underestimate threat occurrence as it represents only a single measure in time. Summer threat levels are likely to be higher and there can be an increase in the number of sites experiencing threats. Furthermore, 11% of observations had evidence of vehicles being present on the beach and 32% had evidence of introduced mammalian predators (Figures 6f and h).



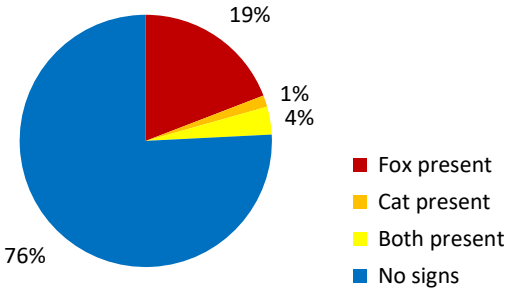
(a) % dog occurrence, all species



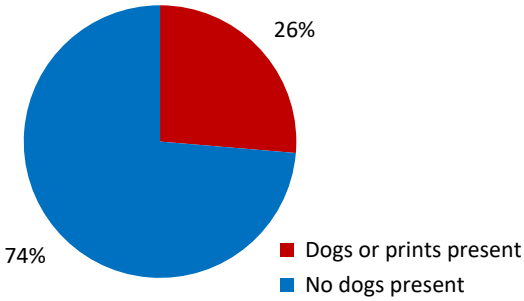
(b) % vehicle occurrence, all species



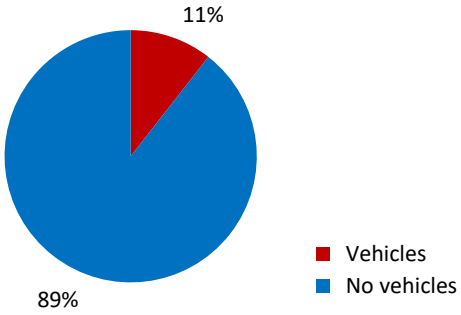
(c) % people occurrence, all species



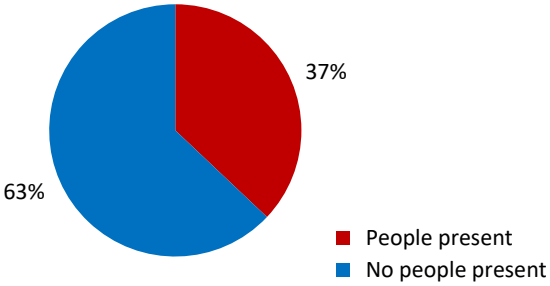
(d) % mammalian predator occurrence, all species



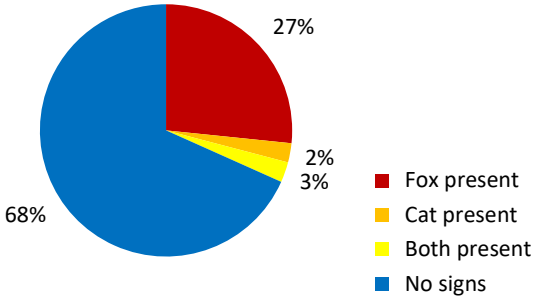
(e) % dog occurrence, Hooded Plover



(f) % vehicle occurrence, Hooded Plover



(g) % people occurrence, Hooded Plover



(h) % mammalian predator occurrence, Hooded Plover

Figure 6. Percentage of key threats recorded within 100 m of beach-nesting species' observations (a-d, all species including terns and e-h, Hooded Plover only).

Invasive weeds

Weeds, such as Marram Grass (*Ammophila arenaria*; deliberately introduced from Europe for dune stabilisation purposes), Sea Spurge (*Euphorbia paralias*; originating from Europe and presumably introduced in shipping ballast water), and Sea Wheat-grass (*Thinopyrum junceiforme*; native to Europe and deliberately introduced for dune stabilisation purposes), have been identified as key species that change the structure of beach and foredune habitats in Australia (Cousens *et al.* 2013).

These structural changes alter the resources available (foraging, nesting, etc.) to Hooded Plovers, leading to either direct impacts (increased predation, mortality, or abandonment of beaches) or to more indirect impacts, such as reduced breeding success due to sub-optimal habitat, to the birds.

