Is an Island Reserve Enough? The Decline and Fall of the White-fronted Chat (Aves: Meliphagidae) in Southern Sydney

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Published on 3 September 2012 at http://escholarship.library.usyd.edu.au/journals/index.php/LIN

Major, R.E. and Sladek, J.L.T. (2012). Is an island reserve enough? The decline and fall of the White-fronted Chat (Aves: Meliphagidae) in southern Sydney. *Proceedings of the Linnean Society of New South Wales* **134**, B205-B214.

Ecological theory predicts that local extinction and recolonisation are normal events, but the frequency of each is likely to change as the habitat matrix between local populations becomes less suitable. Despite these predictions, local extinctions are seldom documented and there is a popular belief that nature reserves conserve biodiversity. This paper traces the decline of the White-fronted Chat (*Epthianura albifrons*) in the region surrounding Royal National Park and examines preliminary data on the species' ecology and population dynamics. Although once widespread across the region White-fronted Chats are now confined to a single breeding population of approximately 20 individuals that spends much of its time as a single flock, mostly roosting, nesting and foraging within Towra Point Nature Reserve. Numbers appear to be relatively stable, but the population has lost genetic variability. In spite of a high abundance of potential nest predators, there is ongoing recruitment, with pairs nesting twice per season. The population is threatened by mangrove encroachment of salt marsh, ongoing development of the Kurnell peninsular, increased predation rates due to anthropogenically-elevated predator abundances, and demographic factors associated with small population size. The history of this species is a clear demonstration that even conservation reserves with a relatively high degree of protection from human disturbance cannot protect regional biodiversity in the absence of active management if they are isolated.

Manuscript received 28 November 2011, accepted for publication 29 February 2012.

KEY WORDS: island biogeography, *Epthianura albifrons*, genetic diversity, microsatellite, nest success, Royal National Park, salt marsh, survivorship, urbanisation, White-fronted Chat.

INTRODUCTION

National parks and nature reserves are often referred to as the "jewels in the crown", providing the backbone for government efforts directed towards the conservation of biodiversity (SEWPaC 2011). As well as providing the habitat in which populations of animals can be maintained, reserves have the potential to produce recruits that can populate sub-optimal habitat patches in the landscape, thereby contributing to off-reserve conservation. Both these benefits are ultimately dependent on the size of the reserve and the degree of similarity between the reserve and the surrounding environment. If reserves are small, thereby supporting small populations, and surrounded by a matrix of habitat that is unsuitable for a particular species, that species is more prone to local extinction. Ecological theory predicts that local extinctions will occur periodically, but subsequent dispersal from other patches will allow recolonisation and persistence through time. If a reserve is remote from other reserves that provide similar habitat, however, the likelihood of recolonisation is low and the local extinction may be permanent. Despite their predicted occurrence, local extinctions are seldom documented and there is a popular belief that animal populations in reserves are secure. The aim of this study is to document the decline of a bird species that was once widespread across southern Sydney, including occurrences in Royal National Park and Towra Point Nature Reserve.

The White-fronted Chat (*Epthianura albifrons*) is a small (13 g) bird which belongs to the honeyeater family (Driskell and Christidis 2004),

despite foraging almost exclusively on ground insects (Major 1991a). The species occupies damp, open habitats in the southern part of Australia from Carnarvon on the Western Australian coast across to South West Rocks in New South Wales (Barrett et al. 2003). In New South Wales its distribution is split by the forests and woodlands of the Great Dividing Range, with coastal birds largely confined to coastal salt marsh, and inland birds occupying wetlands bordered by chenopod shrublands or grasslands. A significant decline in reporting rate over a 20 year period has been identified in New South Wales (Barrett et al. 2007, Jenner et al. 2011) and the species is listed as vulnerable under the New South Wales Threatened Species Conservation Act (NSWSC 2010a). Coastal populations are showing the greatest decline, and the population in the Sydney Metropolitan Catchment Management Authority area has been listed as an endangered population (NSWSC 2010b). This study reviews the decline of the species in the region surrounding Royal National Park and provides preliminary data on population size, connectivity, habitat selection, adult survival and reproductive success. These data are necessary to determine the viability of the population and the extent to which it is protected by the reserve system.

