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Evidence of steep declines in the heavily traded Javan White-eye *Zosterops flavus* from repeated standardised surveys

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Research Article

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Summary

Many Indonesian, and in particular Javan, birds are suspected to have declined dramatically as a result of unsustainable trapping for the cagebird trade, but quantitative evidence of the scale of declines is lacking for the great majority of species. We conducted field surveys of the heavily traded Javan White-eye *Zosterops flavus* at 19 key sites in 2018–2019 matching the methods and personnel used in baseline surveys done around 10 years earlier. Overall numbers counted were 84% lower in the later survey, and while more white-eyes were recorded at three sites in 2018–2019, there was a significant decline in numbers across all sites. The three sites with highest numbers in 2006–2019 (502 birds counted) had 22 individuals counted in 2018–2019, but there was no overall trend for 'declines' to be greater at sites that held more birds originally. Declines in white-eyes were much steeper than those of several lesser-traded bird species at the sites, suggesting that trapping has been a more important driver of declines than habitat changes such as conversion of mangrove to shrimp ponds. Small numbers of white-eyes were recorded at several previously unvisited sites, but we suggest that the species, on Java at least, has shown declines in the region of 80% over the last 10 years. Although since 2018 Javan White-eye is legally protected, we urge that this protection is extended to all white-eye species, because of their similarity.

Introduction

There has been a long tradition of keeping caged songbirds in Indonesia and other parts of Southeast Asia (e.g. Jepson and Ladle 2005, Marshall *et al.* 2020). Recent surveys of ownership across Java, the island at the centre of the songbird trade indicate that around 12 million households across Java keep around 70 million birds, including many wild-caught species, and that ownership levels have increased over the past decade (Marshall *et al.* 2020). This has led to acute concerns for the sustainability of this largely domestic trade, the so-called 'Asian Songbird Crisis' affecting wild bird populations in the region (Eaton *et al.* 2015, Lee *et al.* 2016). Effects on wild bird populations are thought to be manifold, hastening the extinction and near-extinction of much sought after species such as Javan Pied Starling *Gracupica jalla* and other 'Critically Endangered' mynas, but also causing severe declines in birds such as white-eyes, flycatchers, prinias, and other once extremely common species from the wider landscape (Squires *et al.* in prep). While losses in myna species are well-established, largely because they are now extinct or incredibly localised, baseline data for most widespread species are almost totally lacking (e.g. Collen 2008). In these cases, declines are usually inferred from volumes or prices of birds in the market, or from anecdotal information (Harris *et al.* 2015, BirdLife International 2020; but see Harris *et al.* 2016). This is far from ideal in terms of prioritising species for action, predicting precise patterns of decline, communicating the nature of declines to relevant authorities and civil society, and ultimately in targeting conservation actions effectively.

The Javan White-eye *Zosterops flavus* is a coastal passerine largely restricted to the Javan coastal zone Endemic Bird Area which includes the coastal wetlands, grassland, mangroves, scrub, beaches, and mudflats of Java and Madura, Indonesia (BirdLife International 2020). An isolated population occurs in a number of scattered coastal areas in southern Borneo. As the coastal zone in Java and Madura has been densely inhabited for centuries, little of the natural coastal wetlands and grasslands remains (Stattersfield *et al.* 1998). In the 1980s and 1990s, only few records were available for just five scattered localities along the north coast of West and East Java: Pulau Dua, Muara Gembong, Pamanukan and Indramayu in the west, and Ujung Pangkah in the east (Allport and Milton 1988, S. v. B. unpubl. data).

While no Javan White-eyes were identified in the commercial trade in Indonesia in 1991–1993 (Nash 1993), the first decade of this millennium saw a sudden boom in numbers of white-eye hobbyists, with their own specialist clubs and song contests (Yuwono 2013). A 2018 survey of

bird ownership involving over 3,000 households in all six of Java's provinces estimated that around 1,500,000 (± 400,000 SE) white-eyes, are currently kept in Java alone (Marshall *et al.* 2020). The majority of these individuals are likely to be Sangkar White-eye *Zosterops melanurus* (Lim *et al.* 2019), but Javan white-eyes are also heavily targeted presumably because of accessibility but also a demand for novelty. For example, significant numbers were observed in inventories of the main markets on Java in 2014 (Chng *et al.* 2015), and 2015 (Chng and Eaton 2016). A single bird was found during a survey of Singapore bird shops in 2015 (Eaton *et al.* 2015).

An additional immediate threat to the white-eye comes from the loss of habitat, especially the conversion of large areas of coastal wetlands (mangroves, coastal swamps), mainly for shrimp ponds (Masyuri 1997). The erosion induced by these aquacultures, a globally rising sea level, and subsidence due to groundwater and gas extraction along the north Javan coast (Chaussard *et al.* 2013, Marfai 2014, van Wesenbeeck *et al.* 2015) are additional threats.

