CSIRO PUBLISHING
www.publish.csiro.au/journals/emu *Emu*, 2011, **111**, 84–91

Population decline of the White-fronted Chat (*Epthianura albifrons*) in New South Wales, Australia

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Abstract. Habitat modification through urbanisation and the alteration of the natural flows of rivers is a major contributor to the global decline of birds occupying specialist habitats. We measured the extent and pattern of change in range and relative abundance over 25 years of the White-fronted Chat, a small passerine that is predominantly found in saltmarsh. A particular focus of the study was the population in the Sydney region, which is now restricted to two locations in which we measured the response of birds to human disturbance. A significant decline of 65% in the reporting rate of White-fronted Chats was observed over the 25 years, with a decline of 44% over the last 10 years in New South Wales. Historical analysis of the White-fronted Chat in the Sydney region revealed a change in geographical distribution, with the current population now confined to only two of 56 former locations. Surveys of these locations concluded that in 2008, nine White-fronted Chats remained at Newington Nature Reserve and ~20 at Towra Point Nature Reserve. Measurements of the distance at which foraging birds flushed from an approaching observer suggest that this species is more sensitive to human disturbance than other co-occurring species. This study documents the decline of a species listed in 2010 as vulnerable under the New South Wales *Threatened Species Conservation Act 1995*, and confirms the need for recovery planning to prevent the further loss of populations, particularly those in the highly urbanised coastal zone.

Additional keywords: atlas, bird, global climate change, human disturbance, IUCN, saltmarsh, threatened, urbanisation, vulnerable, wetland.

Introduction

Increasing human population has resulted in large expansions of cities throughout the world (Chace and Walsh 2006) causing the modification and replacement of the natural habitat of birds and other organisms. Within Australia, ~84% of the human population lives within the coastal region (Australian Bureau of Statistics 2002), and a major contributor to the loss of specialist bird habitats, such as wetlands around urban areas, is reclamation for residential use (Lee *et al*. 2006). Urbanisation also alters hydrological and geomorphological processes of wetlands leading to structural and functional ecological changes (Winter 2000; Lee *et al*. 2006; Rogers *et al*. 2006; Álvarez-Rogel *et al*. 2007).

Wetland and saltmarsh systems are among the most threatened ecological systems globally (Bridgewater and Cresswell 1999). As well as coastal development, indirect effects of human population growth, such as rises in sea level associated with global climate change, are predicted to have major detrimental effects on wetlands (Winter 2000). The Intergovernmental Panel on Climate Change has predicted that sea levels will increase over the next 100 years by 4–6 mm per year and that weather extremes such as hurricanes, cyclones, drought and days of extreme temperatures will become more frequent. Areas of saltmarsh have decreased globally by ~30% and some areas have seen declines in areas of up to 80% over the past 50 years (Mitchell and Adam 1989*a*, 1989*b*; Saintilan and Williams 1999; Rogers *et al*. 2006). As sea levels rise, mangroves are predicted to encroach on areas of saltmarsh. Theoretically saltmarsh should then colonise higher elevations, but in many situations, further landward progression of saltmarsh is impossible given urban and agricultural constraints.

Losses of saltmarsh are likely to have an impact on the survival of specialist saltmarsh species, such as the White-fronted Chat (*Epthianura albifrons*). The White-fronted Chat is a small, ground-feeding, insectivorous passerine occurring in open country, particularly saltmarsh and other wetland habitats. It was once widespread across the southern half of Australia (Blakers *et al*. 1984) but is thought to be declining in response to human-induced disturbance and habitat loss (Hoskin *et al*. 1991; Keast 1995). Despite inhabiting areas close to human centres, the White-fronted Chat has been the subject of only two detailed studies (Williams 1979; Major 1991*a*, 1991*b*), and although these studies investigated the general ecology of the species, they did not focus on the distribution of the species or the effects of human impacts. Analysis of bird atlas data (Blakers *et al*. 1984; Barrett *et al*. 2003) indicates that the White-fronted Chat underwent a significant decline in reporting rate across Australia between 1984 and 2003 (Barrett *et al*. 2003), which was particularly evident in New South

 10.1071/MU10038 0158-4197/11/010084

Wales (NSW) (Barrett *et al*. 2007). Anecdotal records suggest that the greatest declines appear to be occurring around urban areas on the NSW coastline, particularly Sydney (Keast 1995). The flocks of 50 to 100 birds that were previously observed in the Sydney region (Hoskin *et al*. 1991; Keast 1995) are no longer seen, with the largest flocks reported in recent years containing only 20–30 birds (Straw 1999). These indications of both local and national decline in populations of White-fronted Chats, combined with the global threats to their saltmarsh habitat, suggest the need for an assessment of conservation status.