METHODS

Historical distribution

Information on the historical distribution of the White-fronted Chat in the region surrounding Royal National Park (Parramatta River south to Helensburgh – Fig. 1) was compiled from three forms of data: 1) published accounts of early Australian ornithologists (Ramsay 1863, Gould 1865, North 1904); 2) the collection databases of the Australian Museum and Museum Victoria, and 3) the historical database of the New South Wales Bird Atlassers, which is compiled from published records from the ornithological literature. Location data from each record were mapped and duplicate records from the different sources were excluded.

Current population size

White-fronted Chats currently occur in the study region only at Towra Point Nature Reserve in Botany Bay and at Newington Nature Reserve on the Parramatta River (NSW Scientific Committee 2010b, Jenner et al. 2011), although the Newington population appears doomed, consisting only of four males (unpubl. data). The Towra Point population was therefore the focus of this work, and the size

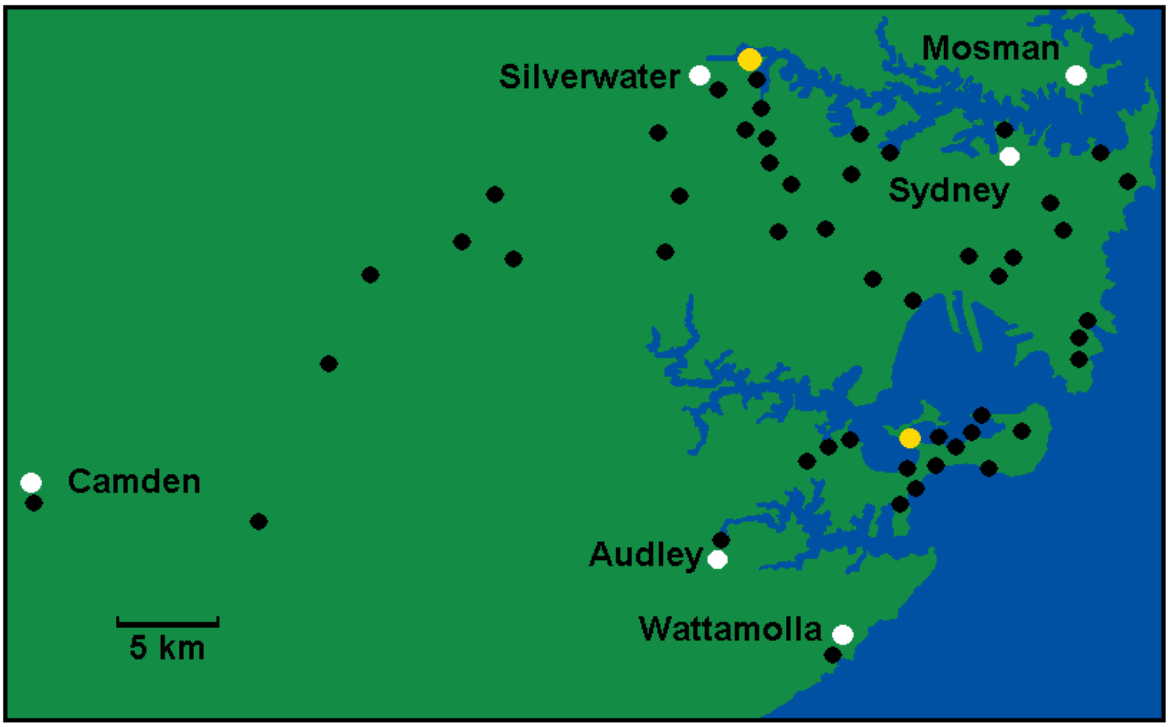

Figure 1. Historical localities of White-fronted Chats in the study region which extends from Royal National Park in the south to the Parramatta River in the north. Historical localities are shown by filled black circles. The two extant localities are shown by yellow filled circles: Newington Nature Reserve on the Parramatta River, and Towra Point Nature Reserve in Botany Bay. White filled circles mark place names.

Figure 2. Air photo of the salt marsh at the "neck" of Towra Point which was the predominant area used by White-fronted Chats. Salt marsh appears as the fine texture, with mangroves appearing as the course texture. R = the location of the mangroves in which the birds roosted during June 2010.

of the population was estimated from 63 surveys conducted between September 2009 and February 2011. Each survey was a minimum of three hours duration, and traversed the 50 ha patch of salt marsh habitat in "the neck" of Towra Point (Fig. 2) (Mitchell and Adam 1989). On each survey we recorded the location of each group of birds encountered and the number of birds in each group. The population size on a particular day was estimated as the maximum number of birds known to be present at one instant. This normally corresponded to the size of the largest flock observed on the day, but on some occasions it included additional birds known to be foraging away from the main flock.

