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GOLDEN WHITE-EYE (*Cleptornis marchei*)

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INTRODUCTION

Long thought to be a honeyeater (Meliphagidae), the Golden White-eye (*Cleptornis marchei*), or Canario in the Chamorro language, is now understood to be a white-eye (Zosteropidae), although its precise relationships within this family remain uncertain. It appears to have evolved in isolation into a singularly unique form, much as the Hawaiian honeycreepers have done. Despite its uniqueness, it remains largely unstudied other than for periodic population surveys. It is known historically from Saipan and Aguiguan in the Mariana Islands of the western tropical Pacific. Prehistorically, it also occurred on Tinian, which sits between these two islands, and to the south on Rota.

The brilliant yellow-orange plumage, bill and legs and whistled, warbling song separate this species from all others within its limited range. It occupies a variety of wooded habitats but reaches its greatest density in mature native forest, where it defends an all-purpose territory against conspecifics and appears to be socially dominant over the only other white-eye species present. It is a versatile forager of the forest canopy and understory, where it gleans and probes surfaces for insects and fruits.

The Golden White-eye is listed as endangered and, although remaining common within its range, at least the Saipan population might be declining as development and urbanization proceed there. It is also under threat from the potential establishment of the predatory brown tree snake (*Boiga irregularis*) on Saipan—a species that has virtually eliminated landbirds on nearby Guam. To aid in its conservation, the species has been translocated to the more northerly, uninhabited Mariana Islands of Sarigan, where it is prospering.

IDENTIFICATION

Field Identification

The brilliant yellow-orange plumage, bill and legs, indistinct white eye ring and whistled, warbling song separate this species from all others within its limited range. The small, sexually monomorphic passerine typically occupies the forest understory.

Similar Species

The only other white-eye within its range is the Bridled White-eye (*Zosterops conspicillatus*), which is much smaller, greenish-yellow and has a black beak and legs. The Bridled White-eye also typically

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occurs in large flocks. Unlike the melodious song of the Golden White-eye, the Bridled White-eye's vocalizations are primarily thin *chit-chit-chit* notes and whines. Other co-occurring small passerines include the brilliant red Micronesian Myzomela (*Myzomela rubrata*) and the brown and burnt orange Micronesian Rufous Fantail (*Rhipidura versicolor*). In the Palau Islands, the similarly sized Giant White-eye (*Megazosterops palauensis*) is tan and olive and has a loud, polyphonic song that is unlike any other.

PLUMAGES, MOLTS AND STRUCTURE

Plumages

The Golden White-eye has 10 primaries (numbered distally, from innermost p1 to outermost p10 and with the outer p10 reduced in length), 9 secondaries (numbered proximally from outermost s1 to innermost s9 and including 3 tertials, s7–s9 in passerines), and 12 rectrices (numbered distally, from innermost r1 to outermost r6 on each side of the tail). No geographic variation in appearance. The following is based primarily on plumage descriptions of Baker (1951), Bruce (1978), Pratt et al. (1987), and van Balen (2008), along with examination of Macaulay Library images. See Pyle et al. (2008), Radley et al. (2011), and Craig (2021) for information on ageing and sexing this species. See Molts for molt and plumage terminology. Appearance of sexes similar in all plumages; definitive appearance is assumed at the Second Basic Plumage. Seasonal variation in plumages (e.g., fresh vs. worn) based on timing of breeding, primarily March-June (see Breeding: Phenology) and molts, which appear to occur primarily in July–September (Pyle et al. 2008).

Natal down. Present in the nest, primarily in April–June but possibly at other times of year. Natal down is undescribed in the Golden White-eye.

Juvenile (first basic) plumage. Present primarily in April–August but possibly at other times of year. An early report of the appearance of juvenile birds described them as darker and duller than adults (Bruce 1978). Field observations of birds in juvenal plumage indicated that they were indeed duller than adults, with areas of brownish-yellow on the back and side of the head and brownish-yellow streaks on the breast (Craig 1990). Juveniles also have been reported to have white mottling and paler yellow feathers on the head and face, as confirmed by largely unpneumatized skulls (Radley et al. 2011). Juvenile primaries and rectrices are thinner and more tapered or pointed at the tips than basic feathers. Juveniles also show largely unpneumatized skulls (Radley et al. 2011) although skulling can be difficult due to thick skin (Pyle et al. 2008).

Formative plumage. Present primarily in August (when fresh) to June (when worn) but possibly showing differing wear levels at other times of year. Similar to definitive basic plumage but can be identified by molt limits between and among back and wing feathers and retained juvenile primaries and rectrices (see images below and illustrations in Pyle et al. 2008). Most to all upperwing coverts appear to be retained, or some inner lesser and median coverts replaced (formative). Newer formative scapulars and inner wing coverts are brighter yellow and contrast with browner and more worn, retained juvenile outer coverts, including most or all greater coverts and all primary coverts. Retained juvenile outer primaries and rectrices are narrower, more tapered or pointed at the tips, browner, and become more abraded with time. Birds in formative plumage also have partially non-pneumatized skulls, but reliability of this in relation to age requires further study (Radley et al. 2011).

Definitive basic plumage. Present primarily in September (when fresh) to July (when worn) but possibly showing differing wear levels at other times of year. Body feathering is relatively soft and lax compared with other white-eyes. The crown, auriculars, chin, throat, and upper breast, are bright yellow to orange-yellow (the throat averaging paler). contrasting with greenish-olive nape, back, and most of the lower underparts, resulting in a contrastingly bright-headed appearance. The rump, uppertail coverts, flanks, and undertail coverts are washed more strongly with orange. The tail, upperwing, coverts, and alula are are similar in color to the back, with dusky inner webs, whitish on their medial ventral surfaces, and broad olive to yellow-olive fringing. There is an indistinct, whitish eye-ring with white also extending toward the gape. The underwing coverts and axillaries are whitish and tinged with yellow orange. Sexes are alike in plumage (males may average the slightest bit brighter); brood patches and cloacal protuberances are reliable for assigning sex during breeding, although some males can develop partial brood patches (Radley et al. 2011, R.J. Craig, personal observation). Bill size, larger in males than females, can be used to sex some birds (Pyle et al. 2008).

Definitive basic plumage is separated from formative plumage by having all upperwing coverts and remiges uniform in wear and quality, brighter yellow-olive (less brown than juvenile feathers) without molt limits; basic outer primaries and rectrices broad, more truncate (less pointed), and relatively fresh compared with retained juvenile feathers. Some intermediates may be difficult to age (Pyle et al. 2008).

Aberrant plumages. A partial albino bird with light creamy-white primaries was reported by Bruce (1978).

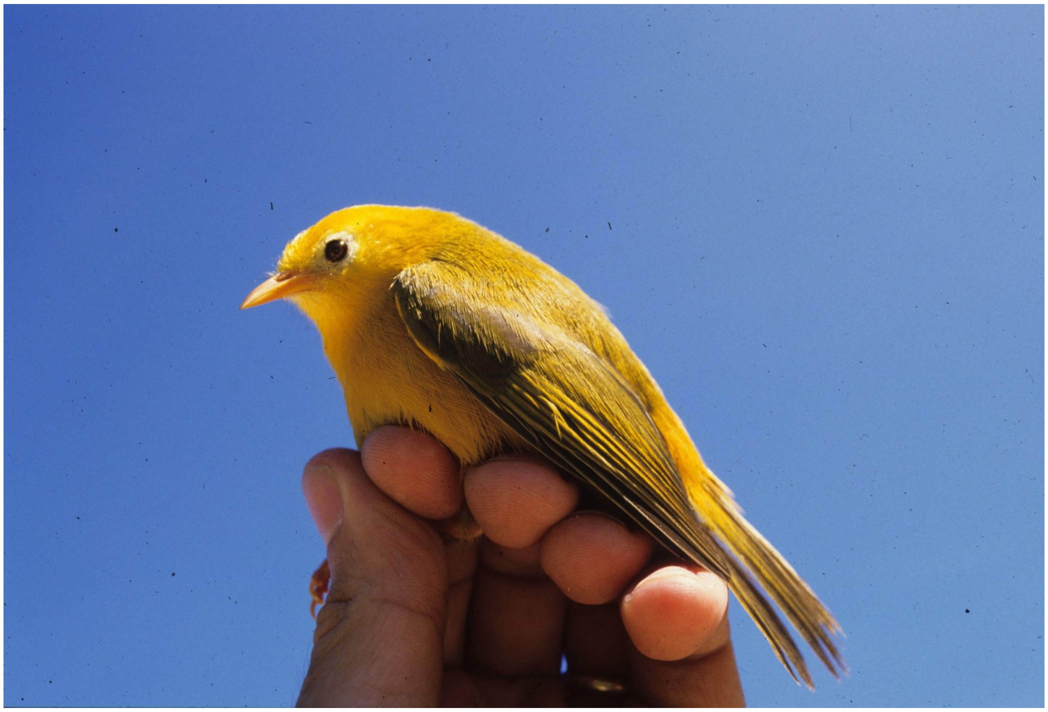

FIG. 1. The Saipan Golden White-eye illustrating brilliant colors.