White-fronted Chats have been reported to be particularly wary of human presence (Hoskin *et al*. 1991) such that direct disturbance may also constitute a threat with increasing density of human population. However, only limited quantitative data are available on the relative sensitivity to disturbance of different bird species (Cooke 1980; Fernández-Juricic *et al*. 2002).

The aims of this study are to: (1) identify the extent and pattern of change in distribution and abundance of the White-fronted Chat in NSW over several spatial and temporal scales; and (2) develop a better understanding of potential mechanisms associated with their decline. In particular we focus on populations within the Sydney Basin Bioregion and measure the sensitivity of the species to direct human disturbance by comparing its ‘flushing distance’ with those of two co-occurring and common passerine species, the Australasian Pipit (*Anthus novaeseelandiae*) and the Superb Fairy-wren (*Malurus cyaneus*).

Methods

Population trends in New South Wales

Changes in reporting rate of the White-fronted Chat within NSW were calculated using bird survey data obtained from the database of the New South Wales Bird Atlassers (see http://www.nswbirdatlassers.com/dataservices.htm, accessed 18 January 2011). This database records species lists in 10-min grid-squares, which are searched for varying periods of time, as determined by the observer. Although the variable time introduces an additional source of sampling error, there is no systematic bias because the same method has been used since the survey started. Regression of the proportion of surveys of 1-day duration (the most common survey period) against year confirmed that there was no significant change in survey duration over time ($F_{1,23} = 0.209$, $P = 0.652$, $R^2 = 0.009$). A particular strength of the New South Wales Bird Atlassers database is that it provides continuous data that allows year-to-year variation in reporting rates to be calculated. This reduces the likelihood that any apparent decline is simply a function of short-term fluctuations, as may be the case in analyses based on two time-period comparisons (e.g. Barrett *et al*. 2003).

The number of surveys in which White-fronted Chats were detected and the total number of surveys in each 10-min grid-square were aggregated for each bioregion in NSW using ArcView 3.3 (ESRI Australia Pty Ltd, Sydney, Australia, see http://www.esriaustralia.com.au, accessed 18 January 2011), and reporting rates were calculated separately for each year between 1981 and 2005. Bioregions were further grouped into coastal, northern inland and southern inland areas to compare changes in reporting rates of the White-fronted Chat in different broad climatic environments.

Linear and quadratic regressions of arcsine transformed data were used to determine whether any changes in reporting rate over time were statistically significant. Only bioregions containing sightings of White-fronted Chats in 10 or more years over the 25 years were analysed, with other bioregions categorised as having insufficient data. Because threatened species status is conventionally based on decline over three generations or 10 years (IUCN 2010), percentage decline was also calculated for the years 1995 to 2005.

To determine whether the reporting rate of White-fronted Chats was related to rainfall, linear regression was used to identify trends in reporting rate in broad geographical regions in relation to annual rainfall lagged by between 0 and 6 years. Annual rainfall was determined by averaging Australian Bureau of Meteorology rainfall data from six weather stations in each region for which complete annual rainfall data were available from 1975 to 2005.

Population trends in the Sydney region

Three sources of data were used to compile population trends of White-fronted Chats in the Sydney region. First, all records of White-fronted Chats in particular locations were mapped from the historical component of the New South Wales Bird Atlassers database. This database contains records of White-fronted Chat sightings since 1859, compiled from museum records, the ornithological literature and recent surveys. Decline in the extent of the distribution was inferred from the dates of the last records in each of the 56 locations from which White-fronted Chats have been recorded.

Second, to identify change in population size over time, survey data collected since 1996 were compiled for the only two extant populations in the Sydney region, one at Newington Nature Reserve at Homebush Bay (33°49′S, 151°04′E) and the other at Towra Point Nature Reserve at Botany Bay (34°01′S, 151°09′E). These data consist of single-day, general bird surveys in which the maximum number of White-fronted Chats seen at any one time was recorded (Straw 1999; Ekert 2000; Shulz 2006; fauna database of the Sydney Olympic Park Authority, Sydney Olympic Park, NSW).

