MARIANA AVIFAUNA CONSERVATION (MAC) PROJECT

Conservation Introduction of the Bridled White-eye (*Zosterops conspicillatus saypani*) from the Island of Saipan to the Island of Sarigan, Commonwealth of the Northern Mariana Islands.

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MAC WORKING GROUP PARTICIPANTS

Along with the overall MAC Project, this translocation effort is a joint endeavor between the Commonwealth of the Northern Mariana Islands' Division of Fish and Wildlife (CNMI DFW), the U.S. Fish and Wildlife Service (USFWS), and the Association of Zoos and Aquariums (AZA). A team of researchers that comprises the MAC Working Group oversees the MAC Project and all translocation work:

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Sarigan, Northern Mariana Islands (photos: Curt Kessler).

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INTRODUCTION

Setting and Rationale

The Commonwealth of the Northern Mariana Islands (CNMI) is a chain of 14 volcanic islands spanning a north-south distance of 375 miles and comprising a land area of 181 square miles (Figure 1). Rota, Tinian, and Saipan are the only islands in the CNMI with significant human inhabitance (3,283, 3,540, and 62,392 people, respectively), while the remaining islands support less than 10 individuals total (U.S. Census Bureau 2003). The CNMI's climate is marine tropical, hot and humid, and characterized by relatively high and uniform yearly temperatures. The annual mean temperature is 83° F, with a seasonal variation in mean monthly temperature of less than 3.5 degrees. Humidity is also high, with monthly averages between 79 and 86 percent; the months of greatest humidity are July to November. The mean annual rainfall is approximately 83.8 inches, but varies from year to year, with the wet season generally occurring from July through October.

The CNMI, in cooperation with the U.S. Department of the Interior, has determined that Saipan supports an incipient population of the Brown Treesnake (*Boiga irregularis*; Colvin et. al. 2005). As of April 2007, there have been 90 credible sightings of the snake in the CNMI (Rota 4, Tinian 10, and Saipan 76), and not all those on Saipan have been limited to its ports; three were captured in three different villages outside port areas (N. Hawley, USFWS, pers. comm.). This introduced species was responsible for the extinction or extirpation of nine of 12 species of native forest birds on Guam within the last half-century, and is believed to be the single greatest threat to terrestrial ecosystems in the CNMI (Colvin et al. 2005).

The Brown Treesnake likely arrived on Guam through the port facility on Manus Island as a passive stowaway in materiel salvaged from the New Guinea area following World War II (Savidge 1987, Rodda et al. 1992, Rodda and Savidge 2007). This secretive nocturnal arboreal species occurs in every habitat on Guam, from grassland to forest (Rodda and Savidge 2007). Undetected transport in shipments of supplies and materials has been the snake's primary mechanism for spreading from Guam to other islands (via both air and sea) and, unfortunately, all goods received in the CNMI are shipped through Guam. Although efforts to prevent the accidental shipment of snakes have been implemented, not all inter-island shipments of cargo are or can be checked. Additionally, the establishment of the species on Saipan creates another potential source of snakes for Rota and Tinian.

As a response to the threat of the Brown Treesnake, biologists with the CNMI Division of Fish and Wildlife (DFW) and U.S. Fish and Wildlife Service (USFWS) met with biologists from the Association of Zoos and Aquariums (AZA) to investigate the possibility of developing a captive management program to safeguard CNMI's unique avian species. It was determined that the long-term survival of these species required the establishment of satellite, "insurance" populations of them on other islands in the Mariana archipelago that afford safety from the Brown Treesnake. This interagency meeting also resulted in the initiation of the Marianas Avifauna Conservation (MAC) Project, developed to identify and implement conservation actions necessary to ensure the persistence of CNMI's avifauna.