Molts

Molt and plumage terminology follows Humphrey and Parkes (Humphrey and Parkes 1959) as modified by Howell et al. (2003). Under this nomenclature, terminology is based on the evolution of molts along ancestral lineages of birds from ecdysis (molts) of reptiles (Pyle et al. 2024), rather than on molts relative to breeding season, location, or time of the year, the latter generally referred to as "life-cycle" molt terminology (Jenni and Winkler 2020; see also Pyle (2022a) and Pyle (2022b) for more information). The Golden White-eye exhibits a complex basic strategy (cf. Howell et al. 2003, Howell 2010b), including a complete prebasic molt and a partial preformative molt but no prealternate molt (Pyle et al. 2008, Radley et al. 2011).

Most molting appears to occur in July–September following peak breeding in March–June but it may occasionally occur at other times of year (Pyle et al. 2008; see Breeding: Phenology). Specimens taken on Saipan in July–September were molting (Hartert 1898, Baker 1951). Individuals captured on Saipan in December–June (*n* = 23), had no molt (Pyle et al. 2008, Radley et al. 2011; R.J. Craig, unpublished data). Individuals captured in June (*n* = 1) showed some primary molt and in October (*n* = 1) showed heavy body, tail, and wing covert molt. A bird captured on Aguiguan in May had fresh plumage, indicating recent completion of molt (R.J. Craig, unpublished data) and indicating that molt may occur aseasonally. Captured Saipan individuals showed low proportions undergoing flight-feather molt in April−May, but over half were undergoing molt after 20 June. Wear on adult feathers, which were fresher in December and wearing by April, support a late summer/fall molting period after breeding (Pyle et al. 2008, Radley et al. 2011).

Primaries (and corresponding primary coverts) are replaced distally (p1 to p10), secondaries are replaced proximally from s1 and proximally and distally from the central or innermost tertial (s8 or s9), and rectrices are generally replaced distally (r1 to r6) on each side of the tail, though variation in sequence of rectrix molt may occur. There is no evidence (e.g., suspension limits among primaries) for suspended prebasic molts (Pyle et al. 2008).

Bare Parts

The following is based on descriptions in Bruce (1978) and Craig (2021), along with examination of Macaulay Library images. See also images under Plumages.

Bill. The bill is somewhat long and relatively decurved, especially in males. Adults have a bright yellow-orange bill. Nestlings have a bright yellow gape and very young juveniles exhibit dusky coloring at the base of the bill. Juveniles have been described as having both brownish and paler bills than adults (Bruce 1978, Craig 2021). More recently, a Saipan individual captured in September, likely a juvenile, had a dull bill (R.J. Craig, unpublished data). First-

FIG. 2. The Aguiguan Golden White-eye shows no clear plumage differences with birds from Saipan..

year birds (in formative plumage) may average duller bills than adults (see right-hand image below).

Iris. At all ages it appears to be dark brown to olive-brown (R.J. Craig, personal observation).

Tarsi and toes. Adults have bright yellow-orange legs and feet. The feet can be slightly brighter than the legs. Very young juveniles exhibit can show dusky coloring on the tarsi. Older juveniles have been described as having pale yellow legs (Craig 2021) and first-year birds (in Formative plumage) may average duller bills than adults (see right-hand image below).

Measurements

Linear measurements. Golden White-eye specimens from Saipan showed that males (*n* = 7) had a flattened wing length of 77−80 mm, full culmen of 19−20 mm, tarsus length of 25−27 mm and tail length of 61−66 mm. Females (*n* = 5) had a flattened wing length of 72−75 mm, full culmen of 17.5−18.5 mm, tarsus length of 23−25 mm and tail length of 56−59 mm (Baker 1951).

Captures on Saipan from 1988−1993 showed that males had a wing chord of 73.1 ± 2.7 mm (*n* = 11), bill length from proximal nares of 10.5 ± 0.6 mm (*n* = 11), bill depth at proximal nares of 4.0 ± 0.4 mm (*n* = 11), tarsus length of 26.0 ± 1.6 mm (*n* = 11) and tail length of 66.0 ± 2.6 mm (*n* = 10). Females (*n* = 2) had a wing chord of 69.2 ± 2.9 mm, bill length from proximal nares of 9.0 ± 0.1 mm, bill depth at proximal nares of 4.2 ± 0.7 mm, tarsus length of 26.0 ± 2.6 mm and tail length of 61.5 ± 4.0 mm (Craig 2021a, R.J. Craig, unpublished data).

Captures on Saipan from 2008−2009 showed that males had a wing chord of 75.3 ± 3.1 mm (*n* = 125), exposed culmen of 15.6 ± 0.8 mm (*n* = 35) and bill length from nares of 10.5 ± 0.6 mm (*n* = 35). Females had a wing chord of 70.5 ± 2.7 mm (*n* = 90), exposed culmen of 13.1 ± 0.7 mm (*n* = 17) and bill length from nares of 8.9 ± 0.4 mm (*n* = 21) (Radley et al. 2011).

Male Saipan specimens (*n* = 8) had a wing chord of 72−82 mm, exposed culmen of 13.9−15.5 mm, bill length from nares of 9.3−12.2 mm and tarsus length of 24.5−29.0 mm. Female specimens (*n* = 8) had a wing chord of 64−76 mm, exposed culmen of 12.7−14.0 mm, bill length from nares of 8.3−11.8 mm and tarsus length of 22−28 mm. Measurements indicate moderate to strong sexual dimorphism, with both wing length and especially bill length useful for sexing. Bill length also proved reliable against the presence of a cloacal protuberance for sexing males (Pyle et al. 2008).

Captures on Aguiguan in May 1992 (*n* = 9) had a wing chord of 69.4 ± 2.2 mm, bill length from proximal nares of 9.6 ± 0.4 mm, bill depth at proximal nares of 3.8 ± 0.2 mm, tarsus length of 24.3 ± 2.0 mm and tail length of 61.9 ± 2.5 mm. Three of these were males sexed by cloacal protuberance and had a wing chord of 69.9 ± 1.9 mm, bill length from proximal nares of 9.7 ± 0.4 mm, bill depth at proximal nares of 4.0 ± 0.1 mm, tarsus length of 24.6 ±

FIG. 3. A Saipan Golden White-eye feeding on papaya fruits.

0.7 mm and tail length of 63.3 ± 2.0 mm. No birds displayed brood patches (Craig et al. 1993b, R.J. Craig, unpublished data).

Mass. Saipan captures from 2008−2009 had a male mass of 20.3 ± 1.7 g (*n* = 113) and a female mass of 16.2 ± 1.5 g (*n* = 80) (Radley et al. 2011). Saipan captures from 1988−1993 had a male mass of 20.8 ± 1.9 g (*n* = 11) and a female mass of 17.6 ± 1.3 g (*n* = 2). May 1992 Aguiguan captures had a mass of 15.7 ± 0.8 g (*n* = 9). Three of these were sexed as males and had a mass of 16.4 ± 0.5 g (Craig 2021a, Craig et al. 1993b, R.J. Craig, unpublished data).

SYSTEMATICS

Systematics History

The type specimen of the Golden White-eye, obtained from Saipan, was first reported as *Ptilotis Marchei by* Oustalet (1889), although he considered it sufficiently distinct to propose the genus *Cleptornis* for it. Authors have classified it as *Cleptornis* since; e.g., Wiglesworth (1891), Oustalet (1895), Hartert (1898), Seale (1901), Ornithological Society of Japan (1942).

Historically, the species has been placed in the Meliphagidae (Oustalet 1889), although its taxonomic affiliation was first questioned by Bruce (1978), who suggested an evolutionary link between honeyeaters and white-eyes. Pratt et al. (1987) hypothesized that the species was instead in the Zosteropidae—a view supported by the DNA studies of Sibley and Ahlquist (1990), Springer et al. (1995) and Slikas et al. (2009), who also noted a distant link between honeyeaters and white-eyes.

Geographic Variation

Discriminant function analysis, albeit with small samples, suggest that Aguiguan birds are smaller than Saipan birds (Craig et al. 1993b).

Related Species

Early phylogenies based on DNA sequence data with limited species sampling found that the Golden White-eye, in the monotypic genus *Cleptornis*, is indeed allied to the white-eyes, being related to the genera *Apalopteron* and *Zosterops* (Springer et al. 1995, Slikas et al. 2009). More comprehensive studies (both in terms of sequence data and species sampling) found that *Cleptornis* is either the sister to the genera *Apalopteron* and *Heleia* (Cai et al. 2019), or to the genera *Dasycrotapha* and *Sterrhoptilus* (Oliveros et al. 2021). Notably, neither of these studies sampled the genus *Rukia*, endemic to the Caroline islands and hypothesized to be closely related to *Cleptornis* by Pratt (Springer et al. 1995). Disagree-

FIG. 4. A Saipan Golden White-eye nest and eggs.

ments among these studies and incomplete species sampling indicate that the true relationships of the Golden White-eye within the family Zosteropidae are not yet solidly known.