The density of vegetation estimated during the 2022 biennial count revealed that the majority of Hooded Plovers were observed within habitats with sparse vegetation or no vegetation (63%, n=691 observations where vegetation density was assessed), which is their preferred nesting habitat. The remainder of Hooded Plover observations were present in moderately (26%) or heavily (11%) vegetated areas. Regions which had Hooded Plover observations in more than 10 moderately or heavily vegetated sites included: Yorke Peninsula (39), Warrnambool to Yambuk (25), Eyre Peninsula (23), Yambuk to Swan Lake (20), Fleurieu Peninsula (19), Lorne to Princetown (15), Venus Bay (15), Kangaroo Island (14), Mornington Peninsula (14), Seaspray to Corner Inlet (14), Wilsons Prom to Waratah Bay (13), and Discovery Bay (11). Weeds were recorded within 89% of these sites (this decreased to 88% when looking at the five target weed species specified during data collection: Marram Grass, Sea Spurge, Sea Wheat-grass, Beach Daisy, and Pyp Grass). Some of the highest weed infestations were recorded in western Victoria and south-eastern South Australia which are in line with the findings of Cousens *et al.* (2013), who indicated that the most extensive Marram Grass infestations occur here, making vast sections of dunes largely unavailable as nesting habitat.

Overall, three major invasive weeds (Marram Grass, Sea Spurge, Sea Wheat-grass) occurred in nearly 61% of Hooded Plover observations where vegetation was assessed. Marram Grass is rated as being of greater threat to the Hooded Plover than other weeds due to Hooded Plovers showing strong avoidance of Marram vegetated dunes, whilst at low to moderate densities of Sea Spurge and Sea Wheat-grass infestations, they still place their nests amongst these weeds in the foredune and dune. However, Sea Spurge and Sea Wheat-grass are still weeds of serious concern, as once established at high densities, these too prohibit successful use of the foredunes and dunes by breeding Hooded Plovers. Also, of concern, is the spread of Cape Beach Daisy across the border from South Australia into Western Victoria, where this weed appears to be rapidly increasing its distribution. Maps of the occurrence of the five main weed species of concern for beach-nesting bird species are provided in Appendices 1-3.

Count participants

The 2022 biennial count attracted 430 participants, 17 fewer participants than in 2020. Table 10 presents the number of participants in each region for 2020 and 2022 and the differences between years. While most participants only surveyed routes in one region, some participants did survey routes in multiple regions. South Australia had the only growth in participation, mainly on Kangaroo Island (Table 10). There was a significant drop in participation in Victoria where only two out of 15 regions experienced minor growth.

Table 10. The number of participants of the 2020 and 2022 biennial counts.

Region	2020 participants	2022 participants	Difference
Victoria			
1. NSW Border to Point Hicks	17	15	-2
2. Mueller River to Lake Tyers	11	3	-8
3. Lake Tyers to Seaspray	6	10	4
4. Seaspray to Corner Inlet	11	9	-2
5. Wilsons Prom to Waratah Bay	15	15	0
6. Venus Bay	7	6	-1
7. San Remo to Inverloch	21	16	-5
8. Phillip Island	15	17	2
9. Mornington Peninsula	17	11	-6
10. Queenscliff to Lorne	27	24	-3
11. Lorne to Princetown	7	5	-2
12. Princetown to Warrnambool	12	6	-6
13. Warrnambool to Yambuk	14	14	0
14. Yambuk to Swan Lake	7	4	-3
15. Discovery Bay	4	3	-1
Total	**191**	**158**	**-33**
South Australia			
16. Southeast South Australia	13	11	-2
17. Coorong	7	6	-1
18. Fleurieu Peninsula	47	51	4
19. Kangaroo Island	52	63	11
20. Yorke Peninsula	47	37	-10
21. Eyre Peninsula	58	55	-3
22. Ceduna and West	11	15	4
Total	**235**	**238**	**3**
New South Wales			
23. New South Wales South	19	25	6
24. New South Wales North	31	20	-11
Total	**50**	**45**	**-5**

Results of Flinders Island and North-east Tasmania

For the first time in the count's history, two regions in Tasmania - Flinders Island and North-east - were included in the 2022 biennial count (Appendix 4). A total of 420 Hooded Plovers were counted (411 adults and 9 juveniles) across 88% of suitable Hooded Plover habitat in the two regions (Table 11). This constituted 35% of the estimated number of birds in the Tasmanian population and 14% of the world population (eastern subspecies). Overall, 24 count participants surveyed over 214 km of suitable habitat where approximately 95% of surveys were conducted

within ten days of the count weekend. Both regions recorded high densities of Hooded Plovers which is consistent with findings from BirdLife Tasmania's population estimates (Woehler, 2013 and 2021).

Table 11. Summary statistics of the two Tasmanian regions that were included in the 2022 biennial count.