Third, surveys were conducted to estimate the current population size of the two extant populations. At each location, the whole saltmarsh area was traversed, recording the maximum number of birds present at one time and, when possible, the number of males and females. As the area of saltmarsh at Towra Point Nature Reserve (~150 ha) is approximately four times the size of that at Newington Nature Reserve (~35 ha) the duration of surveys was approximately two hours at Newington Nature Reserve and six hours at Towra Point Nature Reserve to standardise the survey effort. Eight surveys at Towra Point Nature Reserve and 10 surveys at Newington Nature Reserve were conducted, spread over 9 months between February 2008 and September 2008. This accounted for any seasonal bias, as White-fronted Chats are more commonly observed as pairs during the breeding season and as flocks in the non-breeding season (Major 1991*b*).

Temporal decline in population size was determined by linear regression of population size against the year of observation. Absolute population size is difficult to determine for a species that flocks and is not uniformly dispersed across suitable habitat

(Major 1991*b*), so the maximum number of birds seen at any one time was used as a measure of the minimum population size for the purpose of statistical analysis.

Sensitivity to human disturbance

The distances at which individual birds interrupted their foraging and flew away from an approaching observer ('flushing distance') was considered to be an indicator of sensitivity to direct human disturbance (Cooke 1980). To determine the relative sensitivity of White-fronted Chats compared with other saltmarsh-dwelling species, flushing distances were compared with those of two other passerine species: Australasian Pipit and Superb Fairy-wren. Measurement of flushing distance was compiled over 9 days at Towra Point and Newington Nature Reserves during the winter and spring of 2008. Both sites contained similar saltmarsh vegetation dominated by Austral Seablite (*Suaeda australis*) and Samphire (*Sarcocornia quinqueflora*), and surrounded by mangroves, predominantly Grey Mangrove (*Avicennia marina*).

Flushing data were collected throughout the day by walking steadily through the saltmarsh, scanning ahead and looking for the point from which a foraging bird flushed. (Birds were only included if they were on the ground or in vegetation <1 m tall, with the result that they were not normally seen until flushed.) The locations of the observer and flushing bird were marked with flags and the distance between them was measured with a tape measure. Twenty separate flushing determinations were made for each species at each site. To ensure that flushing data were independent, data were collected for only one bird at a time even if it was part of a group. As the populations of White-fronted Chats were small, individual recordings of flushing distances were separated by a minimum of 20 min to minimise the chance of multiple recordings of the same individual.

A two-factor analysis of variance (ANOVA) was used to determine whether each species differed in flushing distance and whether the distance varied between sites. The order of each flushing record was included as a covariate in the analysis to control for any potential disturbance effects associated with continual sampling of the same birds. Student Newmans Keuls (SNK) multiple comparisons were used to determine the nature of the differences between species at both Newington and Towra Point Nature Reserves.

Results

Population trends in New South Wales

The overall reporting rate of White-fronted Chats in NSW declined by 65% between 1981 and 2005, and by 44% between 1995 and 2005, although the trend was not significant across all bioregions (Table 1). Of the 11 bioregions with sufficient data for analysis, five (Brigalow Belt South, Murray–Darling Depression, NSW South Western Slopes, Darling Riverine Plains and Sydney Basin) recorded significant declines in reporting rate between 1981 and 2005. Another two bioregions (NSW North Coast and South Eastern Highlands) showed declines that approached significance, whereas only one bioregion (Riverina) showed an increase in reporting rate that approached significance. When bioregional data were pooled into broader regions to improve statistical power (Fig. 1), the northern inland ($F_{1,23} = 7.060$, $P = 0.014$, $R^2 = 0.235$), southern inland ($F_{1,23} = 4.378$, $P = 0.047$, $R^2 = 0.160$) and coastal regions ($F_{1,23} = 10.528$, $P = 0.004$, $R^2 = 0.314$) all showed significant declines in reporting rate between 1981 and 2005. However, in the southern inland region a quadratic model provided a better fit to the data ($F_{2,22} = 13.544$, $P < 0.001$, $R^2 = 0.552$), with higher reporting rates observed around 1990 (Fig. 2*b*).