Population isolation

To determine whether the Towra Point population was closed to immigration, we compared the genetic structure of birds from Towra Point (n=10) with birds from the nearest neighbouring populations at Homebush Bay (n=6) and Shoalhaven Heads (n=8). DNA was extracted from feather samples taken from birds captured in mist nets and each bird was genotyped for 19 microsatellite markers (unpubl. data). The program STRUCTURE (Pritchard et al. 2000) was used to determine the number of genetically distinct clusters and to assign each bird to a cluster based only on its genotype (rather than including information from its sampling location). Levels of allelic diversity and heterozygosity were determined using the program GENALEX (Peakall and Smouse 2006).

Use of habitat

To identify important patches of habitat for the Towra Point population, we mapped the location

of flocks of birds during 103 hours of observations during winter, and the location of nests during 104 hours of observation during the spring of 2010. Winter observations were assisted by intensive monitoring of three birds fitted with radio transmitters. Transmitters weighing 0.5 g were glued to the backs of each bird using the technique of Sykes et al. (1990). Each bird was tracked for up to 21 days between 9th and 30th June, 2010, by which time all batteries had discharged. Important breeding habitat was identified by locating nests during the breeding season between 1st September and 20th December, 2010 (see '*Survival rates* below).

Survival rates

To measure the survival rate of adults, a sample of birds was marked with unique combinations of coloured leg bands. Individual birds were identified by observing their bands with a 20 X spotting scope and annual survival was determined by calculating the percentage of birds known to be alive in the spring of 2009 (n=11) that were resighted alive in the spring of 2010.

To measure reproductive success, weekly nest searches were conducted by 1-3 observers during the 2010 breeding season between 1st September and 20th December. Each search lasted for 4-8 hrs commencing between 0 and 1 hrs after sunrise. Nests were located by observing distraction displays (Major 1991b) or watching from a hide at locations where the same banded bird was seen repeatedly. Once located, nests were checked weekly to monitor their outcome, continuing until the contents were depredated or the parents were seen attending fledglings away from the nest.

RESULTS

Historical distribution

There are historical records of White-fronted Chats from numerous localities in the region to the north of Royal National Park as well as a few records from within the Park itself (Fig. 1). There are two atlas records from Audley in 1982, one from Wattamolla in 2001 and four records from unspecified locations (not shown in Fig. 1) in Royal National Park between 1948 and 1960.

The observations of Ramsay (1863) that: "about Botany and the Parramatta River, upon the borders of the Hexham swamps etc., they are plentiful", are confirmed by numerous records throughout the early to mid-1900s that are concentrated around the Kurnell Peninsular and Homebush Bay (Fig. 1). The distribution of the species appears to have been continuous between Botany Bay and the Parramatta River, with records indicating a western link along the Cooks River through Canterbury, Enfield, Strathfield and Homebush; and an eastern link through Mascot, Eastlakes, Centennial Park, Bondi and Rose Bay. Birds in these locations were likely to be resident, given that nesting is also recorded: e.g., "At Canterbury, New South Wales, on the 15th November, 1892, while walking among some rushes, I flushed a male from a tuft where I found it had been sitting on four fresh eggs." (North 1904). The Australian Museum's egg collection indicates that birds were also resident at, amongst other locations, Enfield, Belmore, Randwick, Centennial Park and Bondi. The historic distribution also extended in a south-westerly direction from the Parramatta River through Auburn, Cabramatta, Ingleburn, Campbelltown and Camden.

Population isolation

Analysis of the genotypes of individuals from the three White-fronted Chat populations revealed strong population structuring with the best genetic model identifying three distinct clusters (Fig. 3). There was a strong correspondence between the sampling location of individuals and their position within the clusters, indicating that birds from the three locations made up three distinct genetic populations. All ten birds from Towra Point were strongly assigned to cluster one, all eight birds from Shoalhaven Heads were strongly assigned to cluster two, and five of the six birds from Homebush Bay were strongly assigned to cluster 3, with the sixth bird (H6) in this sample showing ancestry from both clusters two and three.

A loss of genetic diversity, expressed in both heterozygosity and allelic diversity, was evident in the small populations at Towra Point and Homebush Bay, compared with the population at Shoalhaven Heads. Heterozygosity was lower at Towra Point (UHe=0.60$\pm$0.05 s.e.) and Homebush Bay (UHe= 0.64$\pm$0.05) than at Shoalhaven Heads (UHe=0.77$\pm$0.04). Mean allelic diversity per locus was lower at Towra Point (Ne=2.71$\pm$0.23 s.e.) and Homebush Bay (Ne= 2.88$\pm$0.25) than at Shoalhaven Heads (Ne=4.60$\pm$0.48).