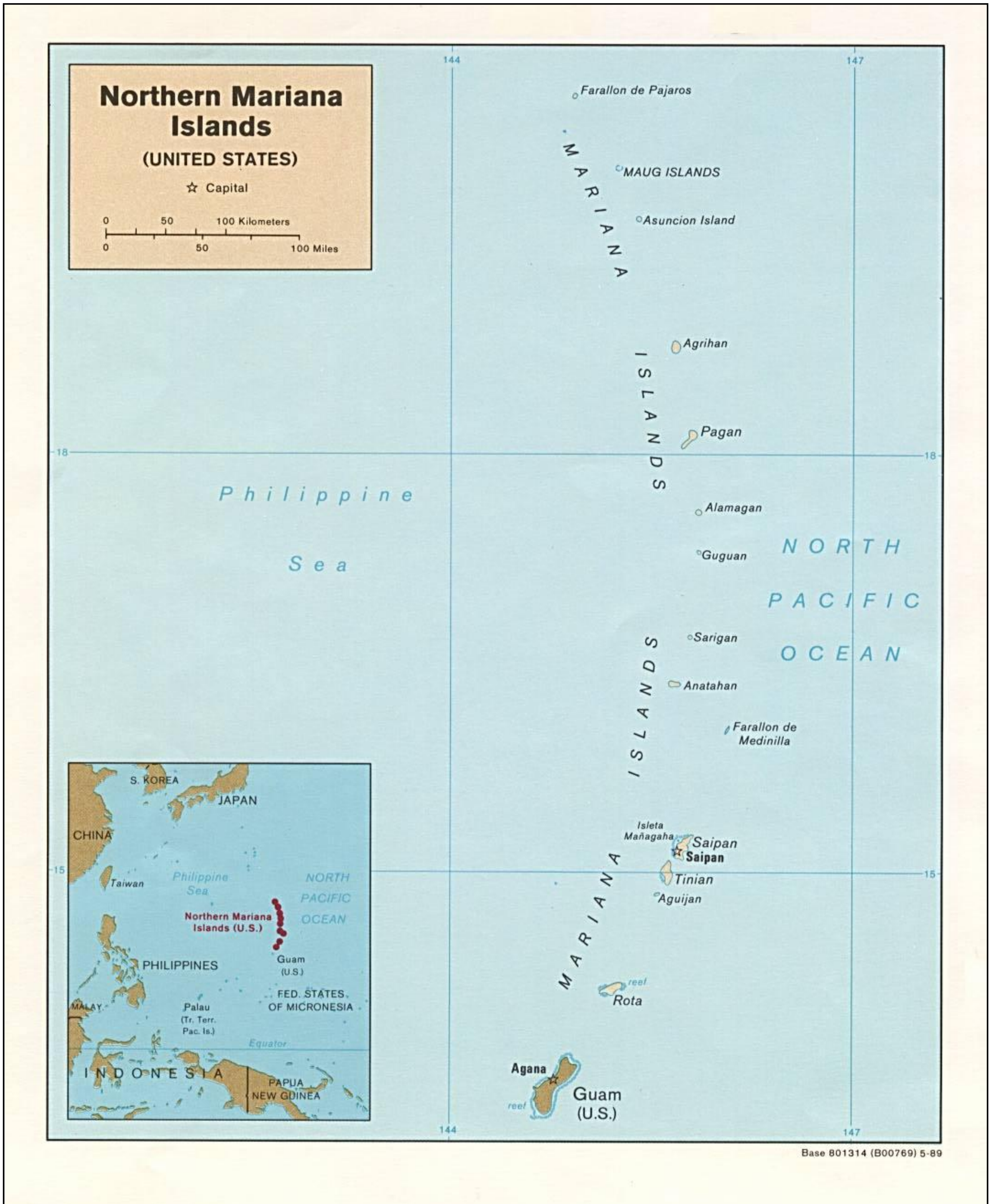

Figure 1. The Northern Mariana Islands, from;
http://www.gesource.ac.uk/worldguide/html/981_map.html

Conservation Introduction and Translocation

To establish satellite avian populations in the Mariana archipelago, the MAC project will use two conservation tools that are endorsed by the World Conservation Union (IUCN): (1) *Conservation Introduction*, which is defined as an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area (IUCN 1998); and (2) *Translocation*, which is a deliberate and mediated movement of wild individuals or populations from one area with free release in another (IUCN 1987, 1998).

A major component of the MAC project is the introduction of species to islands in the Mariana archipelago that are free from Brown Treesnakes. To facilitate this approach to avian conservation, it was decided that an experimental project was necessary to develop, test, and refine techniques of species translocation in the Marianas. The Saipan subspecies of the Bridled White-eye (*Zosterops conspicillatus saypani*; hereafter referred to as the Bridled White-eye) was selected to develop a model for future conservation introduction and translocation efforts. Conservation introduction action plans for other potentially threatened avian species of birds will be prepared and included under the umbrella of the MAC Plan upon their completion. For more details about the MAC Plan and associated translocation plans, please refer to MAC Working Group (*in draft*) at the CNMI DFW website (www.dfw.gov.mp/Wildlife/ConservationIT.html).

Objectives and Goals

The introduction of Bridled White-eyes to Sarigan represents a pilot project under the MAC Plan. The project's principal objectives are threefold:

- To establish a self-sustaining, satellite population of Bridled White-eyes on the northern Mariana island of Sarigan.
- To develop, test, and refine translocation techniques and protocol that are to be used in the future conservation of more sensitive and endangered species of CNMI avifauna.
- To assess the success of introduction efforts through the periodic monitoring of Bridled White-eye survival and reproduction on Sarigan.

Justification of Conservation Action

Translocations of small numbers of endangered, threatened, and sensitive species, even to areas of excellent habitat quality, tend to have low chances of success (Griffith et al. 1989). Thus, sources (Griffith et al. 1989, Ballou 1993) assert that translocation be considered long before it becomes a last resort for such species—before densities (and thus genetic diversity) become low and populations enter a state of decline. With the likely establishment of the Brown Treesnake on Saipan, and the increased threat of the species' establishment on Tinian and Rota, it is imperative that secondary or satellite populations of potentially vulnerable bird species be established in areas determined to be safe, before the genetic diversity of these avian populations decreases.