Table 1. Change in reporting rate of White-fronted Chats in each bioregion of NSW in which the species was recorded in the NSW Bird Atlassers database between 1981 and 2005

Total surveys is the number of surveys conducted in each bioregion; WFC surveys is the number of surveys with records of White-fronted Chats; Years is the number of years in which records were reported (of total of 25 years). The proportion of variation explained by the model (R^2), significance test (F) and probability (P) of the relationship between reporting rate and year are indicated

Bioregion	Code	Region	Total surveys	WFC surveys	Reporting rate	Years	Percentage change 1981–2005	Percentage change 1995–2005	R^2	F	P
NSW North Coast	NNC	Coastal	4656	98	0.021	21	–61	–40	0.073	1.81	0.192
Sydney Basin	SB	Coastal	17548	458	0.026	25	–53	–32	0.237	7.14	0.014
South Eastern Highlands	SEH	Coastal	3420	116	0.034	23	–62	–41	0.085	2.13	0.158
South East Corner	SEC	Coastal	1950	59	0.030	20	–49	–28	0.010	0.24	0.628
Brigalow Belt South	BBS	Northern inland	959	43	0.045	16	–103	–107	0.336	11.61	0.002
Darling Riverine Plains	DRP	Northern inland	1139	94	0.083	22	–66	–44	0.221	6.51	0.018
Cobar Peneplain	CP	Northern inland	1186	84	0.071	23	–52	–31	0.059	1.45	0.241
Murray–Darling Depression	MDD	Northern inland	1266	200	0.158	22	–87	–73	0.350	12.40	0.002
Broken Hill Complex	BHC	Northern inland	364	25	0.069	11	–6	–2	0.000	0.001	0.978
NSW South Western Slopes	NSS	Southern inland	5024	362	0.072	25	–60	–39	0.333	11.50	0.003
Riverina	RIV	Southern inland	2760	514	0.186	25	+49	+16	0.103	2.63	0.118
Australian Alps	AA		14	1	0.071	1	–	–	–	–	–
Mulga Lands	ML		225	24	0.107	9	–	–	–	–	–
Channel Country	CHC		91	10	0.110	6	–	–	–	–	–
Simpson Strzelecki Dunefields	SSD		64	3	0.047	2	–	–	–	–	–

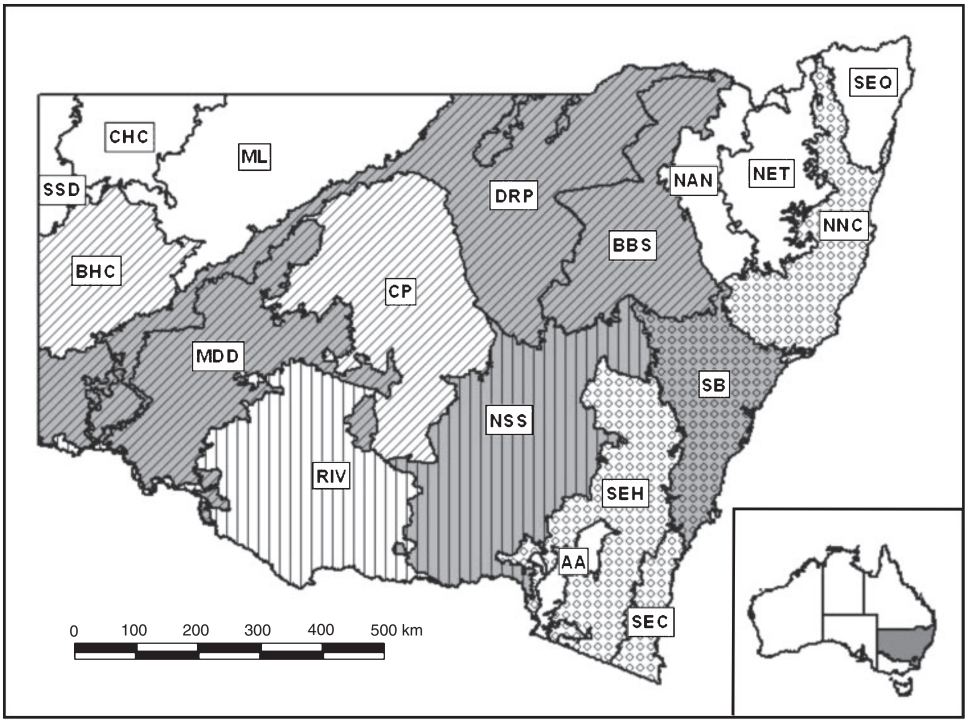

Fig. 1. New South Wales, Australia (inset), showing bioregions in which significant declines in the reporting rates of White-fronted Chats were recorded (dark-grey shading). The pooled bioregions over which broad-scale data were analysed are the Coastal (circle fill), Southern Inland (vertical hatching) and Northern Inland region (cross-hatching) regions. The full names for the bioregional codes are listed in Table 1.