Current population size

Apart from the four remaining males at Homebush Bay (unpubl. data) the only records of White-fronted Chats in the Sydney region since 2001 have been from Towra Point Nature Reserve. The maximum number of individuals seen on any one day ranged from 1 to 24 birds (mean 12.9$\pm$6.9 sd birds) over the 63 surveys, excluding 6 surveys when no birds were detected. The estimated population size was lowest during the two spring seasons (Fig. 4), presumably because most birds were breeding and

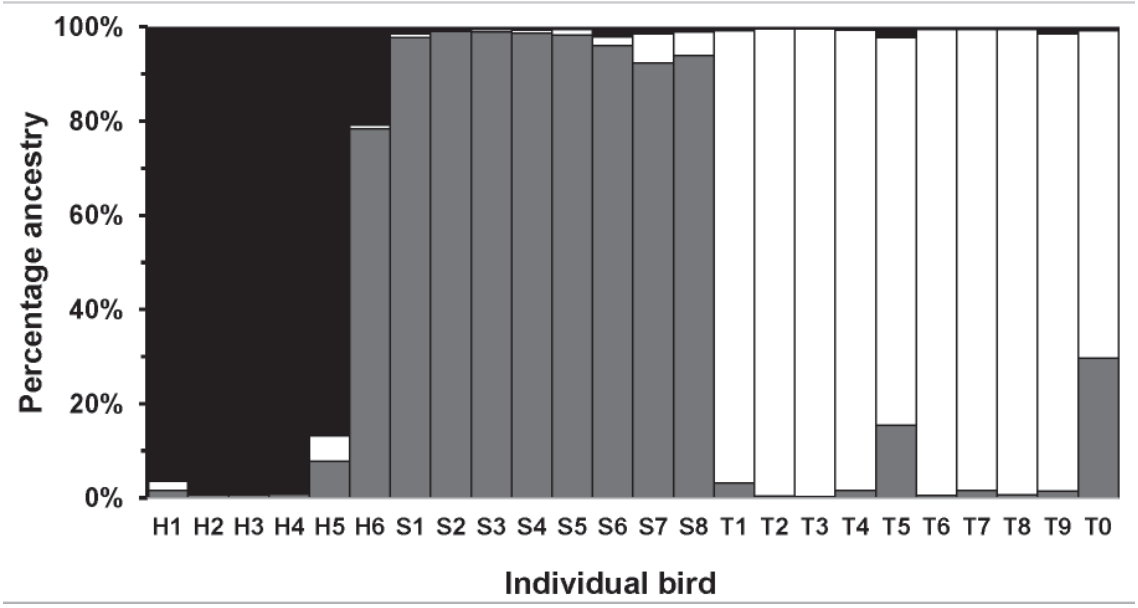

Figure 3. Inferred ancestry (expressed as a percentage) of individual birds from each of three genetic clusters (cluster 1 = black, cluster 2 = grey and cluster 3 = white). The location from which each individual was sampled is indicated by a letter: H = Homebush Bay, S= Shoalhaven Heads and T=Towra Point.

so nesting activities prevented all birds from forming the single foraging flock that was observed in late summer and winter. No birds were detected during four surveys during autumn 2010.

Use of habitat

Despite searching throughout Towra Point, birds with radio-transmitters were detected only within the large patch of salt marsh along the "neck" of Towra Point (Fig. 5). One radio-transmitter failed after only seven days, but each of the remaining two birds (151.382MHz, and 151.051MHz) was observed to forage in flocks of up to 24 birds in several locations across the salt marsh (Fig. 5a, b). For both of these birds, there appeared to be a shift in the area used between the winter and spring seasons.

