

The status of the Double-banded Plover in the Hunter Region, New South Wales

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Received 28 July 2022, accepted 18 September 2022, published on line 4 October 2022.

A proportion of the population of Double-banded Plover *Charadrius bicinctus* migrate to southern and eastern Australia during the non-breeding season, including to the Hunter Region of NSW. This cohort of migrants breed at high altitude on the South Island of New Zealand. Double-banded Plover have been recorded at 13 sites across the Hunter Region over a 55-year period, 1967 to 2021. The majority of records were from six sites – Worimi Conservation Lands, Manning Estuary, Port Stephens, Hunter Estuary, Lake Macquarie and Wallis Lake. Results indicate that there has been a highly significant population decline of 37% in the Hunter Region in the past 14 years. Although a decline is also evident over the entire 55-year period, it could not be measured empirically. The population utilising the Hunter Estuary had declined by the 1980s and the numbers utilizing the Manning Estuary and Worimi Conservation Lands declined after 2014. There was minimal decline in Port Stephens where there was less disturbance at sites used by the birds. Two sites, Manning Estuary and Worimi Conservation Lands are nationally significant for the species as they have often hosted more than 0.1% of the total population.

INTRODUCTION

Double-banded Plover *Charadrius bicinctus* is a small plover which breeds in New Zealand during the austral summer. In New Zealand it is known as the Banded Dotterel. It is described as partly migratory, dispersive and sedentary (Marchant & Higgins 1993). Most birds on the North Island of New Zealand do not migrate and are joined by birds from northern and lowlands areas of the South Island during the non-breeding season. However, most birds found at higher altitudes in the South Island migrate to eastern and southern Australia including Tasmania, Norfolk and Lord Howe Islands. It is also a regular visitor to Fiji and New Caledonia (Pierce 1999; Cooper *et al.* 2014; Wiersma *et al.* 2019). In NSW the majority are present from February until August (Cooper *et al.* 2014). Small numbers are also present in January and September to December. There are two recognized subspecies *bicinctus* and *exilis*. The birds that visit Australia belong to the nominate subspecies *bicinctus*.

In the non-breeding season migrating birds form loose flocks, often displaying high site fidelity from year to year (Marchant & Higgins 1993). Although they have a tendency to roost separately from most other shorebird species, they regularly mix with waders such as Red-necked Stint *Calidris ruficollis*

and Red-capped Plover *Charadrius ruficapillus* when roosting and feeding (Stuart 2008; Department of Climate Change, Energy, the Environment and Water 2022; authors' pers. obs.).

Robertson *et al.* (2017) classified the species as Nationally Vulnerable. The 2019 Australian Waterbird Index (Clemens *et al.* 2019) reported a long-term trend (since the 1980s) of decline, a medium-term trend (over 21 years) of increase and a flat short-term trajectory (last 5 years). The Index did not identify any reduction in the Australian wintering population over the past three generations (since 2007). The IUCN has recently raised the status of the species from Least Concern to Near Threatened (IUCN 2021).

The long-term population change cannot be readily determined due to varying population estimates. Lane (1987) estimated the population to be at least 12,450 birds based on simultaneous counts in Australia and New Zealand. In contrast, Bamford *et al.* (2008) and Garnett *et al.* (2011) estimated the population to be 50,000 birds. The most recent estimate is 19,000 birds (Hansen *et al.* 2016). Barrett *et al.* (2007) identified a decline in Reporting Rate (RR) of 25.4% over the 21 years between the 1977-1981 Atlas of Australian Birds and the analogous 1998-2002 Atlas. The Atlas of the Birds of NSW & ACT (Cooper *et al.* 2014)

reported that the annual RR declined by around 50% between 1986 and 2006.

The objectives of the present study were to review records of Double-banded Plover from all sites across the Hunter Region and to establish the recent population trend.

METHODS

Records for Double-banded Plover were extracted from the BirdLife Australia Birddata portal (<https://birddata.birdlife.org.au/home>), the Cornell Lab of Ornithology eBird Australia portal (<https://ebird.org/australia/home>), the NSW Department of Environment and Heritage BioNet Atlas (<http://www.bionet.nsw.gov.au/>) and the Eremaea Birdline (<http://www.ereama.com/BirdlineRecentSightings.aspx?Birdline=2>). Records were also extracted from Annual Bird Reports for the Hunter Region (<https://www.hboc.org.au/publications/annual-bird-report/>) for years 1993-2019 and from a spreadsheet of early avian records (1979-1993) for the region (A. Stuart pers. comm). Additional early records from Kooragang Island for 1969-1977 were extracted from *Hunter Natural History* (Kendall & van Gessel 1972; van Gessel & Kendall 1972a and 1972b) and from van Gessel & Kendall (2015). Records for Wallis Lake were provided by Ashley Carlson.

Much of the sourced data were from regular standardised surveys, particularly in the Hunter Estuary, Port Stephens, Manning Estuary, Worimi Conservation Lands, Wallis Lake and Lake Macquarie. Regular standardised monitoring of shorebirds in Lake Macquarie commenced in October 1988 and in the Hunter Estuary in April 1999. A detailed description of the survey protocols for the estuary is available (BirdLife Australia 2021). Prior to 1999, monitoring in the Hunter Estuary was intermittent although parts of Ash Island and Kooragang Island were monitored somewhat more regularly during 1971-99. Regular monitoring of other key sites in the region commenced subsequently: Swan Bay (an important Port Stephens site) in September 2000; the Manning Estuary in February 2008; and the Worimi Conservation Lands section of Stockton Beach north of Newcastle in February 2009. Survey protocols for the Manning Estuary and Worimi Conservation Lands are described by Stuart (2014b) and Lindsey & Newman (2014) respectively.

Sites with regular occurrences were identified and the maximum monthly count was determined for each site. When no birds were recorded, the maximum count was recorded as zero. Mean monthly counts were determined for the period in which the majority of birds were present in sites that had 20 or more records. The maximum monthly counts for sites that were surveyed regularly from 2008/9-2021 were accumulated, mean and standard deviations were calculated, and months in which the

majority of birds were present were identified. Sites that were nationally important for the species (i.e. > 0.1% of total population) were identified.