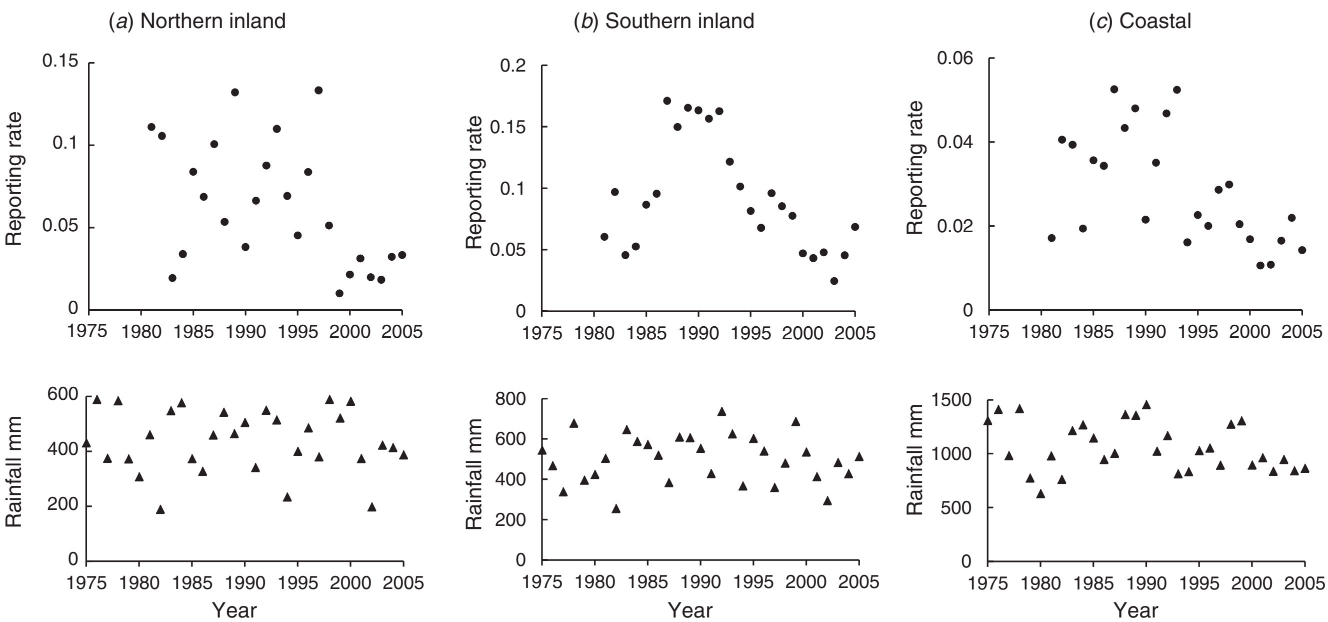

Fig. 2. Change in reporting rate of the White-fronted Chat in relation to annual rainfall in: (*a*) northern inland, (*b*) southern inland and (*c*) coastal areas of NSW over a 25-year survey period from 1981 to 2005.

Variation in annual rainfall did not explain the decline in reporting rate of White-fronted Chats in any of the broad geographical regions. There were no significant relationships between annual rainfall and reporting rate, despite testing for time-lags of between 0 and 6 years (Fig. 2). The strongest (but non-significant) relationship was in the southern inland region with rainfall lagged by 2 years ($F_{1,23} = 3.323$, $P = 0.141$, $R^2 = 0.092$).

Population trends in the Sydney region

White-fronted Chats have been recorded in 56 different locations across the Sydney region since 1859 (Fig. 3). Many records are from the southern side of Botany Bay, extending from Kurnell, Cronulla and westward to Miranda and including the extant population in Towra Point Nature Reserve. White-fronted Chats were also recorded from the northern side of Botany Bay at Malabar and the mouth of the Cooks River. Several locations on the Parramatta River also had regular sightings, especially Homebush Bay, where White-fronted Chats are still present in Newington Nature Reserve (Fig. 3). Along the coastal fringe, White-fronted Chats have been recorded north to Narrabeen and south to Wattamolla. On the western side of the Sydney Basin, White-fronted Chats were sighted south to Picton and northward to Richmond.