Parameter	North-east Tasmania	Flinders Island	Total
Number of survey routes	31	28	**59**
Number of count participants	15	9	**24**
Number of adult (and juvenile) Hooded Plovers	169 (4)	242 (5)	**411 (9)**
Number of adult (and juvenile) Red-capped Plovers	66 (8)	380 (64)	**446 (72)**
Number of adult (and juvenile) Pied Oystercatchers	195 (1)	224 (1)	**419 (2)**
Number of adult (and juvenile) Sooty Oystercatchers	57 (0)	113 (0)	**170 (0)**
Habitat length (km)	88.0	155.1	**243.1**
Habitat surveyed (km)	88.0	126.5	**214.5**
Habitat surveyed (%)	100.0	81.6	**88.2**
Adult Hooded Plover density (birds/km)	1.92	1.91	**1.92**
Hooded Plover breeding evidence (% observations)	15.7	4.3	**9.7**

Of all observations of beach-nesting birds (including terns), 97% of sightings included threat assessments. Out of the 522 observations of beach-nesting birds where threat data was collected, no threat of any kind was observed at 69% of these (363 observations). Most of these observations were made in remote areas of the two regions. A summary of the percentage of sites in the two regions falling within the different threat score categories reveals that in both regions, there were significantly more sites with green threat scores than any other threat score category. There were more sites with yellow and orange threat scores in North-east Tasmania compared with Flinders Island and none of the two regions had any sites with purple threat scores (Table 12).

Table 12. The percentage of sites (observations) in the two Tasmanian regions with beach-nesting birds falling within each threat score category in 2022.

	Green (0-3)	Yellow (4-8)	Orange (9-13)	Red (14-23)	Purple (24+)
North-east Tasmania	63.8	24.9	10.4	0.9	0.0
Flinders Island	91.7	5.0	3.0	0.3	0.0
ALL SITES	79.9	13.4	6.1	0.6	0.0

Discussion and Recommendations

The biennial count data help us further our understanding of the extent of suitable Hooded Plover habitat, distribution, and size of the population, and in detecting changes in occupancy over time. It was biennial count data that provided strong evidence of overall declines in the eastern mainland numbers of Hooded Plovers, and evidence for loss of occupancy which led to the nomination of the eastern subspecies of Hooded Plover for listing (Vulnerable) under the EPBC Act in 2014. The count findings help us identify trends of concern and provide the best assessment of the mainland trajectory for the species.

The biennial count data is complemented by nest monitoring data collected by trained citizen scientists through targeted and regular monitoring which reveals rates of recruitment and severity of threats at sites, in turn allowing us to conduct adaptive management to mitigate threats and improve breeding success. The two monitoring regimes are complementary, and both provide different data used to assess the health of the Hooded Plover population; one at the population scale to see whether breeding success data translates into actual trajectory change, and one at the scale of regional recruitment rates and threat trajectories, as tools for evaluating success in conservation actions and as triggers for adaptive management.

In 2022, the biennial count had funding investment, the third count to have this higher investment. It is evident that the increased coverage, quality of results and speed at which the report and maps can be compiled are significant benefits of having a funded count coordinator. Given the need to track the trajectory of this threatened species and to understand whether investment in on-ground and other threat management actions are effective, maintaining the count over time is critical to monitoring conservation recovery.

Use of an app for collecting data in the field

Utilisation of the Birdata app in the field by count participants significantly improved the quality of data collected compared with previous counts as count participants were able to enter their data in real-time into standardised data fields. This provided users with the opportunity to check their observation data and correct any errors in GPS locations before submitting their survey information. In particular, this significantly reduced the number of records requiring conversion of the GPS coordinates provided, sometimes months after the surveys occurred, which can lead to significant errors in the actual location where the birds were observed.

The value of threat data

The biennial count provides us with a rare opportunity to gain an understanding of threats at Hooded Plover sites (especially remote sites) that are not typically monitored by trained citizen scientists during nest monitoring in the breeding season. As the count involves visiting beaches in three states (and some regions in Tasmania), covering thousands of kilometres, collecting information on threats is crucial especially in trying to assess the distribution of a particular threat e.g., a weed species. The

Beach-nesting Birds Program survey form within Birdata facilitates the efficient recording of this data in the field.

Data from the 2022 biennial count genuinely reveals the major pressures the Critically Endangered population of Hooded Plovers is under, in New South Wales. It is the only state to experience an increase in the number of sites with higher threat categories and a corresponding reduction of lower threat categories which highlights the importance of further investing in localised threat mitigation actions. The South Australian Hooded Plover population is the only state population to have experienced a reduction in the number of sites in moderate and higher threat categories and a corresponding increase in lower threat categories. Although vehicles account for higher threat scores at many of the South Australian sites, there has been a slight decrease in the percentage of sites where evidence of vehicles was present. Furthermore, this count data enables us to obtain an indication of the prevalence of specific threats and to create maps that can be used to identify hotspots in need of management investment.