Fossil History

Prehistoric bone deposits of *Cleptornis* are known from the Mariana islands of Tinian, Aguiguan, and Rota, demonstrating that it had a wider distribution in the last 2,500 years (Steadman 1999; see Historical Changes to the Distribution).

DISTRIBUTION

The Golden White-eye is known historically from Saipan and Aguiguan (Pratt et al. 1979, Engbring et al. 1986).

Historical Changes to the Distribution

Prehistoric bone deposits from the Mariana islands of Tinian, Aguiguan and Rota demonstrate that the Golden White-eye was once present on all three (Steadman 1999) in addition to Saipan. The lack of historical reports from Aguiguan prior to 1954 (e.g., Yamashina 1940, Baker 1951) suggest the possibility that it was rare or locally extinct there and then recolonized. Some reports from Saipan in the 1930s and 1940s, during a time of extensive sugarcane production, suggest that it was also uncommon there (Stott 1947, Baker 1951). Beginning in 2011, the species has been translocated to the more northerly Mariana island of Sarigan (Radley 2012). Beginning in 2018, it was also translocated to Alamagan (Newland et al. 2018).

HABITAT

The earliest reports of Saipan habitat described nests in native trees—*Guamia* [=*Meiogyne*] *mariannae* , *Eugenia* spp. and *Ochrosia mariannensis* (known locally as Langiti but listed as Rakiti) (Hartert 1898). This suggests that at this time the Golden White-eye was principally associated with native forest. Stott (1947) also reported it solely from forest. Marshall (1949) added that by virtue of its large eyes it appeared to be adapted for life in the shade—the forest understory. However, Bruce

FIG. 5. A Saipan Golden White-eye adult and juvenile.

(1978) found it to occur in forest particularly at 1-3 m up, although it also occupied the forest canopy. A fuller but qualitative description of habitat is of birds inhabiting dense forest, introduced *Leucaena leucocephala* thickets, scrubby woods near open fields and in exotic trees in urban areas (Pratt et al. 1979). Particularly high population densities have been found in locations with residential development and agriforest, with the species thought to inhabit all woody vegetation and particularly brushy areas. Lowest densities were in locations with extensive fields (Engbring et al. 1986). Nest records from the Division of Fish and Wildlife, Commonwealth of the Northern Marianas showed that nests were located in all types of wooded and semi-open habitats, including limestone forest (*n* = 5), suburban yards (*n* = 4), farms/agriforest (*n* = 2) and *Leucaena* thickets (*n* = 2) (Stinson and Stinson 1994).

Quantitative analysis of Saipan microhabitat use demonstrated that in native limestone forest the Golden White-eye occupied the forest canopy and mid-understory in roughly equal proportions and occasionally used even the lowest portion of trees. It typically used a wide variety of smaller tree species. Birds occupied both native limestone forest and *Leucaena* thickets, although in the latter it spent most of its time in the thicket canopy. In both habitats, it occupied the outer crown far more than the inner (Craig 1990, Craig and Beal 2001). Population densities were far greater in native forest than in disturbed habitats, including *Leucaena* thickets (Craig 2021). It occurred in all wooded habitats, including strand forest and suburban areas, although it was generally absent from *Miscanthus floridulus* savanna (Craig 1996).

On Aguiguan, birds inhabited native forest at densities similar to those of Saipan, although they also occupied areas once cultivated for sugarcane that had grown up to introduced *Lantana camara* thickets. They predominantly used the upper and mid-forest layers, as on Saipan (Craig et al. 1993c).

MOVEMENTS AND MIGRATION

There are no documented historical instances of inter-island movement, even though an island like Tinian is only a few km from populations on Saipan and Aguiguan. Clearly, however, the species had dispersed at least among the islands of Saipan, Tinian, Aguiguan and Rota, where there is prehistoric evidence of its presence (Steadman 1999). There are no data on potential intra-island movement.

DIET AND FORAGING

Food Capture and Consumption

In the earliest Saipan description of foraging, the Golden White-eye was reported to capture invertebrates as it rapidly flitted from twig to twig (Marshall 1949). A later but brief qualitative examination of

Saipan foraging described the species as using its strong feet and long legs to probe in tree bark crevices and large branches as it hopped back and forth on vertical branches and vines. It also hung upside down to examine leafy twigs, trunk knotholes and under bark flakes. One bird fed at a flower but appeared to be only probing for insects. Another secured three insect larvae after several seconds of poking and scratching with its bill at a cluster of fallen vegetation in the crotch of branches. Each larva was beaten twice against a small branch before it was swallowed. Another bird briefly flashed its slightly raised wings outward before catching an insect that it flushed (Bruce 1978).

In dry season quantitative observations made on Saipan in 1988−1989 (*n* = 252), the Golden White-eye was found to be more sluggish and to move more deliberately through the foliage than the Bridled White-eye, but it was agile and hung upside down from perches while it searched the undersides of branches and leaves. It also stretched upward from perches to inspect leaves, sometimes standing on leaf clusters. It flew or hopped between perches and often made attacks on prey <1 time/min. Another technique used was to move along branches or slender, leaning tree trunks and periodically search the undersides for prey. Percent use of foraging methods in native limestone forest and introduced *Leucaena leucocephala* thickets was ca. 75% glean, 22% probe and 2 % hover, with technique use varying little between habitats (Craig 1990). Use of foraging methods during a limestone forest wet/dry season cycle in 1990−1991 (*n* = 246) was 74% glean, 24% probe and 2% sally/hover (Craig and Beal 2001). On Aguiguan (*n* = 56), use of foraging methods was 75% glean and 25% probe (Craig et al. 1993c).

Microhabitat for Foraging

Despite of the Golden White-eye's long legs and thrush-like build, it was initially thought not to feed on the ground (Marshall 1949). However, Bruce (1978) reported it feeding on the ground occasionally. Later quantitative observations indeed demonstrated that foraging occurred in all locations from the ground to treetops. In measures made over the dry seasons of 1988−1989 (*n* = 252) in Saipan native limestone forest and introduced *Leucaena* thickets, the top outer portion of trees was the predominant foraging substrate, with percent time foraging there 47% in limestone forest and 55% in *Leucaena* thickets. In limestone forest, foraging time was 33% in the middle-outer portion of trees and 6% in the lowest portion of trees. The lower half of *Leucaena* thickets was used 25% of the time. The remainder of time in both habitats was spent foraging in the inner portions of trees. The species foraged primarily from live leaves 58 and 51% of the time in limestone forest and *Leucaena* thickets, respectively, although it also foraged from dead leaves, flowers, fruits, branches and tree trunks. Fruit and dead leaves were used more and live leaves and flowers were used less in *Leucaena* thickets than in limestone forest. Perch sizes 0.25−<1.0 cm were used 76% of the time in limestone forest and 57% of the time in *Leucaena* thickets. Perches >4 cm or <0.25 cm were used infrequently in either habitat. Percent use of plants in limestone forest was: 33.0% *Cynometra ramiflora*, 13.3% vines, 10.5% *Erythrina variegata*, 7.7% each *Pisonia grandis, Ficus* spp.*, 5* .6% *Leucaena leucocephala*, 4.9% *Guamia* [*Meiogyne*] *mariannae*, 3.5% *Melanolepsis multiglandulosa*, 2.8% *Aglaia mariannensis*, 2.1% *Premna obtusifolia*, 1.4% each *Maytenus thompsonii, Aidia cochinchinensis,* 0.7% each *Carica papaya, Artocarpus* spp.*, Phyllanthus amarus, Pandanus* spp.*, Barringtonia asiatica, Hibiscus tiliaceus, Ochrosia mariannensis* and *Intsia bijuga*. In *Leucaena* thickets, 74.0% of foraging occurred in *Leucaena*, which was overwhelmingly predominant in the thicket canopy and understory (Craig 1990).