Monthly counts for sites with periods of regular surveys over the study period were charted using MS Excel. The population change (March-August) over selected periods for sites that had been regularly surveyed was tested for significance by conducting Chi Square tests (Pearson 1900) and determining the probability P of the change being significant. The percentage decline over the selected periods was calculated from the ratio of the mean values for each period. It was determined for the region and for the three sites with regular surveys: Manning Estuary; Worimi Conservation Lands; and Port Stephens.

RESULTS

When present in the Hunter Region, Double-banded Plover are widely dispersed in small numbers across beaches, estuaries and near-coastal wetlands.

From 1967-2021, 647 records from 300 months were obtained for 13 sites (**Table 1**). The majority of records and the highest monthly maximum counts were from six sites: Worimi Conservation Lands; the Manning Estuary; Port Stephens; Hunter Estuary; Wallis Lake; and Lake Macquarie. The other seven sites had relatively few records over the study period or had not been the subject of regular surveys. The mean counts from regular monthly surveys from March-August were calculated for sites with 20 or more records and are shown in **Table 1**, together with the survey period.

The mean monthly count and standard deviation for five sites surveyed regularly from 2008/9-2021 is shown in **Figure 1**. This shows that the majority of birds are present from March until August.

The monthly counts for the Hunter Region from February 1967 to December 2021 are shown in **Figure 2**. The greater frequency of higher counts 2008-2021 reflects the commencement of monitoring on Worimi Conservation Lands and the Manning Estuary. **Figure 2** also displays clusters of higher counts from the Hunter Estuary 1971-1977 and Port Stephens, Lake Macquarie and Wallis Lake 1981-1989. Due to variation in the distribution of numbers across sites in the region, each site is discussed separately below.

Table 1. Months with records and maximum monthly count for 13 sites in the Hunter Region, 1967-2021. Mean counts are for March to August for six sites with 20 or more records.

Location	Months with records (1967-2021)	Maximum monthly count (1967-2021)	Mean count regular monthly surveys (Mar-Aug)	Regular monthly surveys
Worimi Conservation Lands	75	173	64	2009-2021
Manning Estuary	235	123	39	2008-2021
Port Stephens	101	55	16	2000-2021
Hunter Estuary	131	400+	30	1971-2021
Wallis Lake	43	76	26	1985-2006
Lake Macquarie	29	32	12	1982-1985, 1999-2021
Morpeth Wastewater Treatment Works	6	10	-	-
Broughton Island	9	4	-	-
Smiths Lake	9	5	-	-
Saltwater National Park	4	1	-	-
Mungo Brush Beach	3	1	-	-
Cooperbrook	1	1	-	-
Irrawang Swamp	1	1	-	-

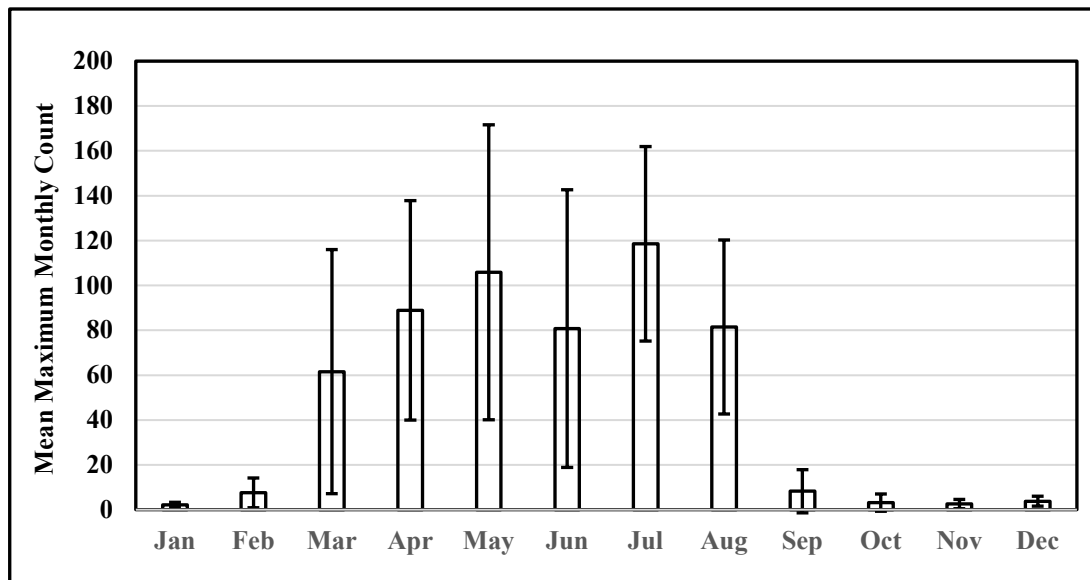


Figure 1. Mean monthly counts for Worimi Conservation Lands, Manning Estuary, Port Stephens, Hunter Estuary and Lake Macquarie 2008/9-2021 (bars), with +/- 1 standard deviation (lines).