Coverage of remote coastline

Some of the survey routes included in the count are only accessible by boat or overnight hikes while others are extremely long where participants require a reasonable level of physical fitness and lifts between access points. Exceptional coverage of survey routes was achieved in the 2022 count in most regions which contained a large proportion of remote coastlines with the exception of Mueller River to Lake Tyers region. This region will require increased coordination support in the next count to assist with any barriers to survey coverage, noting that these areas have fewer participants than any other region and include long stretches of coast that often rely on being covered by vehicle or significant hikes. This region also experienced access issues where some stretches of remote coastline were cut off by flooding. The other major concern lies in areas where a few stalwarts cover large areas over a number of years – e.g., Eyre Peninsula, Far West Victoria and South and East Gippsland. In such areas there is a clear risk of relying heavily on a few key people. Here, a long-term succession plan is required to ensure continuation of survey efforts and more engagement occurs from within the local communities.

Targeted surveys and further data analysis

This report highlights The Coorong as a region of concern where it appears there is a decline in Hooded Plover numbers even with an increase in survey coverage during the count. This decrease in Hooded Plover numbers is likely due to birds abandoning territories due to increased disturbance caused by vehicles being driven on beaches during spring and summer. It is important to investigate breeding success of Hooded Plovers in this stretch to determine the impact of vehicles and to gain a better understanding of the breeding population in the region. There were a few regions where small declines in Hooded Plover numbers were detected which cannot be attributed to lower survey coverage during the count. Southeast South Australia was one region indicating possible localised declines and this is the first count to detect a decline in the region since 2018. Given there was a reasonable increase in numbers during the 2020 count, the small decline detected in the 2022 count does not trigger any potential concerns at this stage. This is the third consecutive count where lower

bird numbers were recorded in the region of Phillip Island. Although these small declines may be due to localised mortality, movement of birds into other regions, temporary abandonment of territories due to increased visitation by beach users and habitat loss, it will be important to monitor the breeding populations closely in these regions over the next few years to ensure these declines are only temporary.

Additional support and emphasis on improving survey coverage in areas such as Mueller River to Lake Tyers and NSW Border to Point Hicks will need to be prioritised for future counts. It will also be important to repeat the exceptional survey coverage of Ceduna and west, but to aim for November timing when birds should be more sedentary, to better understand population numbers in this region. Inclusion of more Tasmanian regions in the count would provide a better understanding of the Tasmanian Hooded Plover population and the threats they face during the breeding season.

Acknowledgements

We are extremely grateful to all the participants who contributed to the 2022 biennial count. It is an enormous achievement to survey so many thousands of kilometres of coast within such a short timeframe and obtaining this snapshot of Hooded Plover numbers is the best opportunity we have in understanding the status of the south-eastern mainland population and regional populations in Tasmania. Few projects worldwide can claim that nearly half the world population of a threatened bird species is surveyed in a matter of weeks! The effort of our participants is something one cannot put a value on, and we cannot thank you enough for your outstanding efforts.

In particular, we would like to thank the regional count coordinators of all 26 regions. They organised participants to survey routes and helped fill gaps when they could not find participants. Without the help of the regional coordinators, none of this would have been possible. Thanks also to Parks Victoria, and the Department of Energy, Environment and Climate Action (VIC), the Department for Environment and Water (SA), Eyre Peninsula Landscape Board, Northern and Yorke Landscape Board, and the Office of Environment and Heritage (NSW) who provided assistance in the form of quad bikes, boats and staff time. For some regions, we would have been unable to access remote areas or survey challenging sites without the assistance of land managers.

At BirdLife Australia, organisation of the count and the subsequent collating, entering and analysing the resultant data consumed a substantial amount of time. We are grateful to Jessica Kent and Melissa Sheedy for assisting with data entry.

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Appendices

Appendices 1 to 4 are provided separately due to file size and can be found on BirdLife Australia's Beach-nesting Bird Hub: https://beachvol.birdlife.org.au/login/index.php?pathway=1

Appendix 1

South Australian maps of routes surveyed, beach-nesting bird sightings, threats assessed and weed occurrence.

Appendix 2

Victorian maps of routes surveyed, beach-nesting bird sightings, threats assessed and weed occurrence.

Appendix 3

New South Wales maps of routes surveyed, beach-nesting bird sightings, threats assessed and weed occurrence.

Appendix 4

Tasmanian maps of routes surveyed, beach-nesting bird sightings, threats assessed and weed occurrence.

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Thank you

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