The Bridled White-eye will be used as a research model for testing and developing translocation techniques and protocols that can be applied to other locally and federally threatened and endangered avian species under threat by the Brown Treesnake in the Northern Mariana Islands. Some of these species have been given alert status by the IUCN (2007) and include: (1) the Rota White-eye (*Zosterops rotensis*), which is restricted to the island of Rota and is given the alert status of Critically Endangered (CR); (2) the Golden White-eye (*Cleptornis marchei*), found on Aguiguan and Saipan and also listed as Critically Endangered (CR); (3) the Tinian Monarch (*Monarcha takatsukasae*), found only on the island of Tinian and given the alert status of Vulnerable (VU); (4) the Nightingale Reed Warbler (*Acrocephalus luscinia*), found on Saipan and Alamagan (recently extirpated from Aguiguan) and listed as Endangered (EN); (5) the Mariana Crow (*Corvus kubaryi*), restricted to Rota and likewise listed as Endangered (EN); and (6) the Mariana Fruit-dove (*Ptilinopus roseicapilla*), which is locally common on Saipan, Tinian, Rota, and Aguiguan, and exists in small numbers on Sarigan (J. Cruz, pers. comm), but is listed as Endangered (EN).

All species taken into account in the MAC Plan (MAC Working Group *in draft*) will be evaluated to determine the most appropriate management strategy to be taken for each, which could potentially include translocation to Sarigan or other islands. Except for the Rota White-eye, the Bridled White-eye (including the extinct Guam subspecies of the Bridled White-eye [*Zosterops conspicillatus conspicillatus*]) is or was sympatric within the Mariana Islands with all previously mentioned federally and locally threatened species. Thus, the Bridled White-eye would not preclude translocation to Sarigan of the majority of species of concern within the Marianas. Additionally, Sarigan is not being considered as a translocation destination for the Rota White-eye because this species is believed to select for high elevation wet forests, a forest type not present on this island (Amidon 2000).

An early assessment of possible management options indicated a need for preliminary work to test and develop translocation techniques specific to the logistical and biological issues associate with the Mariana archipelago. Thus, although listed by the IUCN (2007) as Endangered (EN), the Bridled White-eye has deliberately been selected as a research model for four very important reasons. First, this species is endemic to the Mariana Islands. Second, it has large, extant populations on three islands, and therefore source populations will not be heavily impacted by the removal of a large number of individuals for translocation. Third, the Bridled White-eye is a habitat generalist, which increases the likelihood of establishing a viable population on Sarigan via translocation (see Appendix A). Finally, as previously mentioned, it coexists (or coexisted) with, and in many cases is socially submissive to (Craig 1996), all of the avian species of conservation concern except for the Rota White-eye and is not expected to impede the translocation of additional species to Sarigan.

Species Synopsis: The Bridled White-eye

The Bridled White-eye is endemic to the Mariana Islands and is taxonomically separated into two subspecies; one commonly distributed on Saipan, Tinian, and Aguiguan (*Z. c. saypani*, the Saipan subspecies) and one that is now believed to be extinct on Guam (*Z. c. conspicillatus*, the Guam subspecies; Wiles et al. 2003). The species is a small, sexually monomorphic forest bird, for which the name (white-eye) is derived from the white ring of feathers circling the eyes, a characteristic of all members of the avian Family Zosteropidae.

The Bridled White-eye is a habitat generalist and although found primarily in forested areas (Stott 1947; Engbring et al. 1986; Craig 1989, 1996), they have been reported in native limestone forest, *Leucaena leucocephala* thickets, *Casuarina* forest, beach strand, swordgrass savannah, and suburban areas. Although it is believed to feed primarily on insects, the species has been documented feeding on fruits and probing flowers of various species of tree and vine (Engbring et al. 1986; Craig 1989, 1996).

The Bridled White-eye is abundant and widespread on the islands of Saipan, Tinian, and Aguiguan, and is not currently considered threatened or endangered by U.S. Federal or Commonwealth governments. The primary threats to the species are newly introduced predators and possible diseases, such as the Brown Treesnake and West Nile Virus, respectively.

NOTE**:** See Appendix A for more detailed information on the Bridled White-eye.

Project Funding

All costs associated with field collection of Bridled White-eyes intended for introduction to Sarigan are funded by the AZA. All funds necessary for translocation and post-release and follow-up monitoring will be secured by CNMI DFW from the USFWS through both the Wildlife Restoration and State Wildlife Grants.

TRANSLOCATION TO SARIGAN

As previously defined, translocation is a deliberate and mediated movement of wild individuals or populations from one area with free release in another, with the intent to establish, re-establish, or augment a population (IUCN 1987, 1998; Griffith et al. 1989; Wolf et al. 1996; Pierre 2003). Perhaps more accurately relative to the CNMI, translocation is used to remove a species from an overwhelming local threat or to create a satellite population on another island where it may be safe from extinction by an introduced predator (Griffith et al. 1989, IUCN 1998, Clarke and Schedvin 1997, Whittaker and Fernández-Palacios 2007). In a sense, the long-term intent of such an action is to create genetic reserves for native species whose source populations are potentially threatened with extinction. Such translocation of rare, native species can be quite costly and can be subject to intense public scrutiny (Griffith et al. 1989).