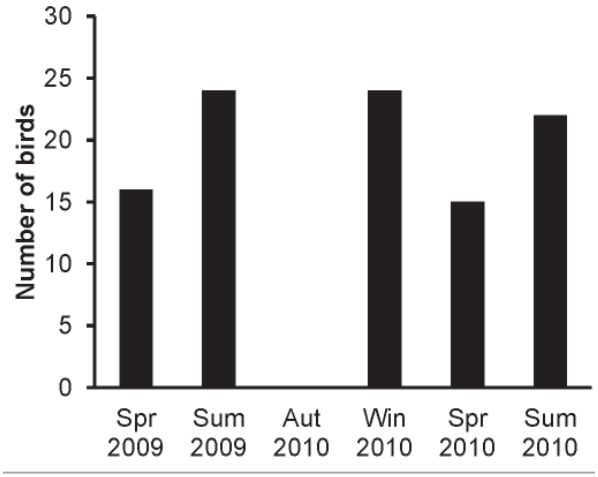

Figure 4. Estimates of the size of the Towra Point population in each season, defined as the maximum number of birds identified on any survey during the season. Each of the 63 surveys had a minimum duration of 3 hrs. No birds were detected during four surveys in autumn 2010.

Anecdotal observations indicate that many of the winter foraging locations were in low salt marsh vegetation comprised mostly of *Sarcocornia quinqueflora* while most of the spring observations were made near nest sites, which were in slightly higher salt marsh vegetation comprised of *Juncus krausii* and *Suaeda australis.* A similar pattern is apparent from records of the locations of all flocks of five or more birds and the location of all nests found during the spring of 2010 (Fig. 5c). Only a single nest and no flocks of birds were located outside the "neck" of Towra Point.

The radio-transmitters also allowed identification of the locations in which birds roosted at night during June 2010. The three birds roosted together with other birds in a clump of isolated mangroves for 20, 14 and 6 nights respectively (Fig. 2), apart from one night during which a single bird roosted in mangroves 200 m to the south.