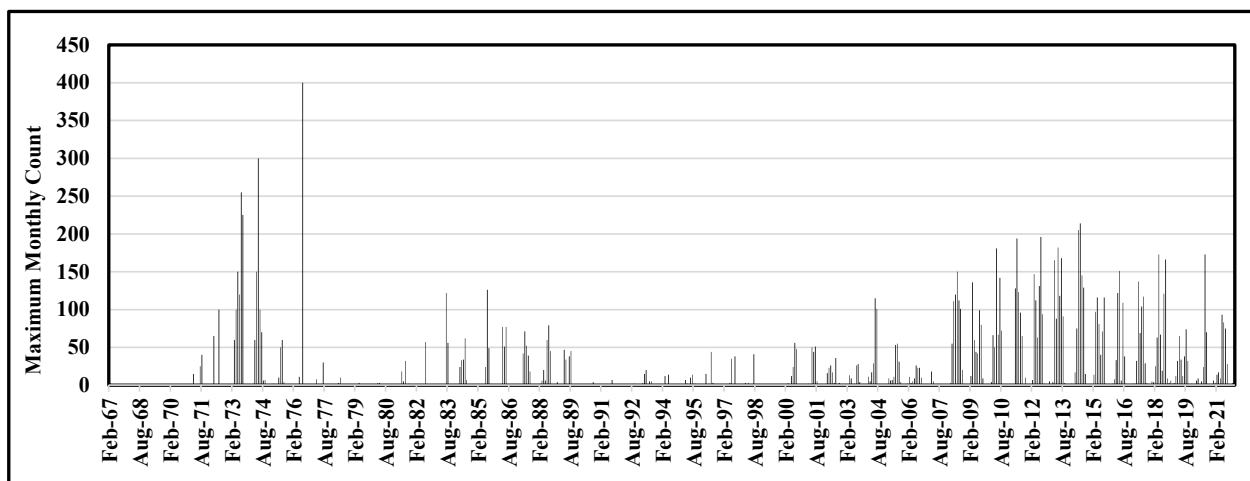


Figure 2. Monthly counts of Double-banded Plover for the Hunter Region 1967-2021

Worimi Conservation Lands

The Worimi Conservation Lands site was divided into three sub-sites for survey purposes. Regular monitoring of shorebirds commenced in 2009 (Lindsey & Newman 2014). Double-banded Plover

were recorded regularly on the beach-front at the most southern of the three sites. 173 birds were present in June 2014 and the mean monthly count for March-August over 2009-2021 was 64 birds (Table 1). There was a marked decrease in numbers from 2014.

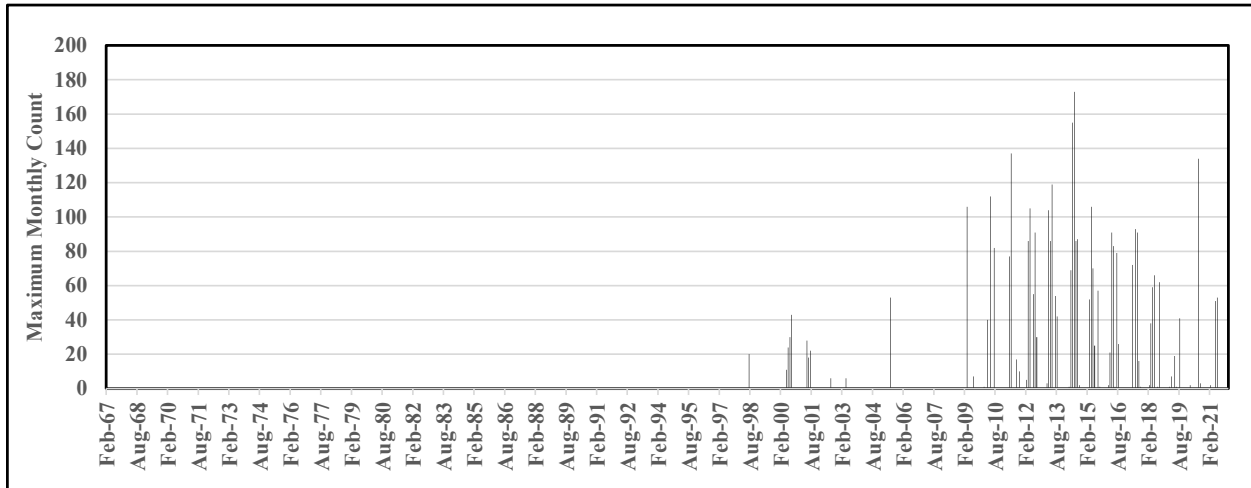


Figure 3. Monthly counts of Double-banded Plover for Worimi Conservation Lands 1967-2021.

Manning Estuary

Regular monitoring of shorebirds on the Manning Estuary commenced in 2008 (Stuart 2008). The Manning River has two entrances. The main channel is at Harrington and a secondary channel is

located at Farquhar Inlet, 6km to the south. The majority of birds were present on the ocean shoreline at Farquhar Inlet. The maximum count was 123 birds in June 2011 and the mean monthly count for March-August over 2008-2021 was 39 birds (Table 1). There was a marked decrease in numbers after 2014.

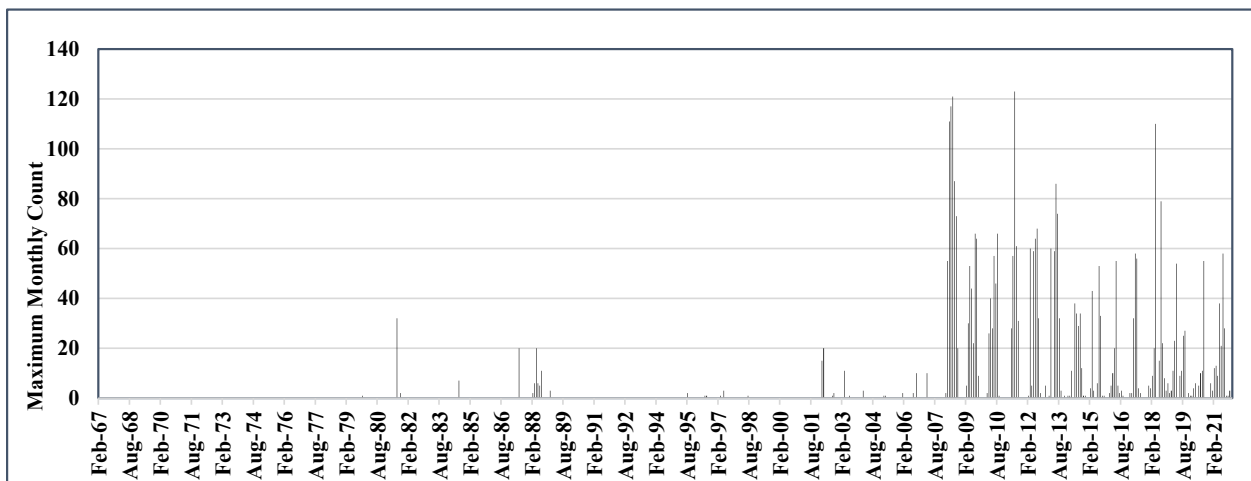


Figure 4. Monthly counts of Double-banded Plover for the Manning Estuary, 1967-2021.