In November–December 2006, and May–June 2009, a number of coastal wetland areas, identified from detailed land-use maps, were visited in collaboration with several Indonesian NGOs and universities. Inventories were made of the local coastal bird assemblages, with particular attention to four restricted-range species largely confined to the coastal zone, including the Javan White-eye *Zosterops flavus*. During these surveys, Javan White-eyes were counted at 19 sites along the north coast of West, Central, and East Java, including Madura. This 2006–2009 dataset represents a unique baseline against which to gauge the possible decline of the species from excessive trade in the last 10 years (Eaton *et al.* 2015). We therefore aimed to repeat these surveys as closely as possible in 2018–2019 both to determine the current status of Javan White-eye, examine scale and patterns of abundance change over the last decade, and to identify key strongholds and new areas of importance for its conservation on Java.

Methods

Survey sites

Prior to the first surveys in 2006, localities to be visited were selected based on a literature review (Scott 1989, Wibowo and Suyatno 1999, Rombang and Rudyanto 1999) and cartographic study. First, maps were scrutinized at large scale (Sandy 1986), based on the presence of estuaries, the remoteness from settlements, and the indication of swamps (*rawa*), and second, maps commercially available at Bakosurtanal at Cibinong (Peta Rupabumi Digital Indonesia series, scale 1 : 25.000; based on field surveys conducted in 1996–2000), were searched for indications of specific vegetation types (*rawa* = "swamp"; *hutan rawa* = "swamp forest", *semak/belukar* ("secondary scrub") to detect extant coastal habitat that might be suitable for Javan White-eye.

For the 2018–2019 surveys, areas were revisited as closely as possible the areas covered by the original surveys. At several sites (notably Muara Gembong and Pamanukan), we were forced to visit a different set of sub-localities in 2018–2019, as some of those visited in 2006–2009 had been submerged during the past decade. An additional four sites were visited for the first time in 2018–2019. Three localities that were known to contain Javan White-eyes before 2006, had not been visited in our surveys: Pulau Dua (Allport and Milton 1988), Jakarta (e.g. Vorderman 1883, Hoogerwerf and Rengers Hora Siccama 1937-1938) and Indramayu (S. v. B. unpubl. data). Also the northern coast of Semarang, intensively surveyed since 2006, where the white-eye was found sparsely distributed in very small numbers (Baskoro 2018), and four localities surveyed in 2016–2020 (Atlas Burung Indonesia 2020), with only two records of >10, and maximum 15 birds, have not been included in the present surveys.

Bird counts

We recorded Javan White-eye numbers along routes walked through as much as possible representative habitat at each site. Total length of routes covered through suitable white-eye habitat depended on accessibility of the areas, and therefore in the more extensive mangroves in the largest areas, coverage was proportionally less than the smaller areas. To counter any biased interpretation of the results, routes were recorded accurately for future repeat surveys.

Search effort in 2018–2019 was checked against that in 2006–2009. Efforts were made to equalise the amount of time spent at each site across the surveys, although logistical constraints meant that matching exact times and timings between the two surveys was unfeasible. In all but a few cases search effort in 2018–2019 was similar to that in 2006–2009. In all other cases, survey effort was allowed to be considerably less in 2018–2019, if these concerned relatively small areas and the survey was considered adequate, as no more white-eyes were expected to be found. All surveys were led by S. v. B.

As Lemon-bellied *Zosterops chloris* and Sangkar White-eye *Z. melanurus* may co-occur marginally, audio-recordings using a Zoom H5 solid State Recorder and Sennheiser MKH70 microphone for documentation and identification were made, in particular of distant individuals.

Data analysis

The abundance of white-eyes at each site in 2006–2009 and 2018–2019 surveys are expressed simply as the total count of individuals made. When visits were made to multiple areas of the same site, we summed the records from each area to give a site total. Differences between numbers of white-eyes recorded at sites between the two (paired) surveys were tested using a Wilcoxon signed ranks test. The degree of change in numbers of white-eyes recorded in the two surveys was expressed as the numbers recorded in 2018–2019 as a percentage of the number recorded in 2006–2009. We tested whether 'declines' had been steepest in areas that originally contained many birds, by examining the relationship between 'starting' number of birds in 2006–2009 and degree of change in numbers recorded across the survey (see above). We used a Spearman's rank correlation analysis to test this relationship and also between the degree of change and longitude (West-East).