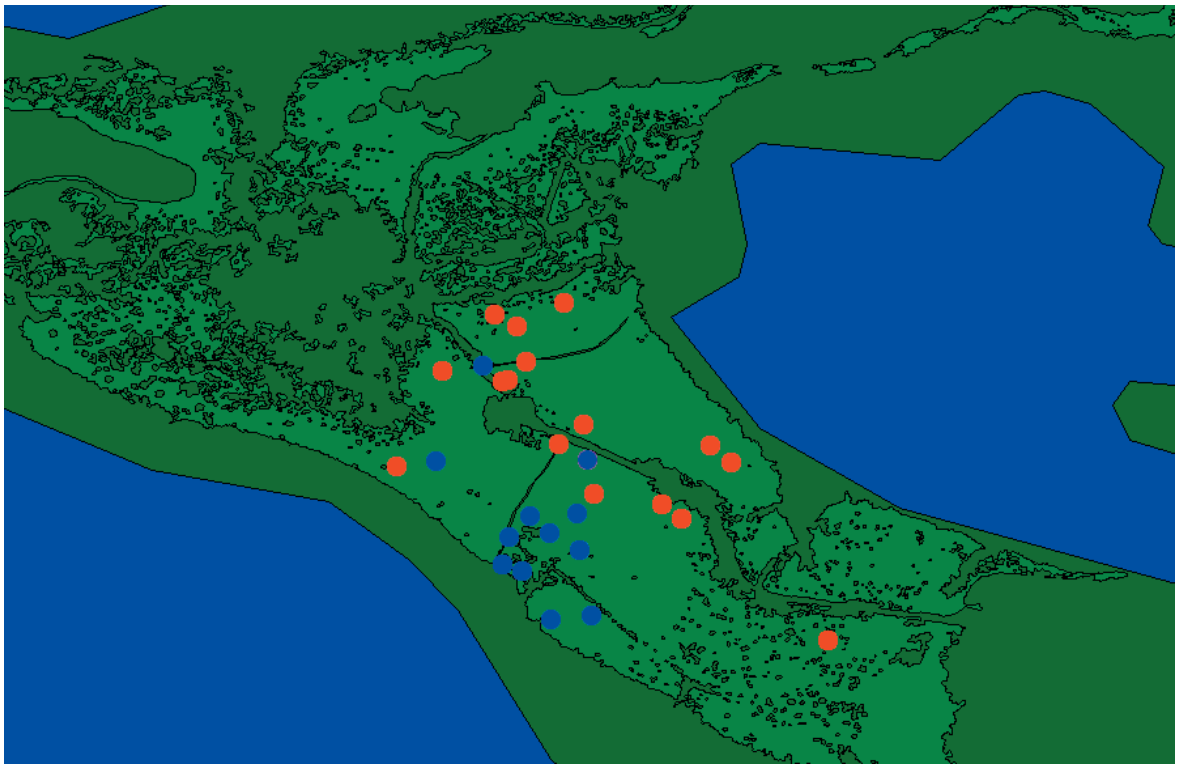

Figure 5a

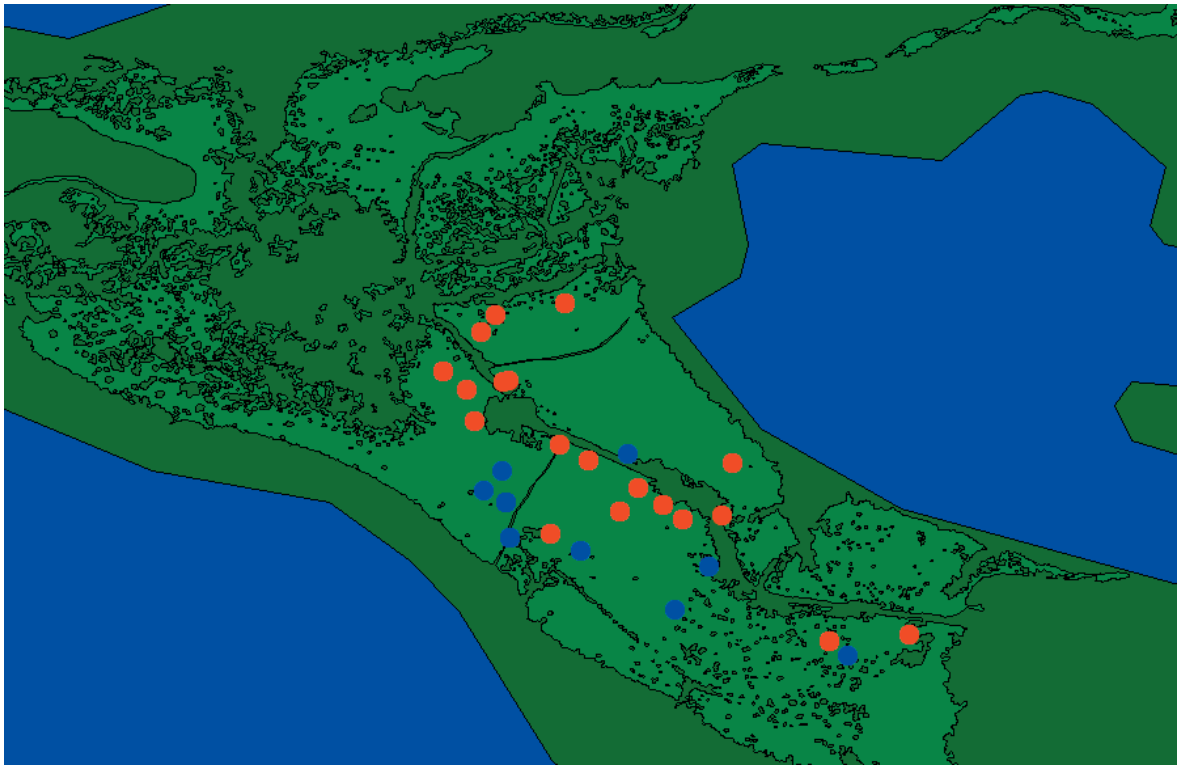

Figure 5b

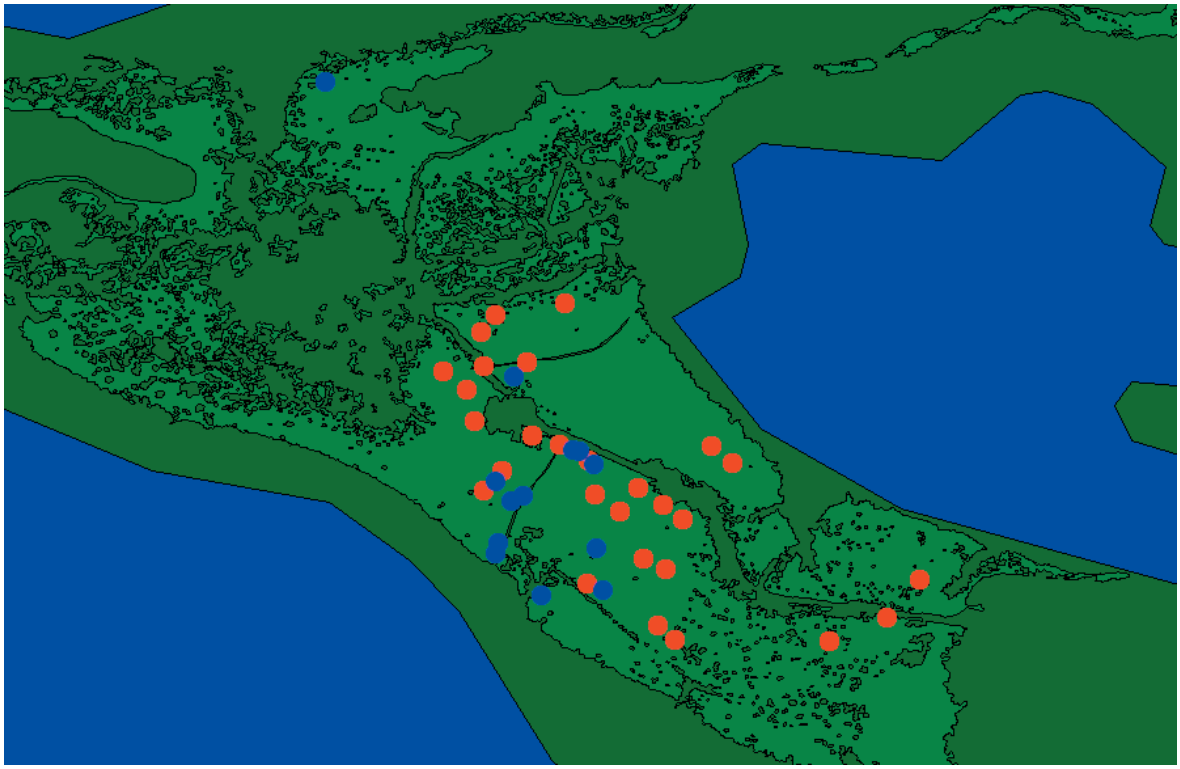

Figure 5c

Figure 5. Winter (red filled circles) and spring (blue) records of White-fronted Chats at Towra Point. (a) Locations of a male fitted with a radio transmitter (151.382MHz); (b) locations of a male fitted with a radio transmitter (151.051 MHz); (c) locations of flocks of five or more birds (red) and the locations of nests (blue).

Survival rates

A total of eleven adult White-fronted Chats, comprised of seven males and four females were colour banded and, through observations, were known to be alive in the spring of 2009. All four females and five of the males were subsequently identified in the spring of 2010. This equates to an adult annual survival rate of 80%.

We were able to identify 13 nesting attempts by seven separate pairs of birds, of which six pairs made two nesting attempts during the spring of 2010. Two pairs were successful with both their nests, four pairs were successful with one of their attempts, and the pair with the single attempt was unsuccessful. Nesting behaviour was observed for another pair but we were unable to locate the nest and so it is not included in the calculations of reproductive success. Overall nest success was 60%, with three failures presumed to be the result of predation given that the entire nest contents disappeared. Two nests were deserted leaving undeveloped eggs in the nest and as one of these nests had been incubated for at least 11 days prior to desertion it appears that the eggs were infertile. Overall, we followed the fate of 33 eggs,

of which 22 hatched and 13 fledged, equivalent to a fledging success rate of 40%.

DISCUSSION