Port Stephens

Records from Port Stephens were from Taylors Beach, Swan Bay/Gir-um-bit National Park, Corrie Island Nature Reserve and Winda Woppa Sandspit. The earliest monitoring was conducted by the Australasian Wader Study Group during 1982-

1984. Regular monitoring by the Hunter Bird Observers Club (HBOC) at Swan Bay commenced September 2000. Monitoring of Corrie Island and Winda Woppa by HBOC commenced February 2004. There were 55 birds present in July 2005 and the mean count March-August 2000-2021 was 16 birds (Table 1). There was a marked decrease in

numbers after 2014. Surveys of Taylors Beach ceased in June 1985. Birds at Corrie Island and Winda Woppa were recorded on sandy beaches while at Swan Bay/Gir-um-bit NP they were present

on saltmarsh. Bartrim (1980) reported up to 150 birds were commonly present on saltmarsh areas of Gir-um-bit NP but gave no temporal details.

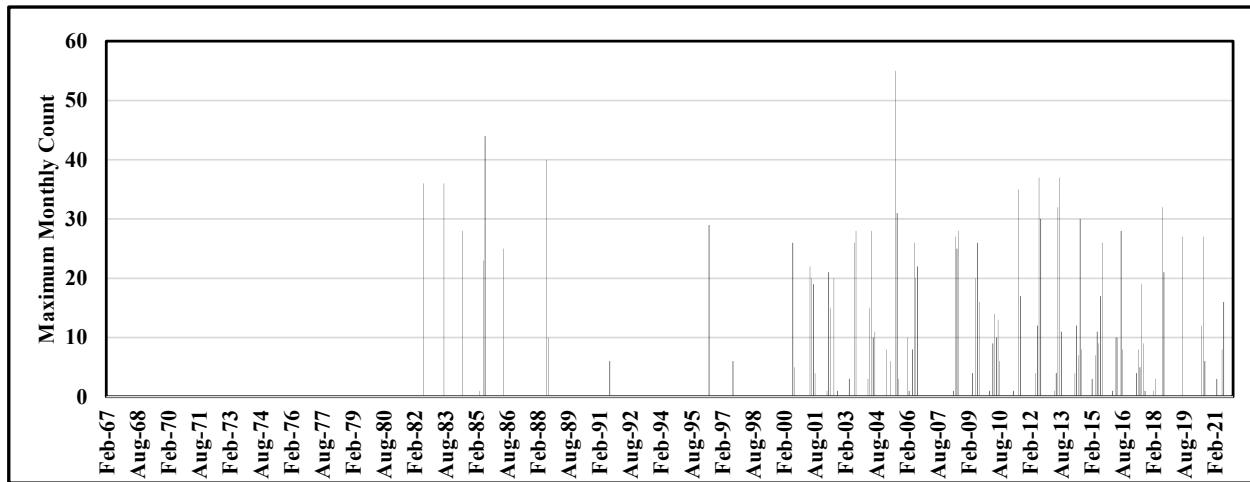


Figure 5. Monthly counts of Double-banded Plover for Port Stephens 1967-2021.

Hunter Estuary

Birds were recorded from multiple sites across the Hunter Estuary including Ash Island, Fullerton Cove, Hexham Swamp, Pambalong Nature Reserve, Stockton Sandspit and Tomago Wetland. There was a discrete cluster of high counts 1971-1976 (Figure 6). The maximum count was 400+

birds in July 1976 (van Gessel & Kendall 2015). Subsequent records were intermittent and mostly were of 1-10 birds. There were isolated higher counts of 96 and 90 birds at Fullerton Cove in June and July 2004 and 60 birds at Tomago Wetlands in August 2018 (Figure 6). The mean count for March-August over 1971-1976 was 96 birds, but over the entire data period, 1976-2021, it was only 24 birds.

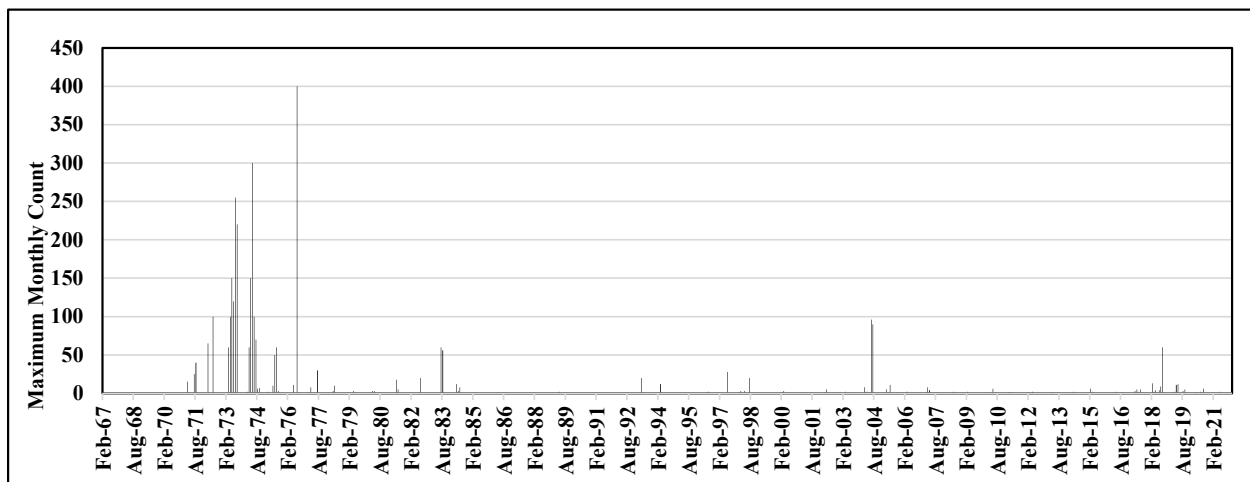


Figure 6. Monthly counts of Double-banded Plover for the Hunter Estuary 1967-2021

Wallis Lake

At Wallis Lake, birds were recorded over 1975-2006, mainly from around Pelican Island, Green Point and Tern Island. A cluster of high counts was

recorded 1985-1989 (Figure 7). The maximum count was 76 birds in August 1980 and the mean count for March-August over 1985-1989 was 42 birds (Table 1). There were a few subsequent records of 1-15 birds.