Some sources (e.g., Griffith et al. 1989, Snyder et al. 1994, Taylor et al. 2005) indicate that among release programs targeting threatened and endangered species, the introduction of wild caught birds is generally more successful than the release of those that are captive reared. Regardless, sources (e.g., Griffith et al. 1989, Lovegrove 1996, Veltman et al. 1996, Wolf et al. 1996, Wolf et al. 1998) also conclude that island introduction efforts are ineffective or fail when too few individuals, with an unbalanced sex ratio, are translocated as a part of introduction efforts. Ultimately, however, Veltman et al. (1996) indicate that both introduction effort (i.e., repeated translocations over time of a species to a given location) and management by humans are crucial in translocation work, citing the translocation of various species of birds in New Zealand and the world over.

Reviewing the success of 45 separate releases of Saddlebacks (*Philesturnus carunculatus*) between islands in New Zealand, Lovegrove (1996) concluded that one of the primary reasons for failure in these introduction efforts was that too few birds, with an unbalanced sex ratio, were translocated and released. All releases of 15 or more birds on islands lacking predators were determined to be successful (i.e., resulted in self-sustaining populations of the target species), at least in the short term—in some cases predators later arrived and became an issue (Lovegrove 1996). The translocation of 31 Seychelles White-eyes (*Zosterops modestus*) from the island of

Conception to the island of Frégate, Seychelles, between October and November 2001 resulted in a skewed sex ratio of 21 males to 10 females (this was primarily attributed to the use of tape playback during capture, which attracted more male than female; Rocamora et al. 2002, J. Hardcastle, TNC, pers. comm.). Interestingly, though, Rocamora at al. (2002) reported in May 2002 a breeding population of 40 to 45 Seychelles White-eyes on Frégate that exhibited the highest success and productivity figures ever recorded for the species (66% of breeding attempts were successful with 0.71 young fledged per breeding adult). Nonetheless, an additional six females were captured and introduced to Frégate in 2003 to help correct for the skewed sex ratio (Rocamora et al. 2003).

In a survey of 134 avian translocation efforts worldwide between 1973 and 1986, Griffith et al. (1989) indicated that releases of 40 or more birds into good quality habitat were generally successful (i.e., resulted in self-sustaining populations of the target species). Griffith et al. (1989) also suggested that increases in success associated with the release of larger numbers of birds became asymptotic; releases of greater than 80 to 120 birds did little to increase translocation success. Phylogenetically based, partial reanalysis of data in Griffith et al. (1989) indicated that the total number of animals released remained a consistent factor in the success of translocation programs irrespective of analytical technique (Wolf et al. 1998). Although populations have been established from small numbers of translocated animals, results in Wolf et al. (1998) indicate that adverse demographic and environmental stochastic effects are indeed more prevalent in smaller populations. However, the minimum viable number of animals released will be dependent upon the unique circumstances surrounding each translocation effort (Wolf et al. 1996).

In light of these findings, CNMI's pilot effort in 2008 will involve the translocation of 50 wild-caught Bridled White-eyes to Sarigan, immediately followed by a week to ten days of initial monitoring effort. (Much of the current plan is modeled after those developed for the Seychelles White-eye translocation and introduction efforts on the islands of Frégate, Cousine, Cousin, and North Island, Seychelles [Rocamora 2002; Rocamora et al. 2002, 2006; Hardcastle 2005, Hardcastle et al. 2005]). Depending upon funding, as many as three post-translocation follow-up visits will be conducted over the following year to monitor survivorship and reproductive status of the introduced Bridled White-eye population. Data gathered during these visits will guide subsequent decisions concerning the need for conducting additional releases to bolster population numbers, correct any skew in sex ratio, or infuse additional genetic diversity into the population.

Although various islands are being assessed, no decisions have been made as yet concerning alternative translocation destinations to be considered under the MAC Plan. For the foreseeable future, all translocation endeavors will focus on the island of Sarigan. However, it should be noted that potentially incompatible or closely related species (i.e., Bridled White-eye and Rota White-eye) will not be placed on the same island.

Suitability of Sarigan

This uninhabited island, which lies 95 nautical miles north (16° 42' N, 145° 47' E) of Saipan, is approximately 500 ha (5 km^2) in area, 549 meters at its highest elevation, and will be the initial focus for avian translocations. An extinct volcano with no recorded history of activity, Sarigan's shoreline is irregular with steep cliffs created by old lava flows (Berger et al. 2005). Artifacts found on the island indicate that it was inhabited by Chamorros, the indigenous people of the Mariana Islands, prior to first European contact in 1521 (Russell 1998). Around 1900, a penal colony was established on Sarigan that included a copra plantation established and maintained by the prisoners (Spennemann 1999). In 1906, the Japanese leased the island for commercial copra production and all prisoners were removed (Spennemann 1999). During the 1930s between ten and twenty families lived on the island but all residents were removed after the Second World War (C. Kessler, USFWS, pers. comm.). Feral animals were estimated to be on Sarigan for at least 50 years prior to their eradication, heavily impacting the island's vegetation (Kessler 2000). To improve habitat for the endangered Micronesian Megapode (*Megapodius laperouse*), the CNMI DFW initiated an intensive US Navy and USFWS funded eradication program from 1998 through 2000 to clear the island of all feral goats, pigs, cats, and introduced rats (Kessler 2002). The island has now been free of ungulates since 1999.