During a wet/dry season cycle in 1990−1991 in Saipan limestone forest (*n* = 378), the Golden White-eye used the top portion of trees 42% of the time and the mid-lower portion 58% of the time. Time spent foraging from live leaves was 46%, dead leaves 26%, branch/trunks 22%, fruits 12% and flowers 4%. Use of perch sizes was 49% <0.5 cm and 51% >0.5 cm. Use of plants was 24.3% *Cynometra ramiflora*, 12.0% vines, 9.4% *Ficus* spp., 9.4% *Guamia* [*Meiogyne*] *mariannae*, 6.8% *Pisonia grandis*, 6.0% *Psychotria mariana*, 7.3% *Premna obtusifolia*, 5.6% *Melanolepsis multiglandulosa*, 2.1% *Intsia bijuga* and 17% other. Limestone forest observations from 1988−1989 vs. 1990−1991 were generally similar, with the principal differences being that there was an increase in use of the mid-lower forest, a decrease in use of live leaves but an increase in use of dead leaves from the earlier to later observations (Craig and Beal 2001). Other tree species used in limestone forest foraging included the native *Aidia cochinchinensis, Ochrosia mariannensis, Neisosperma oppositifolia, Cerbera dilatata, Erythrina variegata, Dendrocnidae latifolia, Pouteria obovata, Maytenus thompsonii, Eugenia* spp.*, Morinda citrifolia, Aglaia mariannensis Artocarpus* spp. and *Pipturus argenteus* and the introduced *Albizia lebbeck, Leucaena leucocephala, Carica papaya* and *Acacia confusa*. In seasonal comparisons of 1990−1991 foraging, the mid-zone of trees was used more, fruit was used less, gleaning was used less and probing was used more in the dry (*n* = 89) vs. the wet season (*n* = 123) (R.J. Craig, unpublished data).

On Aguiguan, dry season measures of Golden White-eye foraging (*n* = 56) showed 51% use of upper portions of trees and 49% use of mid-lower portions. Use of foraging surfaces was 43% live leaves, 5% dead leaves, 43% branch/trunks, 4% fruits and 5% flowers. Use of perch sizes was 48% <0.5 cm and 52% >0.5 cm. Compared with dry season data from Saipan, allocation of foraging time was generally similar, although on Aguiguan foraging occurred more in the top portion of trees and more from branches and trunks (Craig et al. 1993c). However, the degree of annual, seasonal and inter-island variability among foraging measures has yet to be fully quantified and likely is influenced by such factors as temporal shifts in flowering and fruiting by trees and vines.

Diet

The earliest description of diet is that the Golden White-eye ate mostly berries with hard pits, which were swallowed whole, although it also took seeds, insects and spiders (Marshall 1949). Later, a brief qualitative examination of diet reported that food was mostly adult and larval insects as well as other arthropods and berries (Bruce 1978). Based on quantitative foraging data, the species principally feeds upon invertebrates, including flying insects, although it also eats seeds and engages in some frugivory and nectarivory (Craig 1990, Craig and Beal 2001). It has been observed to eat the seeds of native *Momordica charantia* and the fruits of native *Momordica charantia, Premna obtusifolia, Ficus* spp*., Melanolepsis multiglandulosa, Psychotria mariana, Artocarpus* spp. and *Muntingia calabura* and introduced *Lantana camara* and *Carica papaya*. (Fig. 3) It feeds upon the flowers of native *Erythrina variegata* and *Aidia cochinchinensis* and introduced *Lantana camara* and appears to take nectar from the flowers of native *Pisonia grandis, Erythrina variegata, Muntingia calabura, Psychotria mariana, Morinda citrifolia* and *Aidia cochinchinensis* (Craig 1996, R.J. Craig, unpublished data).

SOUNDS AND VOCAL BEHAVIORS

Development

Food-begging calls are short, double-noted, ascending whistles and also harsh *tzeet-weeoo. . . tzeet-weeoo . . . tzeet-weeoo . . .* varying in frequency (Bruce 1978). Food begging calls are given year-round (Craig 1996). Juveniles also communicate with adults with *cherr-cherr-cherr-cheer* calls, with the last note longer and rising and falling in volume (R.J. Craig, unpublished data).

Vocal array

Song. The song is described as melodious whistles (Bruce 1978), although it has also been described as an extended, loud, distinctive warble (Engbring et al. 1986). The song may be written in words as *SEE ME-can you SEE ME-I can SEE YOU-can you SEE ME* (Pratt et al. 1987). Songs recorded on 270 min of bird sounds from Saipan limestone forest and *Leucaena* thickets in January−February, 1988 consisted of whistled, connected rolling notes written as *ZEE-zoo-ZEE-ZEE-zoo-ZEE-zoo-ZEE-ZEE-zoo ZEE-ZEE -zoo-ZEE-ZEE-zoo-zee-ZEE-ZEE-ZEE-zoo-ZEEE* as well as shorter and longer versions and variations on this (R.J. Craig, unpublished data).

Calls. Calls were first described as a mellow whistle (Marshall 1949). Groups of 3−4 birds in the same trees were recorded to make strident wren-like notes during flight. They also were said to have a twanging call similar to that of the Varied Thrush (*Ixoreus naevius*). Contact calls included a single or double-noted *tzreep* or sometimes a *tzip* repeated at various frequencies. Calls were similar to *Zosterops* but slightly louder and deeper in tone. A short, chirping whistle was made by birds flying between foraging sites. A sharp, rapid sequence of the *tzreep* call may have been an alarm call. Short bursts of the *tzip* call were heard during aggressive displays (Bruce 1978).

Contact calls recorded on 270 min of bird sounds from Saipan limestone forest and *Leucaena* thickets in January−February 1988 consisted of loud, low-pitched *tcherr-tcherr-tcherr* notes. Scolding notes were similar but sharper and food begging calls consisted of two-noted chips. When chasing Bridled White-eyes, the species made harsh calls (R.J. Craig, unpublished data).

Phenology

The Golden White-eye was initially thought not to sing (Marshall 1949). Later, song was described as being given infrequently (Engbring et al. 1986) in May−June but frequently in August (R.J. Craig, unpublished data), although the species was thought not to sing during the latter part of the breeding season (Bruce 1978). More extensive observations from 1988−1993 on Saipan reported that the species sang year-round, except during the protracted dry season of 1993, when no singing occurred during June−July despite almost daily field observations. This latter observation may help to explain Marshall's (1949) failure to detect any song. Singing also appeared to be infrequent in January but frequent in May−June 1991 (Craig 1996, R.J. Craig, unpublished data).

BEHAVIOR

Locomotion

The Golden White-eye has been reported to rapidly flit from twig to twig (Marshall 1949). In dry season quantitative observations made on Saipan in 1988−1989 (*n* = 252), the species was found to be sluggish and deliberate in its movements through foliage, but it was agile and hung upside down from perches while it foraged. It also stretched upward from perches to inspect leaves and flew or hopped between perches (Craig 1990).

Self-Maintenance

The Golden White-eye often engages in over-the-wing head-scratching (Bruce 1978) although it also can head-scratch under-the-wing (clearly seen in two instances). It bill-wipes on a branch after capturing prey and drinks water drops that collect at leaf tips (R.J. Craig, unpublished data).

Agonistic Behavior

Golden White-eye individuals have been reported to chase each other, sometimes after noisy vocal encounters involving two or more birds, with chases lasting for a few seconds before birds continued foraging (Marshall 1949). A group of eight birds appeared to be two aggressively interacting family groups (Craig 1990) and groups of up to 12 have been observed (Engbring et al. 1986). The species is territorial, counter-singing between neighboring males occurs throughout the day and banded birds have been observed within 20 m of the banding site. Individuals sometimes supplant others from perches. Territorial banded males responded, although not vigorously, to playback of recorded songs (Craig 1996, R.J. Craig, unpublished data).

Sexual Behavior

The Golden White-eye has only been observed to be monogamous. It is typically observed in family groups and defends an all-purpose territory (Craig 1996, R.J. Craig, personal observation).

Social and Interspecific Behavior

Degree of sociality. During three days of observation on Saipan, the Golden White-eye was found to occur singly, in pairs or small groups of 3−6 at all heights in trees but particularly at 1−3 m, where its acrobatic movements were active but deliberate. In the upper forest canopy, it appeared to occur in looser groups, although it kept less far out on branches than the smaller Bridled White-eye. When perched, the tail was often cocked upward and sometimes moved slowly up and down. The wings were usually held slightly drooped but often flicked outward during foraging. The head was partly lowered and the tail was held downward without spreading any rectrices. A group of five on and near the ground called noisily to each other before dispersing in different directions but keeping within visual range of each other. Immature birds in family groups remained by parents. One, however, did not beg but had insects placed into its throat and afterwards sat motionless for minutes before it again began to move. Allopreening occurred among pairs and small groups, with one bird raising its head in a submissive posture to another, who preened the feathers of the neck, nape, breast and other upperparts (Bruce 1978).

During observations made in January−February 1988−1989, the species foraged in groups of 3.0 ± 0.9 individuals (*n* = 28 observations). These were family groups, as verified from 1988−1993 by food begging of juveniles, adult preening and feeding of juveniles, and plumage differences between adults and juveniles. When food begging, juveniles fluttered their drooped wings and held their bodies toward horizontal with head raised. Juveniles also sometimes perched on branches with an adult with bodies touching. Three sleeping birds facing in opposite directions on a branch were also observed to be touching. When flushed from a nest, the adult flew to the ground and engaged in a broken wing display (Craig 1990, 1996, R.J. Craig, unpublished data).