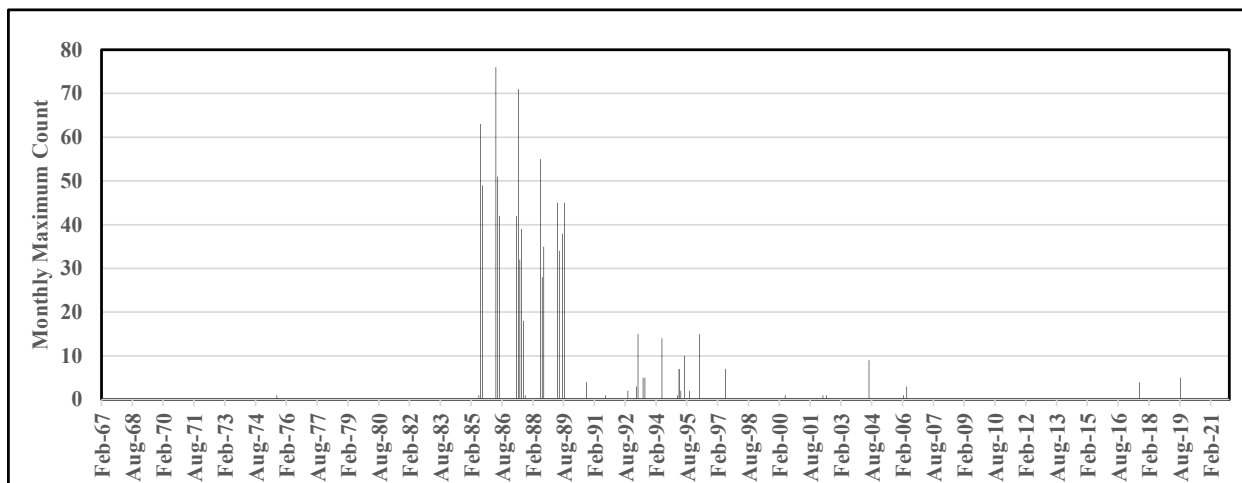


Figure 7. Monthly counts of Double-banded Plover for Wallis Lake 1967-2021.

Lake Macquarie

Sites were clustered around the Swansea Channel at Galgabba Point and Pirrita Island, and at Swansea Heads and Moon Island. Birds were recorded

intermittently from 1973 (Figure 8). The maximum count was 32 birds in August 1997 (Table 1). There was a small cluster of records over 1983-1986 with a maximum count of 31 birds in May 1984. The mean count for March-August from 1982-2021 was 12 birds.

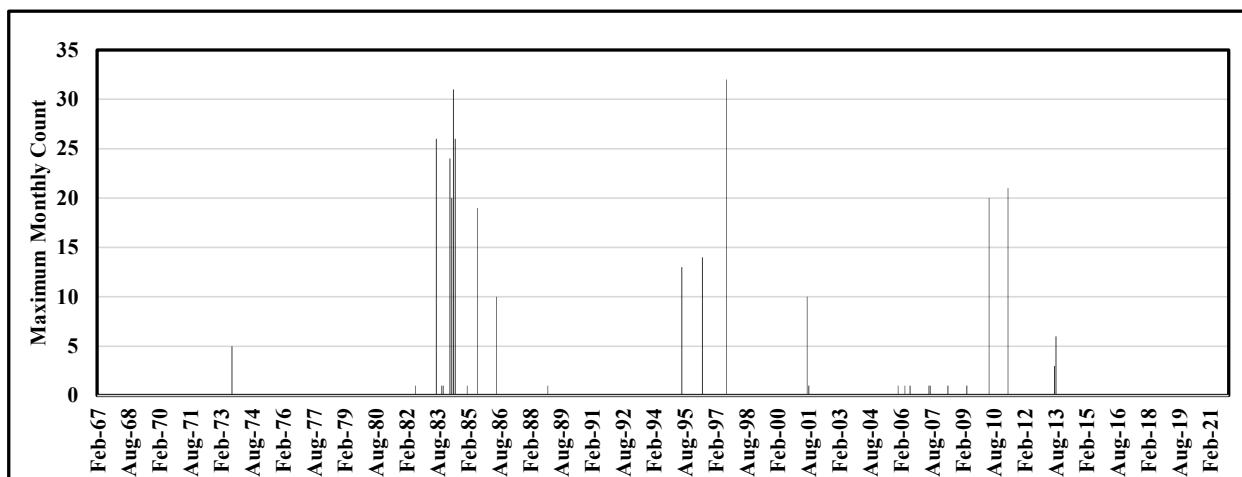


Figure 8. Monthly counts of Double-banded Plover for Lake Macquarie 1967-2021

Other sites

Seven additional sites had 1-9 records and the maximum count was 10 birds at Morpeth Wastewater Treatment Works in June 2002 (Table 1). The other sites were Broughton Island, Smiths Lake, Saltwater NP, Mungo Brush Beach, Coopernook and Irrawang Swamp, all with maximum counts of 1-5 birds (Table 1).

surveys conducted from 1967 to 2007. Additionally, not all known sites were surveyed every year. During the period 1967-2007 counts of 260 birds in July 1973, 300 birds in May 1974 and 400+ birds in July 1976 were recorded in the Hunter Estuary. These are the highest counts for the region over the study period. The maximum count recorded between 2008 and 2021, when most of the important sites were surveyed regularly, was 214 birds in June 2014.

Population decline

The monthly population counts for the Hunter Region are shown in Figure 2. Accurate determination of the long-term population decline was not possible due to the intermittent nature of

The regular surveys from 2008-2021 indicated a pronounced population decline from 2014 (Figure 2). To test the significance of the decline, mean monthly counts for the Hunter Region, Manning Estuary, Worimi Conservation Lands and Port Stephens were calculated for two time periods: prior

to 2015 and 2015-2021. For each of those sites, Chi Square tests were applied to the two time periods to determine the probability (P) of the change being significant, assuming unequal variances. P values <0.05 were classified as significant and values < 0.01 as highly significant. The results, shown in **Table 2**, indicate there has been a statistically highly significant population decline in the Hunter Region over the period analysed. The decline is dominantly in the Manning Estuary and Worimi Conservation Lands. The change in the population

utilizing Port Stephens was not statistically significant. There were insufficient data to conduct statistical tests for the other sites.

For the Manning Estuary, the changes over time at the two monitored sites, Farquhar Inlet and Harrington, were compared (**Table 3**). The reduction in numbers at Farquhar Inlet was statistically highly significant while the change at Harrington was not significant.