To go some way towards putting abundance change in the white-eye into the context of other bird species at the sites, we compared its changes in abundance to changes in the presence of (i) a suite of 12 little-traded bird species, and changes in abundance of (ii) three little-traded species with not dissimilar habitat requirements. The former (i) included: Sunda Collared Dove *Streptopelia bitorquata*, Cerulean Kingfisher *Alcedo caerulescens*, Collared Kingfisher *Todiramphus chloris*, Common Iora *Aegithina tiphia*, Australasian Reed Warbler *Acrocephalus australis*, Yellow-bellied Prinia *Prinia flaviventris*, Plain Prinia *Prinia inornata*, *Ashy Tailorbird *Orthotomus ruficeps*, Golden-bellied

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Gerygone *Gerygone sulphurea*, *Sunda Pied Fantail *Rhipidura javanica*, *Ornate Sunbird *Cinnyris ornatus*, and Brown-throated Sunbird *Anthreptes malacensis*; the latter (ii) are indicated with an asterisk.

To explore whether this suite of little-trapped birds had also declined/disappeared from the sites, we tested whether species richness of these species differed across the two surveys using a Wilcoxon signed ranks test, and determined whether declines in species richness among these birds at sites was correlated with degree of decline in the white-eye with Spearman's rank test. For the three focal species, we report overall differences in numbers seen across all sites and tested whether the proportions of sites at which these species declined differed from the proportion of sites at which the white-eye declined using Chi-squared tests with Yates' corrections. All analyses were done in RStudio (RStudio Team (2020).

Results

A total of 19 localities in which the presence of white-eyes was assessed in 2006–2009 have been re-visited (Table 1; locality names can be obtained from the first author). A total of 805 white-eyes were recorded at the 19 sites in 2006–2009 and 143 individuals in 2018–2019. White-eyes went unrecorded at five sites in 2018–2019, had much lower numbers (60% decrease) recorded in 2018–2019 at five sites, lower to almost equal numbers at seven sites, and had higher numbers in 2018-2019 than 2006-2009 at two sites. There was a significant reduction in white-eye numbers recorded across the 19 sites between 2006–2009 and 2018–2019 (Wilcoxon signed ranks test: V = 172, $P = 0.002$).

The three sites with highest recorded numbers in 2006: 73, 245, and 184 (502) individuals suffered the biggest 'losses' of birds with 11, 11, and 0 recorded in 2018–2019. Despite this, there was no significant relationship between numbers recorded in 2006 and percentage change in numbers in 2018 ($r_s = 0.15$, $n = 19$, $P = 0.54$). Neither was there a significant relationship between 'declines' and longitudinal (West-East) coordinates ($r_s = 0.06$, $n = 19$, $P = 0.82$).

There was no significant difference in species richness of the lesser-traded species across the 19 sites (Wilcoxon signed ranks test: V = 77, $P = 0.66$). Further, there was no relationship between changes in species richness of the little-trapped species and degree of 'decline' in the white-eye across sites ($r_s = 0.09$, $n = 19$, $P = 0.71$). All three focal little-traded species were recorded in lower numbers overall across sites in 2018–2019 than in 2006–2009: Sunda Pied Fantail 81 individuals versus 88 individuals; Ashy Tailorbird 37 vs 62; Olive-backed Sunbird 61 vs 85, these 'declines' being far less steep than that of the white-eye. Absences from sites surveyed in 2018–2019 where they were recorded in 2006–2009 were rare in these species (fantail: one site; tailorbird: two sites; sunbird: three sites). The proportion of sites at which the white-eye had declined (16 of 19) was significantly greater than that for the fantail (7 of 19 sites; $\chi^2_2 = 7.0$, $P = 0.008$), but not for the tailorbird (9 of 15 sites; $\chi^2_2 = 1.4$, $P = 0.23$) or the sunbird (12 of 19 sites; $\chi^2_2 = 1.2$, $P = 0.27$). Small numbers of white-eyes were recorded at two new sites in Sidoarjo regency which were not visited in 2006–2009.

Table 1. Survey efforts (in hours), numbers of Javan White-eyes recorded, and numbers of selected species (see text) recorded during the 2006–2009 and 2018–2019 surveys. Sites are given numbers for security reasons.

Site no.	Effort		Javan White-eye		Selected spp	
	2006–2009	2018–2019	2006–2009	2018–2019	2006–2009	2018–2019
1	18.6	20.5	73	11	10	10
2	15.6	20.4	245	11	8	9
3	2.5	2.3	22	0	7	5
4	7.8	3.3	4	2	6	5
5	2.4	3.9	38	1	6	6
6	7.9	6.4	25	10	7	9
7	3.3	3.1	4	29	8	6
8	6.8	8.8	184	0	8	6
9	1.3	4.0	8	16	9	8
10	1.9	1.4	11	6	7	9
11	3.0	1.7	12	0	5	8
12	2.2	1.9	7	2	7	7
13	4.7	1.0	19	8	8	5
14	2.0	4.4	28	15	6	10
15	5.0	5.1	18	4	7	8
16	2.0	1.5	35	8	9	5
17	8.6	9.4	61	20	11	10
18	1.5	1.1	9	0	6	4
19	1.3	2.3	2	0	5	7