Nonpredatory interspecific interactions. Aggressive encounters with the Bridled White-eye occurred during canopy foraging. Golden White-eye individuals flew at the smaller birds and partially extended both wings outward towards them. The Golden White-eye also made calls and opened its bills at the peak of wing-spreading. After an aggressive encounter, foraging resumed (Bruce 1978). Of the four small passerines that inhabit Saipan forests, the Golden and Bridled white-eye were the only species to show regular interspecific aggression (*n* = 20 observations). The Golden White-eye supplanted the Bridled from perches, snapping its bill when landing, chased it, and flew through flocks of foraging birds, which dispersed them. However, the two species also foraged within 2 m of each other. In two instances, a Golden White-eye also appeared to chase a Micronesian Rufous Fantail (*Rhipidura versicolor)* and in another a Micronesian Rufous Fantail chased a Golden White-eye from near its nest. In contrast to this aggression, the Golden White-eye was sought out by the Micronesian Rufous Fantail to assist in its foraging. The Micronesian Rufous Fantail followed 1−2 m behind a foraging Golden White-eye, hawking insects disturbed from leaves. In contrast, the Micronesian Myzomela (*Myzomela rubratra*) was observed to chase individuals and disperse flocks of Golden White-eyes (*n* = 4) (Craig 1990, 1996). At the nest, Golden White-eye adults chased away other birds from the nest including the Eurasian Tree Sparrow (*Passer montanus*), Bridled White-eye and other Golden White-eye individuals (Stinson and Stinson 1994).

BREEDING

Phenology

The first nesting on Saipan was reported for May and June (Oustalet 1889). Another early Saipan nest was found on 7 July (Hartert 1898). A more recent nest was under construction on 15 February 1981 (Engbring et al. 1986). Three 1989 nests were found on 2 and 8 May and 9 June. The second nest contained two eggs when found but was destroyed by children on 15 May after four days of observation. The third nest contained two newly hatched chicks when examined on 15 June. Both adults at the 9 June nest previously had been color banded and at least the male was known to have nested in the same tree in March−early April. The chicks were flapping their wings on 27 June and appeared to be close to fledging. The nest was empty on 28 June and the chicks were presumed fledged (Stinson and Stinson 1994).

In wet/dry season observations made in 1990−1993, breeding occurred in January (gathering nesting material, eggs, hatchlings, fledglings), February (eggs), March (eggs), May (gathering nesting material, recently fledged nest), June (eggs), July (copulation, carrying nesting material, eggs, nestlings), August (nest construction), and October (eggs). Song and food begging occurred year-round, except during the protracted dry season of 1993, when no singing occurred during June. This latter observation may help to explain Marshall's (1949) failure to detect any singing by this species (Craig 1996, R.J. Craig, unpublished data).

Nest

Nest site. The first Saipan nest (Fig. 4) described was one attached to two ca. 2 mm thick leafy branches on a bifurcated branch (Oustalet 1889). Another early nest description was of one in an *Ochrosia mariannensis* tree. It hung from a fork of a thin branch with the branch's end concealed by leaves. More nests found in late August in *Guamia* [=*Meiogyne*] *mariannae* and *Eugenia* spp. trees also were shaded on one side by overhanging leaves (Hartert 1898). A more recent nest on Saipan was located in second growth woody vegetation and placed in a *Leucaena leucocephala* tree 2.5 m up. It hung from a 1 cm thick branch and was placed directly beneath a *Cocos nucifera* frond (Engbring et al. 1986). Nest records from the Division of Fish and Wildlife, Commonwealth of the Northern Marianas, showed that nests were 2.92 ± 1.62 m above the ground (*n* = 13). Nests were reported in native *Casuarina equisetifolia* (*n* = 3), *Guamia mariannae* (*n* = 3), *Cynometra ramiflora* (*n* = 2) and *Aidia cochinchinensis* (*n* =1) and introduced *Leucaena leucocephala* (*n* = 2), *Citrus* sp. (*n* = 1) and *Malpighia glabra* (*n* = 1).

A 31 January 1988 nest with eggs in interior limestone forest was 1.8 m up in a 2.4 m *Guamia mariannae*. A 4 February 1988 nest with eggs in a *Leucaena leucocephala* thicket within 30 m of *Miscanthus floridulus* clumps was 2 m up in a 6.1 m *Leucaena leucocephala*. A 25 January 1989 nest with nestling in ca. 13 m *Barringtonia asiatica−Artocarpus* spp. forest was 2.7 m up in a 3 m *Cynometra ramiflora*. A 7 February 1989 nest with eggs in 12 m *Guamia* [=*Meiogyne*] *mariannae−Ochrosia mariannensis* forest was 1.5 m up in a 2 m *Guamia* [=*Meiogyne*] *mariannae.* A 16 May 1991 recently used nest in ca. 11.5 m limestone forest was 1.8 m up in a 2.1 m *Eugenia* sp. A 20 June 1991 nest with eggs in 9 m limestone forest was 1.8 m up in a 2 m *Cynometra ramiflora.* A 5 July 1991 nest with nestlings in 12 m limestone forest was 3.7 m up in a 6.1 m *Cynometra ramiflora.* A 15 August 1991 nest under construction in limestone forest was 4.6 m up in an *Aglaia mariannensis* sapling. An 8 October 1991 nest in limestone forest was 2.1 m up in a 3 m *Guamia* [=*Meiogyne*] *mariannae* sapling. A 25 October 1991 nest with an egg in limestone forest was 2.4 m up in a *Guamia* [=*Meiogyne*] *mariannae.* A 14 March 1992 nest with nestlings in ca. 366 m elevation native forest was 1 m up in vines hanging from a *Guamia* [=*Meiogyne*] *mariannae* (R.J. Craig, unpublished data).

Structure and composition. The first description of nest composition reported that the nest was constructed of horsehair-like plant fibers that were intertwined and had green moss on the outside (Oustalet 1889). The sides of another nest were not tightly woven, consisted of roots and grasses, had leaves and light green cocoon silk on the outside and was not lined with soft material (Hartert 1898). A more recent nest was composed of shredded *Cocos nucifera* fibers, fine strands of grass and other fine vegetation (Engbring et al. 1986).

Dimensions. One early description was of a nest 5.5 cm high and 7−8 cm. wide (Hartert 1898). Of nests found in 1989, the first was composed primarily of *Casuarina equisetifolia* stems, grasses, vine tendrils and coarse hairs 7.6 cm long. The second also was made of *Casuarina equisetifolia* stems and grasses (Stinson and Stinson 1994).

A 31 January 1988 nest with eggs was 10 cm wide, 6 cm deep and with a 4.5 cm cup depth. A 4 February 1988 nest with eggs was 7.5 cm wide, 5.5 cm deep and with a 4 cm cup depth. A 25 January 1989 nest with nestling was 8 cm wide and 7 cm deep. A 7 February 1989 nest with eggs was 10 cm wide and 7 cm deep (R.J. Craig, unpublished data).

Eggs

Size. The earliest egg measurements were reported as 20.3 ± 0.6 x 15.1 ± 0.7 mm (*n* = 8) (Hartert 1898). A 31 January 1988 nest had two eggs with one measured at 18.1 x 15.1 mm. A 4 February 1988 egg was 20.0 x 14.9 mm (R.J. Craig, unpublished data).

Mass. Egg weights have been reported as 1.8, 2.2, 2.2 and 2.3 g (Stinson and Stinson 1994).

Color and surface texture. A Saipan nest was reported to have two elongated bluish-white eggs without spots (Oustalet 1889), although the eggs described were those of *Zosterops* (Hartert 1898), which indicates that this record is unreliable. Another egg was described as pale blue without gloss, spotted with rufous, particularly on the thicker end. Additional eggs, of which 2−3 were present/nest, were like this one although some were deeper sky-blue. The richly marked rufous spots were smaller on some eggs and larger and more blotched on others (Hartert 1898). Recent descriptions are similar, with eggs reported as pale bluish-green and having reddish-brown spotting concentrated on the wide end (Stinson and Stinson 1994).

Clutch size. Of 11 active nests found, 10 contained two eggs and the other contained a hatchling (Stinson and Stinson 1994). Mean clutch size is 1.85/nest (n = 39) (BirdLife International 2024).

Egg laying. A 2 May 1989 nest with two eggs was observed for 21 hr over 22 days. For the week prior to egg-laying, adults visited the nest intermittently and moved in and out of the nest tree while calling loudly. Daily checks from 2−10 May at another nest resulted in an egg appearing on 9 May and a second present on 10 May (Stinson and Stinson 1994).

Incubation

Incubation period. At one nest, an egg hatched after 14 days of incubation (Stinson and Stinson 1994).

Parental behavior. At one nest, adults incubated continuously during the daylight hours. Over 29 hr of observation, they left the nest unoccupied for 50 min and left for no more than 5 min. When the incubating pair exchanged places on the nest, the approaching bird usually called and the bird on the nest left nest seconds before the other arrived. The sexes shared incubation nearly equally at two observed nests (incubation observation points = 675 male, 673 female; one-tailed Student's $t = 0.054$, $P > 0.05$) (Stinson and Stinson 1994).