Invertebrate Fauna

While Bridled White-eyes are believed to be primarily insectivorous, they are dietary generalists and consume a broad range of other food items (i.e., fruit, nectar, flowers, and seeds; Appendix A). Due the lack of specific dietary information, biologist Ortwin Bourquin was contracted by CNMI in 2006 to evaluated invertebrate species abundance and composition on both Saipan and Sarigan to determine whether the latter has the necessary resources (i.e., potential food sources, generally invertebrates up to ~25 mm in length) to support a population of insectivorous forest land birds, such as the Bridled White-eye.

Though not statistically supported, the invertebrate fauna represented in collected and observed samples indicate a strong similarity between the higher taxa of both islands (Bourquin 2006). Additionally, Bourquin (2006) reported similar prey numbers per leaf area on both Saipan (1 per 2004 cm^2; n = 725 leaves [66 prey items collected]) and Sarigan (1 per 1680 cm^2; n = 714 leaves [78 prey items collected]). Considering the area of suitable habitat relative to insect abundance, Bourquin (2006) concluded that Sarigan has the food resources necessary to support a viable population of Bridled White-eyes.

The native forests of Sarigan support the healthiest arboreal snail populations known thus far from the Mariana Islands, with densities of the humped tree snail (*Partula gibba*) the highest ever reported for the species (B. Smith, University of Guam, pers. comm.). The humped tree snail, which is a candidate for federal listing under the Endangered Species Act and is considered a species of special conservation need by the CNMI (Berger et al. 2005), was once known from Guam, Rota, Aguiguan, Tinian, Saipan, Anatahan, Sarigan, Alamagan, and Pagan (Kondo 1970). However, populations on most of these islands have been extirpated or have declined substantially, probably due to the introduction of predators like the flatworm (*Platydemus manokwari*; Hopper and Smith 1992, Kurozumi 1994, Smith and Hopper 1994, Bauman 1996).

Justifiably, there is some concern that introducing the Bridled White-eye may threaten snail species on the island (B. Smith, University of Guam, pers. comm.). However, both species are known to have coexisted on the islands of Guam, Saipan, Tinian, and Aguiguan prior to human impacts. Only Marshall (1949) mentions snails in the diet of the Bridled White-eye. Although no sample sizes were given, he noted that snails were found only rarely in stomach samples. Interestingly, Marshall (1949) also noted that snails are "sometimes eaten" by the Micronesian Honeyeater (*Myzomela rubratra*), a species that is very abundant on Sarigan (J. Cruz, pers. comm.). Additionally, the literature concerning the foraging and diets of seven other species of white-eye worldwide indicate a preference for insects (and some spiders), fruit, and nectar, but not snails (Skead and Ranger 1958, Gill 1971, Feare 1975, Catterall 1985, Cheke 1987, Van Riper 2000, Rocamora and Henriette 2002, Jolliffe et al. 2007). Nonetheless, because the humped tree snail is a candidate for listing under the U.S. Endangered Species Act, the MAC team will undertake an experiment prior to the tentative translocation to determine if Bridled White-eyes will select and eat this and other species of snails (refer to Appendix D, *Bridled White-eye Snail Consumption Study* for details).

In summary, we do not believe that the establishment of the Bridled White-eye on Sarigan will have a significant impact on the island's native snail population, because: (1) native snail species (such as the humped tree snail) coevolved and previously coexisted with Bridled White-eyes elsewhere within their historic range; and (2) because sufficient insect, nectar, and fruit resources for foraging by Bridled White-eyes are likely available on Sarigan.

Potential Predators

Sarigan currently has populations of four potential Bridled White-eye predators. The Collared Kingfisher (*Todiramphus chloris*) is a known predator of adult Bridled White-eyes (F. Amidon, pers. comm., Marshall 1949) and their nests (L. Williams, pers. comm.). In 2006, a population of 141 pairs (91 – 217 pairs; 95% CI) of kingfishers was estimated for the island (J. Cruz, pers. comm). Sarigan also has an estimated population of 1002 pairs (500 – 2005 pairs; 95% CI) of Micronesian Starlings (*Aplonis opaca*; J. Cruz, pers. comm.), which have been reported preying on nests of forest bird species on Saipan (Sachtletben 2005). Monitor lizards (*Varanus indicus*) and pacific rats (*Rattus exulans*) are also present on the island and may potentially predate Bridled White-eye nests. The number of monitor lizards on Sarigan is unknown but they were considered "numerous" in 2000 (DFW 2000). Rat abundance estimates were 5.7 rats per 100 trap nights for coconut forest and 0.0 rats per 100 trap nights in native forest over three nights in 2000 (in both cases, peanut butter baited *Victor* [Woodstream Corporation, Litiz, Pennsylvania] rat snap-traps were used for survey work; DFW 2000). A two-night survey of rats in native forest on the island in 2006 also yielded no captures (N. Hawley, USFWS, pers. comm.).