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Discussion

Our surveys of 19 sites in coastal Java recorded 143 individual white-eyes, less than 18% of the 805 counted using similar methods around a decade earlier. We found a few new sites holding modest numbers of white-eyes. White-eyes had systematically 'declined' across the 19 sites, and although there was no consistent pattern that sites holding most birds in the earlier survey had seen steepest declines, three sites where over 500 birds were recorded in 2006–2009 had just three individuals in the recent survey. We did not undertake a formal analysis of habitat change at the sites but did find that a suite of lesser-traded co-occurring species had not declined or disappeared from the 19 sites in any way similar to the declines suffered by the white-eye. Taken together, we posit that the white-eye is likely to have undergone a serious decline, perhaps in the order of 80%, over the past decade. Our surveys sampled birds at the sites and as such tell us little about the population sizes of white-eyes at each site. This said, our surveys covered fairly well many of the 'best' sites for the species, so we suggest that its Java-wide population is certainly not large, perhaps in the order of 250–2,500 individuals.

White-eyes have become extremely heavily traded on Java over the past decade or so (Iqbal 2015, Marshall *et al.* 2020). While not commonly recorded during market or ownership surveys, on account of difficulties in species identification (van Balen 2008) and due also to the large numbers of Sangkar and other white-eyes for sale, Javan white-eyes are without doubt significantly traded. The tens of individuals that have been recorded in market surveys this decade are likely to make up a considerable proportion of the wild population on Java. At all localities, especially where white-eye numbers had decreased drastically, direct evidence or local reports indicated intensive trapping, usually with the use of lime sticks. Concurrent with this trapping pressure has been habitat change and we acknowledge that loss and degradation of mangroves and other suitable habitat for the white-eye has occurred at some sites – Symes *et al.* (2018) estimated that around 15% of the species' habitat has been lost in the last decade. Such figures for habitat lost seem more compatible with the degrees of decline we noted in some of the lesser-traded species such as Sunda Pied Fantail, Ashy Tailorbird, and Olive-backed Sunbird, than those of the white-eye. In none of the survey areas had suitable white-eye habitat disappeared or deteriorated entirely, except for large parts of the two of the larger areas that had inundated permanently since 2006–2009. In some areas, the extent of mangroves has actually expanded due to reforestation schemes (e.g. Randy *et al.* 2015). Detailed accounts of the habitat condition and protection measures already underway are not given here for security reasons but are available on request from the corresponding author.

It is striking that the three areas with largest numbers of white-eyes recorded in 2006–2009 had greatest losses. An obvious conclusion is that the abundance of white-eyes in the past was a major attraction for bird trappers, who were able to trap out large numbers of white-eyes effectively. In one of these sites, we were told that Javan White-eye was the main target for bird trappers coming from outside the region. The white-eye should not be a difficult bird to catch – the habitat is fairly low and often linear in nature, while the white-eye occurs in fairly large, cohesive, groups which may be trappable *en masse*, as they are strongly attracted by the distress calls of already captured conspecifics. In smaller mangrove plots, the few scattered Javan White-eye flocks were possibly less worth the effort, as are areas already depleted of most of their white-eyes. This possible 'damping down' of differences in population density of traded birds is not often confirmed but should be of great interest to conservationists and ecologists. On one hand it may act as a welcome brake on local trapping when local densities of remaining birds become not economically worthwhile harvesting but on the other it may be the nail in the coffin of remnant local populations unable to withstand Allee effects (Peteren and Levitan 2001) or other barriers to recovery (e.g. Bundy and Fanning 2005) and doomed to extinction.

As far as we know, no single local Javan White-eye population is included in a national park on Java, however, in several areas, local conservation measures, such as the establishment of mangrove plots by replanting schemes may have/have had a positive effect on white-eye populations. Local awareness programmes at these sites should explain the Javan White-eyes' ecological importance as insectivores, of mainly beetles and caterpillars (M. E. G. Bartels unpubl. data, Sody in Becking 1989). We also recommend further surveys on Java, especially Madura island, as our own surveys were certainly not exhaustive. The Javan White-eye population on Kalimantan is also very little known, and a survey of the coastal areas of the southern half of the island is urgently needed, especially since the discovery of a shipment of 14 Javan White-eye offered for sale in Kediri (E Java), allegedly originating from Kalimantan (I. Kartiko pers. comm. 2020).

Since 2018, the Javan White-eye is protected under Indonesian law (Anonymous 2018). Law enforcement however may be a problem because of a fair number of near-identical yellow-bellied white-eye species in trade. The protection of all species of white-eye is therefore necessary. This said, there may be a ray of hope in the report that bird fanciers are slowly realizing that Javan White-eye are actually poor songsters (I. Kartiko pers. comm. 2021).

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