Historical evidence indicates that White-fronted Chats were once widespread and relatively common inhabitants of the region between Royal National Park and the Parramatta River. Records suggest that the most favourable locations were in open habitats along the Cooks River, Georges River and the chain of swamps running through the eastern suburbs into Botany Bay. Salt marsh vegetation was particularly favoured (Ramsay 1863, Keast 1995), and the two extant populations inhabit the two largest remnant patches of salt marsh on the Parramatta River and Georges River respectively. There are few records from Royal National Park and the location

information of the early records in not specific. The only significant area of salt marsh in Royal National Park is at "The Basin" between Maianbar and Bundeena, but it is much smaller than the patches at Homebush Bay and Botany Bay.

Urban development has not only destroyed most of the suitable habitat for White-fronted Chats in the region, but it has transformed the matrix between suitable patches into a medium that restricts its passage. The species is sensitive to direct human disturbance as was noted by Gould (1865): "It is rather shy in its disposition, and when disturbed flies off with considerable rapidity to the distance of two or three hundred yards before it alights again". More recent research indicates that the species is less tolerant of people and human habitation than other species with which it co-occurs (Hoskin et al. 1991, Jenner et al. 2011). Preliminary data presented here indicate genetic isolation of the Towra Point population despite it being distant from its nearest neighbour by a distance of only 20 km. Given that the species has been recorded flying a distance of at least 18 km across the ocean from Rottnest Island to mainland Australia (Williams 1979) and that movements across Bass Strait are suspected (Schodde and Mason 1999), it appears that the urban environment represents a severe barrier to dispersal for this species.