The impacts of each of these predators on Bridled White-eye populations within their current range are unknown. Sachtletben (2005) recorded predation events on Saipan by Micronesian Starlings, along with one attempt by a Collared Kingfisher, on Golden White-eye (*Cleptornis marchei*) and Rufous Fantail (*Rhipidura rufifrons*) nests. Sachtletben (2005) did not monitor Bridled White-eye nests during this study, but determined nest survival to be lower for the species than either Golden White-eyes or Rufous Fantails. However, it is not known if predation by Micronesian Starlings and Collared Kingfishers was responsible for lower survival rates or if some other factor played a role. Regardless, there is no reason to suspect significant differences in historic rates of nest predation between Saipan and Sarigan. Predation on adult white-eyes by Collared Kingfishers has never been studied and its potential impact on Bridled White-eyes on Sarigan is unknown. Although some predation is likely, we do not expect these events to prevent the species from becoming established on Sarigan because Bridled White-eyes have coevolved with Micronesian Starlings and Collared Kingfishers on Saipan, Tinian, and Aguiguan.

On Pacific islands, rats have been found to be important predators of native birds and are believed to be responsible for the population decline or extinction of some species (Atkinson 1985). Although monitor lizards have also been reported to prey on eggs and young birds in the Mariana Islands (Aguon and Henderson 1998), Sachtletben (2005) failed to identify either monitor lizards or rats as significant predators of Golden White-eyes and Rufous Fantails on Saipan. However, as Sachtleben (2005) did not monitor Bridled White-eye nests the impacts of rats and monitor lizards upon them are unknown. Recent rat abundance estimates for Saipan resulted in 6.9 to 41.4 rats trapped per 100 trap nights (G. Rodda, USGS, pers. comm.), numbers that are considerably higher than those reported for Sarigan. Thus, the impact of rats on Bridled White-eye nest success may be lower on Sarigan than on Saipan but whether these impacts will significantly affect efforts to establish white-eyes on Sarigan are unknown. Likewise, the expected affect of monitor lizards is also completely unknown. Therefore, the need for control and/or eradication of rats and monitor lizards on Sarigan will be evaluated after the first year post-release monitoring is completed.

Potential Competitors

The Bridled White-eye is not only considered primarily insectivorous, but is also a habitat generalist. The only bird species on Sarigan that could compete with Bridled White-eyes is the Micronesian Honeyeater (*Myzomela rubratra*), which does coexist with the former on the islands of Saipan, Tinian, and Aguiguan (Engbring et al. 1986). The honeyeater, like the white-eye, feeds on both insects and nectar (Marshall 1949, Jenkins 1983, Engbring et al. 1986, Craig 1996) and has been observed foraging for nectar on the same tree species as Bridled White-eyes (Craig 1996). However, foraging observations of both species tentatively indicate that the honeyeater may specialize on nectar more than the white-eye (Craig and Beal 2001). A study on microhabitat partitioning on Saipan by Craig and Beal (2001) indicates that the honeyeater and white-eye are both relatively specialized in canopy foraging but appear to differ in foraging substrate and methodology (flower probing and leaf gleaning, respectively) and perch sizes (large and small perches, respectively). Therefore, these species do overlap ecologically but appear to differ in microhabitat components and manner of foraging. Additionally, Craig (1996) noted that Micronesian Honeyeaters aggressively defended their food sources, and socially dominated Bridled White-eyes in interactions. Therefore, we would not expect that Micronesian Honeyeaters would be excluded from food sources as a result of Bridled White-eyes being present on Sarigan. Instead, we would expect honeyeaters to aggressively defend some food sources from white-eyes.

While only limited data are available concerning Micronesian Honeyeater nesting habitat; Sachtleben et al. (2006) described the nest site characteristics of seven honeyeater nests found on Saipan. In general, nest site characteristics of the Micronesian Honeyeater and Bridled White-eye overlap in terms of nest location, nest tree height, distance of nest from trunk of tree, and diameter of supporting branches. However, both the overlap in nest-site characteristics and the overall availability of potential nest sites will preclude either species from excluding the other from nesting. Bridled White-eyes also nest in the two tree species (*Guamia mariannae* and *Psychotria* sp.) in which Sachtleben et al. (2006) reported finding honeyeater nests. However, of the two tree species, only one is reported to occur on Sarigan (Fosberg et al. 1979, DFW 2000). Because additional information on Micronesian Honeyeater nests is not available it is not possible to determine if the availability of suitable nesting tree species will be a factor. However, Bridled White-eyes nest in a wide variety of tree species and do not appear to be specialized in terms of nesting habitat. Therefore, we would not expect the availability of nesting trees to be limited.

Based on available information, some competition between Micronesian Honeyeaters and Bridled White-eyes may occur as a result of the establishment of a population of the latter on Sarigan. However, we do not expect this competition to significantly affect either species for the following reasons: (1) both species currently coexist on the islands of Saipan, Tinian, and Aguiguan (Engbring et al. 1986); (2) both species show a difference in microhabitat use and foraging methodology; and (3) availability of resources for foraging and breeding do not appear to be limited, and are therefore unlikely to prevent coexistence.