Table 2. Calculated Chi square values, probability and percentage decline for population change of Double-banded Plover for the Hunter Region, Manning Estuary, Worimi Conservation Lands and Port Stephens.

Location	Mean Maximum Survey Counts (March-August)			χ^2 Value	P	Decline
		2008-2014	2015-2021			
Hunter Region				8.94	< 0.01	37%
	Surveys	42	42			
	Mean	110	69			
Manning Estuary		2008-2014	2015-2021	8.72	< 0.01	52%
	Surveys	38	37			
	Mean	56	27			
Worimi Conservation Lands		2009-2014	2015-2021	11.38	< 0.01	36%
	Surveys	24	28			
	Mean	80	51			
Port Stephens		2008-2014	2015-2021	0.00	-	13%
	Surveys	30	24			
	Mean	16	14			

Table 3. Mean counts and Chi-square values for population comparisons for Double-banded Plover at Harrington and Farquhar Inlet, Manning Estuary.

Location	Mean Maximum Survey Counts (March-August)			χ^2 Value	P
		2008-2014	2015-2021		
Farquhar Inlet				4.04	< 0.01
	Surveys	37	26		
	Mean	46	18		
Harrington		2008-2014	2015-2021	0.02	-
	Surveys	22	23		
	Mean	16	17		

DISCUSSION

Although Double-banded Plover have been observed from North Queensland to Tasmania, and west to Perth, the largest numbers spend the winter in Victoria and Tasmania. In the Hunter Region, the known main population sites are currently Worimi Conservation Lands, Manning Estuary and Port Stephens. Previously, regular populations were recorded in the Hunter Estuary, Lake Macquarie and Wallis Lake.

Nationally Important Sites

Initial monitoring of the Worimi Conservation Lands (Lindsey & Newman 2014) and the Manning Estuary (Stuart 2008; 2014) established that these were the most important sites for Double-banded Plover in the Hunter Region and that they were of national importance.

Under the Wildlife Conservation Plan for Migratory Shorebirds (Department of Environment 2015), shorebird habitat is considered nationally important if it regularly supports 0.1% or more of an East

Asian-Australasian Flyway population of any migratory shorebird species (Department of Climate Energy, the Environment and Water 2022). As the most recent population estimate for Double-banded Plover is 19,000 birds (Hansen *et al.* 2016), a site regularly supporting 19 or more is nationally significant. Worimi Conservation Lands and the Manning Estuary have mean counts of 64 and 39 birds respectively, for the period March - August. The Hunter Estuary and Wallis Lake previously supported regular populations for periods of 4-6 years that would have made them nationally significant, but they no longer do so.

Population decline

In assessing the status of Double-banded Plover, the IUCN measured decline over a period of 15 years (i.e. three generations of five years) for the application of their Criterion A, near threatened (IUCN 2021). Robertson *et al.* (2017) classified the species as nationally vulnerable. This was based on the IUCN criteria of a moderate to large population (5,000-20,000 mature individuals) and moderate to high ongoing or predictable decline (30-70%).

Consistent with that assessment, the population in the Hunter Region declined by 37% over 14 years to 2021, while the decline at individual sites varied from ~0 to 52%. The general decline evident in the regional population from 1967 to 2021 (**Figure 2**) correlates with the long-term trend identified by Clemens *et al.* (2019). However, the medium- and short-term trends identified by these authors were not evident.

Cooper *et al.* (2014) suggested that the decline in numbers in some areas of New South Wales was likely a reflection of the level of disturbance at those sites. They noted that most NSW sites used by the species were now affected by coastal development resulting in habitat loss and disturbance from humans and their activities. In the Hunter Region, the most important sites for Double-banded Plover, Worimi Conservation Lands and Manning Estuary, have seen an increase in the number of people and vehicles using the sites for recreational purposes.

In December 2015 the Worimi Conservation Lands Board of Management released their ten-year Plan of Management to guide, amongst other things, conservation of the site. Even so, more than 1000 vehicle movements have been recorded during peak holiday periods (NSW Office of Environment and Heritage 2015). There are always vehicles on the beach-front even during non-peak periods (authors' pers. obs.). This level of usage must impact on

Double-banded Plover and other species that use the beach-front for foraging and roosting, and is likely to have been a factor in the decrease in population which was manifest after 2014 (**Figure 3**).

A factor for reduction in population at Farquhar Inlet, Manning Estuary, was probably regular disturbance due to vehicle activity and/or walkers, sometimes with dogs, along Mudbishops Point (Stuart 2008). A decrease in numbers is evident from 2014 (**Figure 4**). In Port Stephens, where numbers have declined only marginally, birds were present at Gir-um-bit National Park, Corrie Island Nature Reserve and the Winda Woppa Sandspit, all of which are relatively isolated from the general public and were not vehicle accessible.

At Farquhar Inlet, Manning Estuary, during high-tide surveys, birds were observed roosting along the beach-front, often in tyre tracks (A. Stuart pers. comm.). In Worimi Conservation Lands birds were mostly observed at the southern end of the site, also roosting on the beach-front and often in tyre tracks (pers. obs. the authors). This makes them particularly vulnerable to vehicular disturbance.

The decrease in numbers in the Hunter Estuary after 1977 may be due to a number of factors. Kendall & van Gessel regularly surveyed a number of sites in the estuary from 1969 to 1977 but after 1977 their regular surveys ceased (van Gessel & Kendall 2015). This would account for the lack of records until the 1980s when counts showed that Double-banded Plover numbers were already decreasing. There are no known records over 1986-1994, but small numbers were recorded over 1995-98 (Stuart 2014a). The majority of observations in the 1970s came from the open sandy areas on Stockton Sandspit and Curlew Point on Kooragang Island (T. Kendall pers. comm.). By the 1990s, mangroves had enclosed both sites and the open sandy areas had become overgrown with exotic vegetation such as Bitou Bush *Chrysanthemoides monilifera* and Spiny Rush *Juncus acutus* (Streever 1998). As a result, the sites became unsuitable for shorebirds which favour sites with good visibility in order to reduce predation risk while roosting (Jackson & Straw 2021).

Surveys at Wallis Lake were conducted from 1985 to 2006. Good numbers were present 1985-1989 when the mean count March-August was 42 birds. Subsequently, numbers decreased and records were intermittent. The cause of the decline is not evident.