Young Birds

Condition at hatching. At one nest, a nestling was altricial and had yellow skin. Two days after hatching, the nestling had a mass of 6.4 g and on day 7 it was 15.2 g (Stinson and Stinson 1994).

Parental Care

During the nestling period for 1989 nests, both adult birds brought food, brooded the young and removed fecal sacs from a nest. During 232 min of observation, a nestling was fed 13 times and four fecal sacs were removed. The week-old nestling was seen unsuccessfully begging for food from a curious Eurasian Tree Sparrow. The nestling was fed insects exclusively and four of 13 times the food appeared to be green caterpillars. One adult brooded the nestling for 72 min and the other brooded it for 40 min, but the average brooding period was 9.1 min (Stinson and Stinson 1994).

Fledgling stage. At one nest, the nestling fledged 10−12 days after hatching and was seen with both adults near the nest tree on day 16. At that time, the fledgling appeared to be unable to fly well. Adults stayed with the fledgling (Fig. 5) and noisily chased away other Golden White-eyes that approached (Stinson and Stinson 1994).

DEMOGRAPHY AND POPULATIONS

Causes of Mortality

Depredation. Nest predators include the native Mariana Kingfisher (*Todiramphus albicilla*), the introduced green tree skink (*Lamprolepis smaragdina*) and rats (*Rattus* spp.) (BirdLife International 2024). Differences in rat species occupying Saipan vs. Aguiguan have been suggested to be related to differing population densities on these islands (Amidon et al. 2014), although no empirical evidence supports this possibility. Rats, monitor lizards (*Varanus indicus*) and cats (*Felis cattus*) are not known to be major predators of tree nesting birds in the Marianas, although the native Micronesian Starling (*Aplonis opaca*) is documented to prey upon nests of other Marianas forest birds (Sachtleben 2005).

Exposure. U.S. Fish and Wildlife Service roadside surveys on Saipan conducted over 20 years showed no relationship between Golden White-eye counts and typhoon frequency or severity (Ha et al. 2018). However, populations of other Marianas bird species have shown significant negative population effects associated with typhoons (Ha et al. 2012) and typhoon-related nest failures have been documented for other white-eye species (Amidon 2000). Now that a Golden White-eye population is established on Sarigan, volcanic activity is also a potential cause of mortality, as the nearby island of Anatahan and an undersea volcano are both volcanically active (Brainard 2012).

Disease. As part of an effort to establish a captive breeding program for the Rota White-eye (*Zosterops rotensis*) in 1993 and 1995, 20 birds were screened for avian pox, avian malaria and other diseases. No evidence of disease was found, although disease has been found in Saipan *Z. conspicillatus*, albeit without obvious effect on populations. A potential threat a45from West Nile virus also exists, as other *Zosterops* have proven susceptible to this disease, although to date this virus has not been detected in the Mariana Islands (USFWS 2007).

Population Status

Early reports of the population status of the Golden White-eye on Saipan are conflicting. Stott

(1947) found it at only one location even though he made an extensive search for it. Marshall (1949), in contrast, described the species as numerous but absent from the Lake Susupe marshes. Kobayashe (1970) reported that there were generally few birds on Saipan, Bruce (1978) found the Golden White-eye to be locally common, but Pratt et al. (1979) found it to be abundant throughout the island as did Ralph and Sakai (1979).

The first quantitative population survey of Saipan occurred in 1977, when censusing was conducted through 7.7 km of forest to yield a population density estimate of 680 birds/km^2. The first major survey, which had 14 variable circular plot transects and 244 survey points, was conducted in 1982 (Engbring et al. 1986). Updated computation methodology yielded birds/km^2 estimates for 1982 of 1287.3 ± 191.0, for 1997 of 995.5 ± 160.0 and for 2007 of 711.8 ± 112.1 (Camp et al. 2009). This suggests that a long-term population decline has occurred, although multiple and differing observers with varying experience and perceptual abilities were employed on these surveys. Hence, the evidence for such a decline is not definitive although a decline is likely given that continued human development is occurring on the island (Camp et al. 2009, Craig 2021b).

In addition to these counts, U.S. Fish and Wildlife Service roadside surveys with 50 stations placed 0.8 km apart along a 40 km route began in 1991 and continued through at least 2010. These showed a pattern of increasing followed by decreasing relative density (Ha et al. 2018), which suggests the presence of population cycles. However, 1991−1993 surveys were conducted by a single observer (Craig 1996) and different observers conducted them thereafter, which again raises questions about the reliability of these patterns.

Quantitative wet/dry season Saipan population surveys through native limestone forest, where densities of the Golden White-eye were by far the greatest, were performed on two transects with 30 survey points. Differences from 1990 to 1993 and between wet and dry seasons were limited and varied from 2073.1 ± 478 to 2661.2 ± 337.4 birds/km^2 over three wet seasons and 1845.4 ± 403.7 to 2322.6 ± 307.9 birds/km^2 over three dry seasons. Hence, there were no clear annual or seasonal difference in populations. In contrast to these native forest counts, single 1993 dry season surveys through non-native woody habitats along four transects with 59 survey points yielded 366.0 ± 70.5 birds/km^2 (Craig 2021b).

On Aguiguan, the first quantitative survey also occurred in June 1982 along four transects with 66 survey points. This yielded 1094 ± 196 birds/km^2. Subsequent surveys along these transects by differing observers yielded a May-June 1995 estimate of 1901 ± 382, a March−April 2000 estimate of 2224 ± 396, a March 2002 estimate of 1693 ± 275 and a June 2008 estimate of 2433 ± 466 birds/km^2. This suggests that no clear population trend has occurred despite variation in feral goat (*Capra hircus*) numbers during this time (Amidon et al. 2014). A May 1992 dry season census through native limestone forest by a single observer surveying two transects with 32 points yielded an estimate 3121.9 birds/km^2 (Craig 2021b). A second observer surveying along two different transects produced an estimate of 5556 birds/km^2, which demonstrates observer effect in producing density estimates (Craig et al. 1993a).

Population Regulation

From 2008−2018, capture-recapture data from six Saipan mist-netting stations showed that estimates of population growth rate indicated no decline in Golden White-eye populations. Survival probability was the largest contributor to growth rate. There was greater temporal than spatial variation in vital rates; i.e., survival probability, recruitment rate and population growth rate. In a study linking vital rates to rainfall and vegetation greenness, the species had the highest predicted productivity when relative greenness contrasted between wet and dry seasons, such as when especially dry seasons followed especially wet seasons (Saracco et al. 2016).

CONSERVATION AND MANAGEMENT

Conservation Status

The Golden White-eye is listed as endangered on the IUCN Red List due to its small range and possible decline of the Saipan population due to human-caused habitat loss. Moreover, the potential introduction of the brown tree snake to islands in its range could result in rapid elimination of populations. Based on the most recent estimates from transect counts, the current total Saipan and Aguiguan population is 43,806−96,857 (BirdLife International 2024). The species is not federally listed as endangered, however, and evidence from capture-recapture studies demonstrate no Saipan population decline (Saracco et al. 2016).

Effects of Human Activity

Habitat loss and degradation. Habitat loss has been cited as a cause of the Golden White-eye's possible Saipan decline. Since the 1980s, considerable uninhabited land on Saipan has been developed for residential, commercial and tourist-related purposes (Camp et al. 2009, Craig 2021b). In contrast, on uninhabited Aguiguan, where agricultural land has reverted to thickets and secondary forest, the population appears to be stable (Amidon et al. 2014). Despite the potential for forest cover reduction to influence populations, the species' ecological versatility (Pratt et al. 1979, Craig 1990) suggests that it is likely to persist in the face of such change, albeit at reduced densities.

Changing climatic conditions related to fossil fuel consumption might also affect populations, as wet and dry seasons are predicted to be wetter and warmer in the western tropical Pacific (BirdLife International 2024). Given that the Golden White-eye had the highest predicted productivity when relative greenness contrasted between wet and dry seasons (Saracco et al. 2016), such a change could yield lower productivity.

Effects of invasive species. Perhaps the most ominous threat to face Golden White-eye survival is the potential for introduction of the brown tree snake (Rodda and Savidge 2007). Once the snake became established on the southernmost Mariana island of Guam in the 1940s, most endemic landbirds declined to extinction within ca. 40 years (Savidge 1987, Wiles et al. 2003). Accidental introduction via cargo ships and planes has been the primary dispersal mechanism from Guam. All goods received in the Northern Mariana Islands are shipped through Guam, with most arriving on Saipan. There have been over 70 reports of brown tree snakes on Saipan, including sightings away from port areas (Rodda and Savidge 2007, MAC Working Group 2014). Saipan was feared to have an incipient population, but there have been no confirmed records for 20 years (BirdLife International 2024). In contrast to Saipan, the risk of snake introduction to Aguiguan or Sarigan is low, as they are uninhabited.

Management

Conservation areas. Protected areas have been established on Saipan (BirdLife International 2024) and Aguiguan is set aside as a reserve (Engbring et al. 1986).