Habitat Suitability

As much as 45% (223 ha) of Sarigan is covered by forest, the remainder consisting of either grass or barren areas. A DFW survey of the island in 2006 indicated that forest cover consisted of approximately 75-90 ha of native forest and 133 ha of old coconut plantations or agricultural forest (L. Williams, pers. comm.). As a result of the earlier eradication of feral goats and pigs (Kessler 2002), much of the native forest was young and regenerating, and had substantially increased from the 29 ha DFW (2000) estimated during surveys in 2000. As discussed above, Bridled White-eyes primarily utilize forested habitat but have been observed in grassland as well, often utilizing trees that are widely dispersed throughout. In addition, white-eyes have been documented foraging on the fruits and flowers of 33 plant species and nesting in 17 different plant species on Saipan (Craig 1989, 1996; T. Sachtleben, pers. comm., 2005). Of these plant species, 19 utilized for foraging and eight utilized for nesting occur on Sarigan (Fosberg et al. 1979, DFW 2000, L. Williams, pers. comm.), and two plant species commonly used for foraging (i.e., *Cocos nucifera*, and *Hibiscus tiliaceus*) are dominant components of the coconut forests on the island. Three other plant species (i.e., *Carica papaya*, *Erythrina variegata*, and *Neisosperma oppositifolia*) are also well represented in Sarigan's native or coconut forests, and increasing in distribution and overall importance (DFW 2000, L. Williams, pers. comm.).

The average density of trees in forested areas on Sarigan has shown an increased from 1.48 trees/100m^2 in 1999, 9.81 trees/100m^2 in 2000 and 13.70 tree/100m^2 in 2006 (L. Williams, pers. comm.). Overall, density and importance has shown an increase for five species of tree in forested habitat on the island: *Neisosperma oppositifolia*, *Erythrina variegata*, *Pisonia grandis*, *Leucaena leucocephala*, *Carica papaya*, *Morinda citrifolia* and *Melanolepis multiglandulosa* (L. Williams, pers. comm.). Canopy cover also increased from an average of 52% to 77% between 1999 and 2006 (USFWS 1999, L. Williams, pers. comm.), and combined with the increase in tree density has contributed to an increase in forest complexity. Therefore, sufficient fruit and nectar sources would appear to be available to support a population of Bridled White-eyes, along with an ample availability of potentially exploitable foraging niches.

Of the plant species used for nesting on Saipan, only *Melanolepis multiglandulosa* and *Leucaena leucocephala* were recorded during vegetation surveys along six transects on Sarigan in 2000 (DFW 2000). *Melanolepis multiglandulosa* was only recorded in the native forest and *Leucaena leucocephala* was only recorded along one transect and appeared patchily distributed (DFW 2000). Data from 2006 indicate that the density of *Leucaena leucocephala* has shown an increase but the fate and status of *Melanolepis multiglandulosa* is yet unknown (L.Williams, pers. comm.). However, nest placement on Saipan is probably related more to the availability of appropriate microhabitat (e.g., number of support branches, canopy cover, foliage volume) than to specific tree species. For example, of 167 Bridled White-eye nests documented by Sachtleben (2005) on Saipan that include data on tree species, 66% (110 nests) were recorded in the dominant tree species within study sites. The dominant component of the native forest on Sarigan is the small to medium height understory tree, *Aglaia mariannensis* (DFW 2000, L. Williams, pers. comm.). Because this species was not reported by Sachtleben (2005) for the forests on Saipan, its use for nesting by white-eyes is uncertain; however, it is similar in size and structure to other native tree species that are regularly used for nesting (e.g., *Cynometra ramiflora*, *Guamia mariannae*) and may also be used if available. The coconut forests on Sarigan are probably less optimal for nesting due to the dominance of *Cocos nucifera*, which does not possess the structural components of trees used for nesting by Bridled White-eyes (e.g., small diameter supporting branches).

Rocamora et al. (2002) reported that 37% of observations of foraging by 31 Seychelles White-eyes translocated to Frégate Island were on plants that did not occur on Conception, the source island of the donor population. Rocamora (2002) also noted that one of the three species of fruit tree most frequently used as forage by the translocated white-eyes was virtually absent on the source island. Additionally, of Seychelles White-eye nests (*n* = 9) found post-translocation on Fregate between November 2001 and June 2002, four were in a tree species that does not occur on Conception, and an additional three were in a species present but marginal on the source island (Rocamora et al. 2002). Although these observations are of only one species, they may be indicative of both the flexibility and adaptability of species in the genus *Zosterops*.

In summary, potential ecological plasticity of the species aside, sufficient and increasing foraging habitat is thought to be available on Sarigan to support a population of Bridled White-eyes. However, the availability of nesting habitat may be limited to the native forest, which could limit the population size of Bridled White-eyes that could be supported.

Carrying Capacity

Insufficient data are available to predict the carrying capacity of Bridled White-eyes on Sarigan and whether this population would prove to be viable. However, we can use available data on this and other white-eye species in other locations to evaluate potential outcomes of this translocation program. As discussed so far, a population of Bridled White-eyes on Sarigan would likely not be limited by the availability of food resources, competition with other species, or predation beyond what is currently experienced by the species on Saipan. However, the population could be limited by habitat availability, especially in terms of breeding habitat, as Sarigan is a small island with a limited availability of forest.