The lack of regular records from the seven additional sites may indicate that the birds use these

as temporary staging sites when transiting between preferred sites or it may simply be a result of irregular surveying.

Rehabilitated wetlands

Four major rehabilitation projects have been established in the Hunter Estuary focussed on the reintroduction of tidal flushing and/or vegetation management. These are at Ash Island, Hexham Swamp, Tomago Wetland and Stockton Sandspit (Svoboda 2017; Reid 2019; Lindsey 2021; Stuart & Lindsey 2021). As a result, a mosaic of saltmarsh and mudflats was created attracting several species of shorebirds including small numbers of Double-banded Plover. An unusually high number (60 birds) was recorded at Tomago Wetland in August 2018 (Lindsey 2021). At the rehabilitated Fish Fry Flats site on Ash Island, small numbers have been recorded since 2016/17 following restoration of tidal flushing (Reid 2019). In 1995, Kooragang Wetland Rehabilitation Project recontoured the Stockton Sandspit and removed invasive weeds and in 2002 National Parks and Wildlife Service removed half a hectare of mangroves from in front of the beach (Svoboda 2017). Despite the return of open, sandy substrate and improved visibility, Double-banded Plover numbers did not recover and the birds are now seldom seen in this section of the estuary. In response to the disappearance of suitable habitat at the Sandspit and Curlew Point, it is possible that the species relocated to the beach on Worimi Conservation Lands. However, that is speculative as no regular surveys of the beach took place prior to 2009.

Site fidelity

It is known that many species of birds and mammals are faithful to their natal and breeding site or group (Greenwood 1980). Double-banded Plover are reported to show high site-fidelity on wintering grounds (Marchant & Higgins 1993). Barton & Minton (1987) reported that birds showed high fidelity to their wintering site based on banding studies between 1976 and 1986 by the Victorian Wader Study Group. During that time, 1,993 birds were captured of which 1,732 were new birds and 261 were re-traps. Of 241 re-traps investigated, only six birds were found to have moved from the original banding site. In addition, re-sightings of colour-banded and/or dyed birds 1980-1986 revealed only five movements. From 1973-1989 van Gessel banded 150 birds at Stockton Sandspit and Curlew Point, Kooragang Island and of these 33 were re-trapped, from one to four years after initial capture (van Gessel pers. comm.). In the Manning

Estuary and at Worimi Conservation Lands, Double-banded Plover exhibited an apparent degree of site fidelity with most observations, though not all, on the same areas of the local beaches. However, without banding studies, it is not possible to be certain that the same individuals are present.

The relatively high previous short-term counts at Hunter Estuary (1971-1976), Lake Macquarie (1983-1986) and Wallis Lake (1985-1989), may however indicate that birds choose a foraging/roosting location for a period and then subsequently choose a different location for unknown reasons. The reduced number of birds present in June (**Figure 1**) compared to preceding and subsequent months, may indicate birds moving from the Hunter Region in June and then returning in July and August. This may indicate that part of the Hunter Region population uses the area only temporarily when over-wintering. Data from this study indicate the overwhelming majority of birds are present in the Hunter Region from March until August. Data compiled by Cooper *et al.* (2014) for the whole of NSW and ACT (1986-2006) indicate that the majority are present from February to August. This difference may reflect varying patterns of temporal movement through different parts of NSW.

While Double-banded Plover exhibit some degree of site fidelity, it is also apparent that they will exploit newly-established, suitable habitat if available, such as Tomago Wetlands and Fish Fry Flats, Ash Island. This may be partly driven by the loss of habitat in other areas through development or change in vegetation, and/or through increased disturbance. The variation in the spatial and temporal data from the Hunter Region suggests that site fidelity is an oversimplification of Double-banded Plover behaviour when wintering in the region and that its movements are more complex.

CONCLUSIONS

Double-banded Plover have been recorded at 13 sites across the Hunter Region over a 55-year period. However, only five sites have supported large numbers on a regular basis and currently only three sites, Worimi Conservation Lands, Manning Estuary and Port Stephens support regular winter populations. Previously, populations were regularly recorded in the Hunter Estuary, Lake Macquarie and Wallis Lake. The size of the populations at Worimi Conservation Lands and the Manning Estuary make these sites nationally significant.

A decline of 37% was determined across the Hunter Region in the last 14 years (2008-2021). This decline is highly significant. The medium- and short-term national trends (reported by Clemens *et al.* (2019) were not evident. The degree of population change varied across sites with the greatest decline occurring in the Manning Estuary and no significant decline in Port Stephens. Although a general decline was evident over the entire 55-year period, an empirical measurement could not be determined due to intermittent surveying during the first 30 years.

The decline on Worimi Conservation Lands and the Manning Estuary (mainly the Farquhar Inlet) is postulated to be the result of increased human disturbance, particularly from vehicles. There is very little human disturbance of sites in Port Stephens where decline is minimal.

ACKNOWLEDGEMENTS

We thank the Worimi Land Council for providing access to their lands and allowing us to undertake this study, and to NSW National Parks and Wildlife Service for logistic support and encouragement. We would like to thank HBOC member Mike Newman for taking part in the first five years of surveys at Worimi Conservation Lands and Daniel Williams for providing his vehicle and skills for the past three years. Ashley Carlson is thanked for providing records for Wallis Lake. Comments by an anonymous referee and Alan Stuart have greatly improved this article.

REFERENCES

Bamford M., Watkins, D., Bancroft, W., Tischler, G. & Wahl, J. (2008). Migratory Shorebirds of the East Asian - Australasian Flyway: Population estimates and internationally important sites. Wetlands International. <https://www.wetlands.org/publications/migratory-shorebirds-of-the-east-asian-australasian-flyway-population-estimates-and-internationally-important-sites/>. Accessed 18/12/2021.

Barrett, G., Silcocks, A., Cunningham, R., Oliver, D., Weston, D. and Baker, J. (2007). Comparison of atlas data to determine the conservation status of bird species in New South Wales, with an emphasis on woodland-dependent species. *Australian Zoologist* **34** (1): 37–77.

Barter, M. and Minton, C. (1987). Biometrics, moult and migration of Double-banded Plovers *Charadrius bicinctus bicinctus* spending the non-breeding season in Victoria. *Stilt* **10**: 9-14.