Of the 56 sites from which White-fronted Chat populations were recorded before 1960, they have been recorded at only 21 sites since then, and at only four locations since 2000. Since 2003, White-fronted Chats have been recorded at only two sites: Newington Nature Reserve and Towra Point Nature Reserve.

Between 1996 and 2008, the minimum population size of White-fronted Chats at Newington Nature Reserve has dropped considerably ($F_{1,12} = 6.397$, $P = 0.014$, $R^2 = 0.348$; Fig. 4). Straw (1999) estimated the population to consist of 60–100 individuals in 1996, although the greatest number of birds seen at one time in surveys in 1997 was 26 birds (Straw 1999; Ekert 2000). A maximum flock of 22 birds was observed in 2000, declining to 11 birds in 2007. In the 10 surveys conducted in this study, a flock of nine individuals was seen on three occasions, consisting of six males and three females (sex-ratio of 2 : 1). A subsequent colour-banding study has confirmed that only nine individuals remained in the Newington Nature Reserve population in 2008, indicating that maximum flock-size is a good indicator of total population size for a small population occupying a discrete area of suitable habitat.

Fewer abundance data were available from the Towra Point population, with 20 individuals recorded in 1995 (Keast 1995) and 16 individuals in 2006 (Shulz 2006). In the eight surveys conducted in this study, the maximum number of birds seen at any one time was 19. The sex of all 19 birds could not be determined during the sighting but 12 males and three females were seen at the same time in a single survey, providing the minimum number of each sex.

Sensitivity to human disturbance

There was a significant interaction between site and bird species in the distances from the observer at which birds flushed ($F_{2,113} = 11.46$, $P < 0.001$). White-fronted Chats flushed at shorter distances from the observer at Towra Point Nature Reserve than they did at Newington Nature Reserve, whereas Australasian Pipits flushed at shorter distances at Newington Nature Reserve than they did at Towra Point Nature Reserve (Fig. 5). However, despite this interaction, the relative differences between flushing distances of the three species between sites remained the same. The order of records, included as a covariate in the analysis was not significant ($F_{1,113} = 0.10$, $P = 0.75$).

Of the three species, White-fronted Chats showed the lowest levels of tolerance to human disturbance, flushing at significantly greater distances than Australasian Pipits and Superb Fairy-wrens

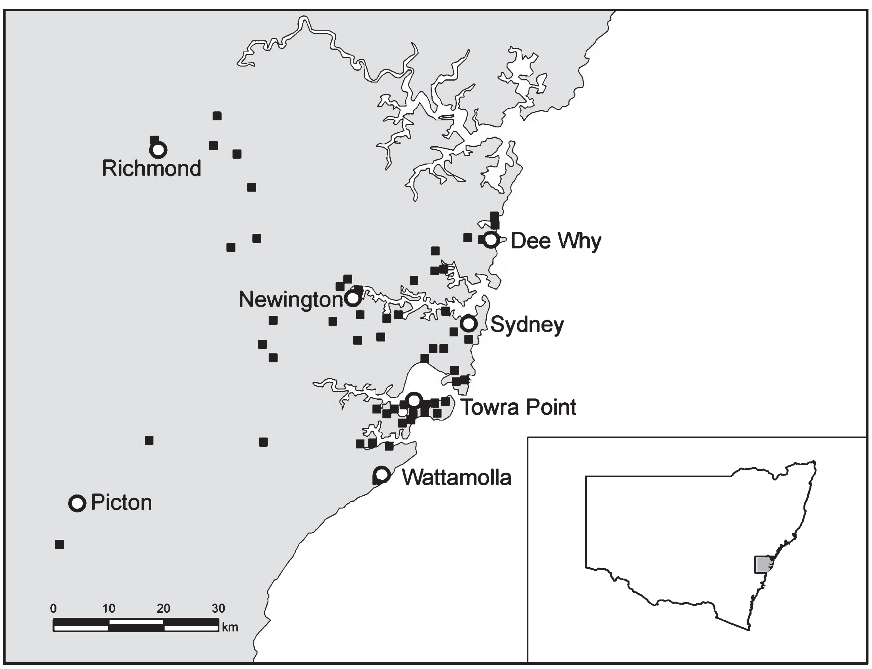

Fig. 3. Locations in the Sydney region, NSW (inset), where White-fronted Chats have been recorded since 1859 (filled squares). Populations are now present only at Newington and Towra Point Nature Reserves. Reference locations are indicated by open circles.