Conservation measures and habitat management. A captive breeding and translocation program has been developed for the Golden White-eye, with 24 brought into captivity in 2007 and another 24 added in 2008. Successful breeding has occurred at four of 10 participating institutions, although chick mortality has been reported (MAC Working Group 2014, BirdLife International 2024). In addition, on 20 and 22 April 2011, 38 Golden White-eyes were mist netted in the Marpi region of Saipan for translocation to the northern Mariana island of Sarigan and for inclusion in a captive breeding program at the Honolulu Zoo. After capture, birds were transported to a holding facility and maintained on a mix of local papaya, meal worms, fruit-blend pellets, insectivore pellets and nectar supplement. Most were weighed daily to track health and the status of acclimation to captivity. To treat health issues and to prevent transmission of disease to Sarigan, fecal scans were examined and birds wormed if necessary. Birds to be translocated were banded with aluminum leg bands and given a unique combination of two color bands. Of the captive Golden White-eyes, 24 were translocated to Sarigan on 28 April and 12 were transported to the Honolulu Zoo. Selection of individuals for translocation was based on indicators of gender and adaptation to captivity. Post-translocation monitoring was planned but not carried out (Radley 2011).

On 21 and 23 April 2012, additional birds were captured at Marpi. The same capture and handling protocols were followed as in 2011. To facilitate post-translocation monitoring, all were again color banded and fitted with radio-transmitters. Post-translocation monitoring of 24 Golden White-eyes on Sarigan was conducted between 1 and 7 May. Radio tracking was largely unsuccessful but at least five color banded birds were re-sighted, four of which were introduced in 2011. These birds were paired and building nests. Golden White-eyes were heard singing at multiple locations on the island (Radley 2012).

From 18–24 April 2018, 51 birds were captured at Marpi, banded and prepared for translocation using procedures similar to those used previously. On 7 May, these birds began transportation via ship to Alamagan, where they arrived and were released on 8 May (Newland et al. 2018). During 27 April–4 May 2019, 43 additional birds were captured at Marpi and prepared for a second release on Alamagan. On 7 May, the birds began transportation via ship to Alamagan, where they were released on 8 May. During the release, unbanded Golden White-eyes were observed, indicating successful establishment of a population (Newland et al. 2019).

An issue not given sufficient consideration in translocation plans is the order of species translocation. The Golden White-eye is generally socially dominant to the Bridled White-eye and, likely, the Rota White-eye, as well as the Micronesian Rufous Fantail, although the Micronesian Myzomela appears to dominate the Golden White-eye (Craig 1990, 1996, 2021). It is conceivable that a large population of a socially dominant species could interfere with the successful establishment of a translocated subordinate species although, to date, this has not occurred. The Golden White-eye has succeeded in establishing itself on Sarigan even though a large population of the Micronesian Myzomela is present there. However, in this instance, there is limited ecological overlap between these species (Craig and Beal 2001), which likely limits social interaction between them.

To prevent establishment of the brown tree snake on Saipan, cargo arriving from sea and at airports is checked for snakes. Moreover, traps have been installed to catch any snakes that are missed and barriers have been constructed at docks to allow escaping snakes to be contained. Sniffer dogs have been trained to detect snakes at Saipan airport. Port officers have been trained in prevention of snake establishment and educational programs have been developed to increase awareness among the population of the importance of reporting sightings (MAC Working Group 2014).

Regular quantitative population monitoring with variable circular plot and roadside survey procedures began on Saipan in 1990 (Craig 1996) and continue to the present (Camp et al. 2009, Ha et al. 2018). In addition, a regular capture-recapture program, the Tropical Monitoring of Avian Productivity and Survivorship program, has provided a more detailed view of population productivity and survivorship (Saracco et al. 2016).

PRIORITIES FOR FUTURE RESEARCH

1. The highest priority is continued monitoring and implementation of interdiction efforts at ports to prevent the establishment of brown tree snake populations on other Mariana islands.
2. As the highest densities of the Golden White-eye are attained in native limestone forest, a second priority is the preservation of this habitat by setting it aside from any encroachment by agriculture, residential or commercial development. In addition, much of secondary forest that is presently dominated by alien species, particularly that adjacent to seed sources in native forest, have the potential to be revegetated by native forest species (Craig 1994). Native birds and Mariana fruit bats (*Pteropus mariannus*) are major dispersers of native seeds (Caves et al. 2013), so further research into facilitating conversion of alien forest into that dominated by native species is needed.
3. High feral goat densities on Aguiguan are interfering with reproduction of native trees in the forest and goat reduction efforts yield improvement in native seedling development (Rice and Stinson 1993). Hence, ongoing management of feral goats on Aguiguan is required to maintain high densities of the Golden White-eye and other native bird species.
4. Expand translocation efforts to additional Mariana islands. The northern Mariana islands of Guguan, Agrihan and Asuncion, all of which have apparently suitable areas of native forest habitat, are also candidates for translocation of the Golden White-eye. However, these islands are presently slated for Tinian Monarch (*Monarcha takatsukasae*) and Rota White-eye translocation, so there are no plans to translocate it to these islands. However, considering the fact that similar species prehistorically co-occurred on Tinian, translocation of all these species to these islands appears to be feasible (MAC Working Group 2014).
5. In addition to northern uninhabited islands in the Marianas chain, Tinian and Rota should be considered as translocation destinations. Both prehistorically supported populations of the Golden White-eye. Moreover, as Tinian and Rota are near Saipan and are readily accessible by plane, such efforts would be comparatively low cost, would receive little human interference as the populations on Tinian and Rota are small and follow-up monitoring of birds would be comparatively easy to conduct.

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LITERATURE CITED

Amidon, F.A. 2000. Habitat relationships and life history of the Rota Bridled White-eye (*Zosterops rotensis*). M.S. thesis. Virginia Polytechnic Institute and State University, Blacksburg, VA.

Amidon, F., R.J. Camp, A. Marshall, T.K. Pratt, L. Williams, P. Radley and J.B. Cruz. 2014. Terrestrial bird population trends on Aguiguan (Goat Island), Mariana Islands. Bird Conservation International 24:505-517.

Baker, R.H. 1951. The avifauna of Micronesia. Its origin, evolution, and distribution. University of Kansas Publications, Museum of Natural History 3:1–359.

BirdLife International 2024. Species factsheet: *Cleptornis marchei*. Downloaded from https://datazone.birdlife.org/species/factsheet/golden-white-eye-cleptornis-marchei on 6 March 2024.

Brainard, R.E. 2012. Coral reef ecosystem monitoring report of the Mariana Archipelago: 2003–2007. NOAA Pacific Islands Fisheries Science Center Special Publication, SP-12-01.

Bruce, M.D. 1978. The Golden Honeyeater (*Cleptornis marchei*): Notes on behaviour, vocalizations and taxonomic affinities. Bonn Zoological Bulletin 29:441−445.

Cai, T., A. Cibois, P. Alström, R.G. Moyle, J.D. Kennedy, S. Shao, R. Zhang, M. Irestedt, P. G.P. Ericson, M. Gelang, Y. Qu, F. Lei and J. Fjeldså. 2019. Near-complete phylogeny and taxonomic revision of the world's babblers (Aves: Passeriformes). Molecular Phylogenetics and Evolution 130:346–356.

Camp, R.J., T.K. Pratt, A.P. Marshall, F. Amidon

FIG. 6. A painting from life of the Golden White-eye, by Barbara A. Lussier, ca. 1991.

and LL. Williams. 2009. Recent status and trends of the land bird avifauna on Saipan, Mariana Islands, with emphasis on the endangered Nightingale Reed-warbler, *Acrocephalus luscinia*. Bird Conservation International 19:323–337.

Caves, E.M., S.B. Jennings, J. HilleRisLambers, J.J. Tewksbury and H.S. Rogers. 2013. Natural experiment demonstrates that bird loss leads to cessation of dispersal of native seeds from intact to degraded forests. PLOS ONE 8(5):1−9.

Craig, R.J. 1990. Foraging behavior and microhabitat use of two species of white-eyes (Zosteropidae) on Saipan, Micronesia. The Auk 107:500-505.

Craig, R.J. 1994. Regeneration of native Mariana Island forest in disturbed habitats. Micronesica 26:97–106.

Craig, R.J. 1996. Seasonal population surveys and natural history of a Micronesian bird community. Wilson Bulletin 108:246–267.

Craig, R.J. 2021a. External morphology of Mariana Island passerines. Micronesica 2021-04:1−9.

Craig, R.J. 2021b. The structure and dynamics of endangered forest bird communities of the Mariana Islands. Pacific Science 75:543−559.

Craig, R.J. and K.G. Beal. 2001. Microhabitat partitioning among surviving members of a Pacific island bird community. Wilson Bulletin 114:102–116.

Craig, R.J., R. Chandran and A. Ellis. 1993a. Bird populations on Aguiguan: a ten-year update. Proceedings, Marianas Research Symposium 1:8−15.