Given that the Towra Point population is the last breeding population in Sydney, prospects for the continued survival of the species in the region surrounding Royal National Park are not promising. We estimate the population to be extremely small, with a maximum of 24 birds, comparable with previous counts of White-fronted Chats at Towra Point of 20 birds in 1995 (Keast 1995), 16 birds in 2006 (Shultz 2006) and 18 birds in 2008 (Jenner et al. 2011). White-fronted Chats were occasionally absent from the salt marsh at Towra Point, notably in the autumn of 2010, which provides some possibility that there may be patches of suitable habitat on the Kurnell peninsular that are unknown to us, and potentially supporting a larger population. Anecdotal observations from shorebird observers indicate that birds were sometimes present on Spit Island, just off the northern end of Towra Point and 1.5 km distant from the winter roost site; and we have occasionally observed banded birds flying to feed in grassland 2 km to the south west. Although we cannot confirm the absence of additional birds, information collected from the radio transmitters supports our contention that 24 birds was the maximum size of the Towra Point population during our fieldwork: whenever the flock of 24 birds was encountered, all birds with functioning transmitters were always present. Furthermore, the loss of genetic diversity in the population provides a further indication of its small size.

Although of small size, the populations appears to have been relatively stable over the last 15 years, and neither adult survival (Robinson 1990a, Debus 2006) nor reproductive success (Robinson 1990b, Berry 2001) are low by comparison with other Australian passerines. As they nest close to the ground, White-fronted Chats are prone to predation from both mammalian and avian predators and reproductive success can be extremely low (18%), even in large stable populations (Major 1991b). An active fox-baiting program was in place at Towra Point during this study which may have contributed to the relatively high nesting success, although our sample size was unavoidably small and it is possible that our single-season sample was unrepresentative. Large numbers of ravens (up to 80 individuals originating from urban and industrial land adjoining Towra Point) were observed foraging in the salt marsh on most days of fieldwork, and such a strong presence of this confirmed nest predator (Major 1991b) represents a significant threat to the population of White-fronted Chats. With its small population size and recent isolation, demographic stochasticity could rapidly move this population below a critical level. Additionally, there is already an indication that the population is susceptible to genetic effects associated with inbreeding, further compounding this threat.

There are two other likely threats that may have resulted in the small population size at Towra Point, despite the relatively large patch of salt marsh habitat. Firstly, White-fronted Chats have frequently been reported to make medium scale (up to 3 km) foraging excursions away from their roost sites (Major 1991a), and the numerous historical locations from which birds have been reported on the Kurnell peninsular suggest that the Towra Point population may once have exploited foraging opportunities outside the reserve. With ongoing development of the peninsular, there has been a large decline in potential foraging area. Secondly, there is a well documented decline in the area of salt marsh, resulting from mangrove invasion (Mitchell and Adam 1989), and White-fronted Chats are likely to have used a much larger area of salt marsh in the past. At present we have no knowledge of the extent of habitat required to support a viable population.

Overall, this study provides an example of how intensification of land use in a region can result in the gradual extinction of local populations occupying remnant habitat. Without management intervention it seems inevitable that the population of White-fronted Chats in the region surrounding Royal

National Park will become extinct, due to the small size of suitable habitat protected in nature reserves and their isolation by an urban matrix. As well as its obvious consequences for regional biodiversity, the loss of this population, along with the recent loss of populations on the Illawarra and Central coasts, will open up a discontinuity between the Shoalhaven and Hunter Rivers. Depending on the level of connectivity between inland and coastal populations, this discontinuity may have consequences for the long term persistence of the northern end of the species distribution.

ACKNOWLEDGEMENTS

This project was funded by grants from Lake Macquarie City Council and the Herman Slade Foundation. We are grateful to the New South Wales Bird Atlassers, the National Museum of Victoria and the Australian Museum for providing their historical records, and to Rebecca Johnson, Andrew King and Georgina Cooke for assistance with DNA analysis. We thank Greg West from the Port Stephens Fisheries Institute (Industry and Investment, NSW) for providing mapping data on the distribution of salt marsh. Birds were banded under a scientific licence (S12586) issued under the NSW National Parks and Wildlife Act, and an Australian Bird and Bat Banding Scheme license A1166. Ethics approval for this project was granted by the Australian Museum Animal Care and Ethics approval number10/01.

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