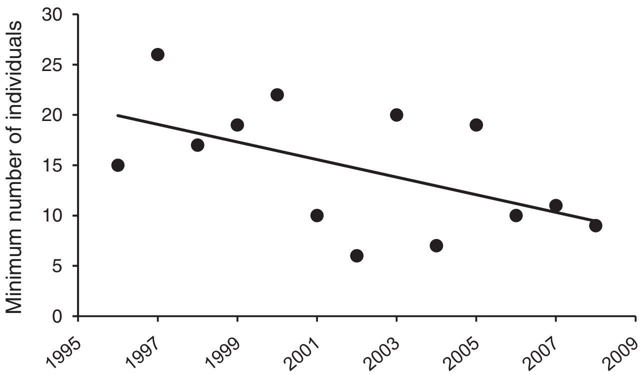

Fig. 4. Decline of the White-fronted Chat population at Newington Nature Reserve since 1996 as indicated by the minimum number of individuals observed on each survey.

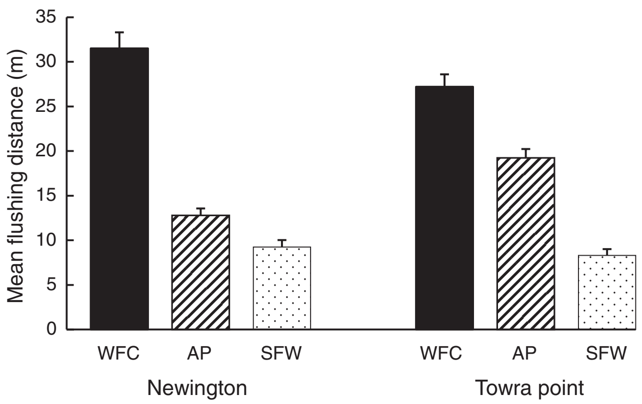

Fig. 5. Flushing distance of White-fronted Chats (WFC), Australasian Pipits (AP) and Superb Fairy-wrens (SFW) at Newington Nature Reserve and Towra Point Nature Reserve. Error bars represent one standard error from the mean.

(Fig. 5). There was no relationship between the size of species and their tolerance of human disturbance, with the Australasian Pipit being the largest bird yet having a mean flushing distance between that of the White-fronted Chat and the Superb Fairy-wren.

Discussion

Population trends

The decline in reporting rate for the White-fronted Chat across NSW of 44% over the 10 years between 1995 and 2005 is of a magnitude (>30% decline in an index of abundance appropriate to the taxon) that supports classification of the species as vulnerable according to the IUCN Red List Guidelines (IUCN 2010). Comparison with Birds Australia atlas data between 1977–81 and 1998–2002 also showed a significant decline in reporting rate of 36% nationally (Barrett *et al*. 2003) and 52% in NSW (Barrett *et al*. 2007). Assuming a linear decline, this latter figure is equivalent to a 35% decline over a 10-year period. Despite different survey methods, each with inherent uncertainties, the New South Wales Bird Atlassers database and the Birds Australia Atlas database detected a similar decline in the species, providing strong evidence of a genuine state-wide decline.

The decline was not uniform across NSW, particularly in the southern inland region, which showed a non-linear trend. The bioregions with the greatest declines tended to be in the northern inland region – a trend also apparent in the Birds Australia atlas data (Barrett *et al*. 2003). These bioregions have intense agricultural production and declines in ground-foraging insectivores have been associated with heavy grazing by livestock and the replacement of native perennial grasses with annual grasses (Baker-Gabb *et al*. 1990; Barrett 2000; Barrett *et al*. 2007). No relationship between rainfall and reporting rate could be detected in any broad geographical region in this study, but the availability of water is still likely to be an important factor influencing populations of White-fronted Chats. A series of droughts over this period has been associated with changed irrigation regimes and wetland conditions (Reid and Brooks 2000). Widespread declines in woodland birds attributed to declining rainfall have been observed in central Victoria since 1995 (Mac Nally *et al.* 2009) with reduced reproductive activity thought to be a consequence of reduced food resources. Although the White-fronted Chat is not a woodland species, a similar mechanism may be operating in the once-moist inland habitats that are now dry as a consequence of regulation of rivers (Kingsford and Thomas 1995).