Craig, R.J., A. Ellis and R. Kaipat. 1993b. Genetic isolation and the comparative morphology of small passerines on Aguiguan and Saipan. Proceedings, Marianas Research Symposium 1:22−25.

Craig, R.J., R. Kaipat, B.A. Lussier and H. Sabino. 1993c. Foraging differences between small passerines on Aguiguan and Saipan. Proceedings, Marianas Research Symposium 1:16−22.

Engbring, J., F.L. Ramsey and V.J. Wildman. 1986. Micronesian forest bird survey, 1982: Saipan, Tinian, Aguijan, and Rota. United States Fish and Wildlife Service, Honululu, HI.

Ha, J.C., J.R. Buckley and R.R. Ha. 2012. The potential for typhoon impact on bird populations on the island of Rota, Northern Mariana Islands. Micronesica 43:214−224.

Ha, J., J.B. Cruz, S. Kremer, V.A. Camacho and P. Radley.. 2018. Trends in avian roadside surveys over a 20-year period on Saipan, Commonwealth of the Northern Mariana Islands. Pacific Science 72:81-93.

Hartert, E. 1898. On the birds of the Marianne Islands. Novitates Zoologicae 5:51−69.

Howell, S.N.G. 2010. Peterson reference guide to molt in North American birds. Houghton Mifflin Harcourt, Boston, MA .

Howell, S.N.G., C. Corben, P. Pyle and D.I. Rogers. 2003. The first basic problem: A review of molt and plumage homologies. The Condor 105:635–653.

Humphrey, P.S. and K.C. Parkes. 1959. An approach to the study of molts and plumages. The Auk 76:1–31.

Jenni, L. and R. Winkler. 2020. Moult and Ageing of European Passerines. Second edition. Bloomsbury, London, UK.

Kobayashe, K. 1970. Observation of the birds on Mariana Islands. Tori 20:24-29.

MAC Working Group. 2014. Marianas Avifauna Conservation (MAC) plan: long-term conservation plan for the native forest birds of the Northern Mariana Islands. CNMI Division of Fish and Wildlife, Saipan, and U.S. Fish and Wildlife Service, Honolulu, HI.

Marshall, J.T. 1949. The endemic avifauna of Saipan, Tinian, Guam, and Palau. The Condor 51:200−221.

Newland, S., H. Bailey, P. Luscomb and H. Roberts. 2018. The Mariana Avifauna Conservation Program 2018. Field Collection of Golden White-eye (*Cleptornis marchei*) and Rufous Fantail (*Rhipidura rufifrons saipanensis*) from Saipan for Translocation to Alamagan, CNMI. Mariana Avifauna Conservation Program 2018 Progress Report .

Newland, S., H. Bailey, P. Luscomb and H. Roberts. 2019. The Mariana Avifauna Conservation Program 2019. Field Collection of Golden White-eye (*Cleptornis marchei*) and Rufous Fantail (*Rhipidura rufifrons saipanensis*) from Saipan for Translocation to Alamagan, CNMI. Mariana Avifauna Conservation Program 2019 Progress Report .

Oliveros, C.H., M.J. Andersen and R.G. Moyle. 2021. A phylogeny of white-eyes based on ultraconserved elements. Molecular Phylogenetics and Evolution 164:107273.

Oustalet, M.E. 1889. Sur la faune ornithologique des Iles Mariannes. Le Naturaliste Series 2,3: 260–261.

Oustalet, M.E. 1895. Les mammifères et les oiseaux des Iles Mariannes. Nouvelles Archives Du Museum D'Historie Naturelle. Series 3,7:141−228.

Ornithological Society of Japan. 1942. Handlist of Japanese birds, 3rd edition. The Ornithological Society of Japan, Tokyo, Japan.

Pratt, H.D., P.L. Bruner and D.G. Berrett. 1979. America's unknown avifauna: the birds of the Mariana Islands. American Birds 33:227−235.

Pratt, H.D., P.L. Bruner and D.G. Berrett. 1987. A Field Guide to the Birds of Hawaii and the Tropical Pacific. Princeton University Press, Princeton, NJ.

Pyle, P., P. Radley, J. Bradley and C. Carter. 2008. Manual for aging and sexing birds on Saipan, with notes on breeding seasonality. Institute for Bird Populations, Point Reyes Station, CA.

Pyle, P. 2022a. Defining moults in migratory birds: A sequence-based approach. Journal of Avian Biology 2022:e02958.

Pyle, P. 2022. Identification Guide to North American Birds. Part I. 2nd edition. Slate Creek Press, Forest Knolls, CA.

Pyle, P., S.N.G. Howell, D.I. Rogers and C. Corben. 2024. Moult terminology: Envisioning an evolutionary approach. Journal of Avian Biology 2024:e03169.

Radley, P.M. 2011. Mariana Avifauna Conservation (MAC) Project: First translocation of Golden White-eyes (*Cleptornis marchei*) from Saipan to Sarigan, 28 April 2011. Division of Fish and Wildlife, Saipan, CNMI.

Radley, P.M. 2012. Marianas Avifauna Conservation (MAC) project: a second and first translocation of Golden White-eyes (*Cleptornis marchei*) and Mariana Fruit Doves (*Ptilinopus roseicapilla*), respectively, from Saipan to Sarigan, and an assessment of Bridled White-eyes (*Zosterops conspicillatus*) on Sarigan, 1-8 May 2012. Division of Fish and Wildlife, Saipan, CNMI.

Radley, P., A.L. Crary, J. Bradley, C. Carter and P. Pyle. 2011. Molt Patterns, Biometrics, and Age and Gender Classification of Landbirds on Saipan, Northern Mariana Islands. The Wilson Journal of Ornithology 123:588-594.

Ralph, C J. and H.F. Sakai. 1979. Forest bird and fruit bat populations and their conservation in Micronesia: notes on a survey. Elepaio 40:20−26.

Rice, C.G. and D.W. Stinson. 1993. Goat eradication on Aguiguan. Proceedings, Marianas Research Symposium 1:39.

Rodda, G.H. and J.A. Savidge. 2007. Biology and impacts of Pacific Island invasive species. 2. *Boiga irregularis*, the brown tree snake (Reptilia: Colubridae). Pacific Science 61:307-324.

Saracco, J.F., P. Radley, P. Pyle, E. Rowan, R. Taylor and L. Helton. 2016. Linking vital rates of landbirds on a tropical island to rainfall and vegetation greenness. PlosONE 11: e0148570.

Sachtleben, T. 2005. Predation and nest success of forest birds in native and non-native habitat on Saipan, Mariana Islands. M.S. Thesis. Colorado State University, Fort Collins, CO.

Seale, A. 1901. Report of a mission to Guam. Occasional Papers, Bernice P. Bishop Museum 1:17−128.

Sibley, C.G. and J.E. Ahlquist. 1990. Phylogeny and classification of birds. Yale University Press, New Haven, CT.

SLIKAS, B., I.B. JONES, S.R. DERRICKSON and R.C. FLEISCHER 2000. Phylogenetic relationships of Micronesian white-eyes based on mitochondrial sequence data. The Auk 117:355–365.

SPRINGER, M.S., H. HIGUCHI, K. UEDA, J. MINTON and C.G. SIBLEY (1995). Molecular evidence that the Bonin Islands "Honeyeater" is a white-eye. Journal of the Yamashina Institute for Ornithology 27:66–77.

STEADMAN, D.W. 1999. The prehistory of vertebrates, especially birds, on Tinian, Aguiguan, and Rota, Northern Mariana Islands. Micronesica 31:319–345.

STINSON, C. AND D. STINSON. 1994. Nest sites, clutch size and incubation behavior in the Golden White-Eye. Journal of Field Ornithology. 65: 65–69.

STOTT, K., Jr. 1947. Notes on Saipan birds. The Auk, 64:523-527.

U.S. FISH AND WILDLIFE SERVICE. 2007. Recovery plan for the Nosa Luta or Rota Bridled White-eye (*Zosterops rotensis*). U.S. Fish and Wildlife Service, Portland, OR.

VAN BALEN, S. 2008. Family Zosteropidae (white-eyes). Pages 402–485. In: Handbook of the Birds of the World, Volume 13: Penduline-tits to Shrikes (J. del Hoyo, A. Elliott and D.A. Christie, Editors), Lynx Edicions, Barcelona, Spain.

WIGLESWORTH, L.W. 1891. Aves Polynesiae. A catalogue of the birds of the Polynesian subregion. Abhandlungen und Berichte des Koniglichen Zoologischen und Anthropologisch Ethnographischen Museums zu Dresden 6.

WILES, G.J., J. BART, R.E. BECK and C.F. AGUON. 2003. Impacts of the brown tree snake: patterns of decline and species persistence in Guam's avifauna. Conservation Biology 17:1350–1360.

YAMASHINA, Y. 1940. Some additions to the *List of the birds of Micronesia*. Tori 10:673−679.