Bartrim, G. (1980). The Proposed Pipeclay Creek Nature Reserve - A Resource Survey, for NSW National Parks & Wildlife Service. (NSW National Parks and Wildlife Service.)

BirdLife Australia (2021). Hunter Estuary Waterbird Survey Protocols. (Unpublished report for Hunter Local Land Services.)

Clemens, R., Driessen, J. and Ehmke, G. (2019). Australian Bird Index Phase 2 - Developing Waterbird Indices for National Reporting. (Unpublished report for the Department of the Environment prepared by BirdLife Australia, Melbourne.)

Cooper, R.M., McAllan, I. and Curtis, B. (2014). 'An atlas of the birds of NSW & the ACT, Volume 1. Emu to Plains-wanderer'. (NSW Bird Atlassers Inc.: Woolgoolga, NSW.)

Department of Environment (2015). Wildlife Conservation Plan for Migratory Shorebirds. <https://www.awe.gov.au/sites/default/files/documents/wildlife-conservation-plan-migratory-shorebirds.pdf>. Accessed 9 /01/2022.

Department of Climate Change, Energy, the Environment and Water (2022). Species Profile and Threats Database, *Charadrius bicinctus* - Double-banded Plover. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=895. Accessed 13/07/2022.

Garnett, S., Szabo, J. and Dutton, G. (2011). 'Action Plan for Australian Birds 2010'. (CSIRO Publishing: Melbourne.)

Greenwood, P. (1980). Mating systems, philopatry and dispersal in birds and mammals. *Animal Behaviour* **28** (4): 1140-1162.

Hansen, B.D., Fuller, R.A., Watkins, D., Rogers, D.I., Clemens, R.S., Newman, M., Woehler, E.J. and Weller, D.R. (2016). Revision of the East Asian-Australasian Flyway Population Estimates for 37 listed Migratory Shorebird Species. (Unpublished report for the Department of the Environment by BirdLife Australia, Melbourne.)

IUCN, (2021). The IUCN Red List of Threatened Species. Version 2021-3. Double-banded Plover, *Charadrius bicinctus*. <https://www.iucnredlist.org/species/22693845/180230226>. Accessed 18/12/2021

Jackson, M.V. and Straw, P. (Eds) (2021). Coastal hightide shorebird habitat management guidelines. figshare. Online resource. doi: 10.6084/m9.figshare.16628560.v1. Accessed 30/08/2022.

- Kendall, T. and Van Gessel, F. (1972). The Birds of Kooragang Island. Preliminary Report. *Hunter Natural History* May: 79-94.
- Lane, B.A. (1987). 'Shorebirds in Australia'. (Thomas Nelson Australia: Melbourne.)
- Lindsey, A. (2021). The birds of Tomago Wetland after reinstatement of tidal flushing. *The Whistler* 15: 6-26.
- Lindsey, A. and Newman, M. (2014). Worimi Conservation Lands bird surveys (2009-2013). *The Whistler* 8: 23-32.
- Marchant, S. and Higgins, P.J. (Eds) (1993). 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 - Raptors to Lapwings'. (Oxford University Press: Melbourne, Victoria.)
- NSW Office of Environment and Heritage (2015). Worimi Conservation Lands Plan of Management. <https://worimiconservationlands.com/plan-of-management/>. Accessed 15/07/2022.
- Pearson, K. (1900). On the criterion that a given system of deviations from the probable in the case of a correlated system of variables is such that it can be reasonably supposed to have arisen from random sampling. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science* 50 (302): 157-175. <https://www.tandfonline.com/doi/abs/10.1080/14786440009463897>. Accessed 13/09/2022.
- Pierce, R. (1999). Regional patterns of migration in the Banded Dotterel (*Charadrius bicinctus bicinctus*). *Notornis* 46:101-122.
- Reid, P. (2019). Changes in wetland use by shorebirds following mangrove removal, Area E. Ash Island, New South Wales. *The Whistler* 13: 62-68.
- Robertson, H.A., Baird, K., Dowding, J.E., Elliott, G.P., Hitchmough, R.A., Miskelly, C.M., McArthur, N., O'Donnell, C.F.J., Sagar, P.M., Scofield, R.P. and Taylor, G.A. (2017). Conservation status of New Zealand birds, 2016. New Zealand Threat Classification Series 19. (NZ Department of Conservation: Wellington.)
- Streever, W.J. (1998). Kooragang Wetland Rehabilitation Project: opportunities and constraints in an urban wetland rehabilitation project. *Urban Ecosystems* 2: 205-218
- Stuart, A. (2008). A preliminary assessment of the importance of the Manning River for shorebirds and other waterbirds. *The Whistler* 2: 13-19.
- Stuart, A.D. (2014a). Early Hunter Region avian records, Part 3. A review of historical data about shorebirds in the Hunter Estuary. *The Whistler* 8:10-22.
- Stuart, A.D. (2014b). Manning Estuary population counts 2008-2013. *Stilt* 65: 38-40.
- Stuart, A. and Lindsey, A. (2021). Shorebird surveys in the Hunter Estuary of New South Wales. *Stilt* 76:47-63.
- Svoboda, P. (2017). Kooragang Wetlands: Retrospective of an integrated ecological restoration project in the Hunter River Estuary. (26th NSW Coastal Conference: Port Stephens.)
- Van Gessel, F. and Kendall, T. (1972a). A Checklist of the Birds of Kooragang Island. *Hunter Natural History* August: 194-215.
- Van Gessel, F. and Kendall, T. (1972b). A Checklist of the Birds of Kooragang Island, Supplement 1. *Hunter Natural History* November: 256-261.
- Van Gessel, F. and Kendall, T. (2015). Kooragang Island Bird Counts 1969 -1977. *HBOC Special Report No. 7*. (Hunter Bird Observers Club Inc.: New Lambton, NSW.)
- Wiersma, P., Kirwan, G.M. and Boesman, P. (2019). Double-banded Plover (*Charadrius bicinctus*). In 'Handbook of the Birds of the World Alive'. (Eds J. del Hoyo, A. Elliott, J. Sargatal, D.A. Christie and E. de Juana). (Lynx Edicions: Barcelona.) <https://www.hbw.com/node/53844>. Accessed 18/12/2021.