The dramatic reduction in the distribution of White-fronted Chats in the Sydney region, as shown by the loss of 96% of site records, suggests that the species is highly susceptible to urbanisation. Declines were suggested earlier (North 1904; McNamara 1948; McGill and Lane 1955; Gibson 1977; Hoskin *et al*. 1991; Keast 1995) and confirmed here with a more comprehensive dataset. The differing abilities of species to adapt to changing environments and the change in composition of biodiversity across urban gradients have been well described (Recher and Serventy 1991; Keast 1995; McKinney 2002; Parsons *et al*. 2003; Chace and Walsh 2006; Parsons *et al*. 2006). Loss of habitat for habitat specialists like the White-fronted Chat is likely to be the major factor contributing to their decline (McKinney 2002; Parsons *et al*. 2006). The eventual extinction of White-fronted Chats from the Sydney region seems inevitable based on the current pattern of decline, unless direct conservation intervention occurs. Loss of the Sydney population, combined with loss of populations on the NSW central coast and in the Wollongong region (R. E. Major, unpubl. data), will eliminate the stepping stone populations that may prevent isolation of the extant population north of Newcastle from the more secure populations on the NSW south coast.

Threats

White-fronted Chats flushed at significantly greater distances from an observer than both Australasian Pipits and Superb Fairy-wrens, indicating that they are more vulnerable to human disturbance than other co-occurring species. Our results are not consistent with other studies that suggest that larger birds are more sensitive to human disturbance and flush at greater distances (Cooke 1980; Fernández-Juricic *et al*. 2002). It is therefore possible that direct human disturbance may be an important factor contributing to the decline of populations of White-fronted Chats. High levels of disturbance can increase energy costs associated with retreat, as well as loss of feeding time while relocating to different feeding areas. Increased bird density at non-disturbed sites may intensify competition or increase susceptibility to predation (Goss-Custard *et al*. 2006). At both Homebush Bay and Botany Bay, the distribution of White-fronted Chats has contracted from a wide range to those areas from which public access is restricted, despite no recent loss of habitat. Human disturbance may also cause nest abandonment and decreased nest attentiveness resulting in decreased survival of species with low tolerance to human disturbance (Gotmark 1992; Gutzwiller *et al*. 1998).

To arrest the decline of White-fronted Chats in NSW, we recommend monitoring of extant populations and, if necessary, the introduction of buffer zones to reduce disturbance in locations where human disturbance is likely (Fernández-Juricic *et al*. 2002). It appears more than coincidental that the four extant coastal populations between Nowra and Newcastle (inclusive) are all located in nature reserves with restricted public access (R. E. Major, unpubl. data). Even within conservation areas, active management may still be required to ensure the persistence of saltmarsh in the face of rising sea-levels. In particular it may be necessary to control mangroves to promote the survival of saltmarsh flora. Given the speed of decline of populations in the Sydney region, direct action, such as caging of nests to boost population recruitment (Isaksson *et al*. 2007), may be worth investigating. Finally we recommend an adaptive management approach be taken to the control of potential nest predators, including Red Foxes (*Vulpes vulpes*), Cats (*Felis catus*), rodents and artificially elevated abundances of corvids (Recher and Serventy 1991) that are frequently observed in natural habitats in close proximity to urban development.

Acknowledgements

We are grateful to the Sydney Olympic Park Authority, the Hermon Slade Foundation and Lake Macquarie City Council for providing financial assistance. Approval to work in the Nature Reserves was granted under NSW Department of Environment, Climate Change and Water (DECCW) Scientific Licence S12585 and animal ethics approval was granted under Australian Museum project number 08/06. We greatly appreciate the generosity of the New South Wales Bird Atlassers Inc. for providing the data necessary to analyse the distribution and abundance of the White-fronted Chat across NSW. Historical data on the two extant Sydney populations were provided by the DECCW for Towra Point Nature Reserve, and the Sydney Olympic Park Authority for Newington Nature Reserve. Thanks also to Jess Bramley-Alves for helpful comments on earlier drafts of the manuscript.

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Manuscript received 24 May 2010, accepted 1 September 2010