Approximately 75-90 ha of native forest currently cover Sarigan, along with 133 ha of old coconut plantations. Of available habitat, the coconut forest is likely marginal and would support fewer Bridled White-eyes than would the native forest due to a lower expected availability of insects (Bourquin 2006) and a limited availability in potential nesting sites. Data pertaining to Bridled White-eye densities in coconut forest or agricultural forest are not available at this time. However, surveys between 1982 and 1984 on the Citrine White-eye (*Zosterops semperi*), a species similar to the Bridled White-eye on the islands of Uman (470 ha), Onei (375 ha), Pata (445 ha), and Udot (493 ha) in Chuuk, Federated States of Micronesia, identified densities of the species within native and agricultural forest (Engbring et al. 1990). Densities in agricultural forest on these four islands ranged from 2 to 7 birds per ha, with a cumulative average density of 5 birds per ha for all the islands combined. In general, these densities were between one-quarter and one-half those for white-eyes found in native forest in Chuuk. Based on these results, Bourquin (2006) estimated that coconut forests on Sarigan could support about one quarter of the density supported in native forest. Therefore, the combination of native forest and coconut plantations yields an effective area of approximately 108-123 ha of potential Bridled White-eye habitat.

In 1982, Engbring et al. (1986) estimated densities of Bridled White-eyes on Saipan, Tinian, and Aguiguan to be 22, 29, and 19 birds per ha, respectively. In addition to the 1982 survey, DFW conducted additional surveys on Aguiguan in 2000 and 2002, with total densities from these surveys estimated to be 33 and 68 birds per ha, respectively (DFW 2002). Though these densities are not directly comparable to Sarigan because of differences in habitat and species composition, they do provide a range of potential densities for consideration. Therefore, utilizing the estimated acreage of native forest on Sarigan (75-90 ha) and high and low density estimates from Aguiguan (the island closest in size to Sarigan [700 and 500 ha, respectively]), a carrying capacity numbering between 1,425 and 6,120 Bridled White-eyes would be predicted in native forest. Assuming that coconut/agricultural forests (133 ha) can support one quarter the density of Bridled White-eyes as native, we estimate that this forest type could support between 627 and 2,244 additional birds, resulting in a total population of between 2,052 and 10,336 Bridled White-eyes on Sarigan.

Evaluation of Release Stock

Avian Disease Assessment

The occurrence of disease is an inherent part of introduction programs (as well as with captive breeding and reintroduction programs [Ballou 1993]). Thus, quantitative assessments of the risks of disease should be an important part of developing such conservation strategies (Ballou 1993). A number of sources (e.g., Cunningham 1996, Ballou 1993, Woodford and Rossiter 1996, Leighton 2002) recommend that individual animals to be translocated be screened for pathogens and necropsies be performed when possible.

During the CNMI DFW biological inventory of Sarigan in 2006, Shelly Kremer (USFWS, Honolulu, Hawaii) and Robby Kohley (Zoological Society of San Diego, Escondido, California) collected disease samples from the island's avifaunal populations with mist net (212.69 net hours with eight nets over seven days). Blood feathers were collected and the right hallux of 21 birds (20 Micronesian Honeyeaters and one Collard Kingfisher) clipped to produce microscope slide blood smears. Likewise, six birds (three honeyeaters, three kingfishers) were collected for necropsy and placed in a 37% formaldehyde and seawater solution. All samples are to be analyzed by Thierry Work (Appendix B) and the results are forthcoming.

In June 2007, as a preparatory measure for pilot translocation efforts in 2008, the MAC Working Group issued a letter of inquiry (including PDF versions of all known literature pertaining to avian disease in the Mariana Islands; Silva-Knott et al. 1998, Savidge et al. 1992, and Fontenot et al. 2006) to the USFWS's Avian Disease Recovery Working Group (ADRWG; Appendix B) for disease testing recommendations for the Northern Mariana Islands. The letter contained three specific charges relative to the translocation needs of the MAC project:

1. What diseases does the ADRWG feel would present the greatest cause for concern on behalf of our planned translocation project? To stay within a reasonable frame of both time and cost, we are looking for something perhaps akin to a list of the top five diseases that we should consider surveying for.

2. What would the ADRWG recommend as detection methods to be used for the suggested target pathogens?
3. Given the nature of translocation plans, would the ADRWG recommend testing equally the donor (Saipan) and recipient (Sarigan) populations, or focus testing specifically on the donor population?

Given the absence of knowledge of the status of wildlife disease in the Mariana archipelago, the ADRWG asserted that the greatest risk to the endemic avifauna of Saipan (along with Rota and Tinian) is the Brown Treesnake. The ADRWG suggested that the priority of the MAC program at this point should be placed upon determining how to 1) safely translocate birds to Sarigan, or in lieu of this 2) minimize the damage that the Brown Treesnake can cause to the native avifauna of Saipan, and 3) implement an effective monitoring program on Sarigan to gauge the success of translocations and to follow up on mortalities to determine their cause.

While the priority should be the establishment of "insurance" populations, the ADRWG also recommended that the captured white-eyes be screened and appropriately treated for internal and external parasites as warranted to prevent the introduction of pathogens to Sarigan as best possible. However, some members of the working group felt that unless known parasites of pathological importance were encountered, prophylactic treatments might be counter-productive by disrupting the gut flora of healthy birds. Thus, the recommended pathogen screening will be conducted but treatment will not be administered to any birds unless absolutely necessary.

***NOTE*:** Birds that appear to be in serious need of treatment will be deemed unsuitable for translocation. These birds will be released on Saipan at their location of capture, perhaps after prophylactic treatment, the need for which will be determined by the Wildlife Veterinarian.

Assessment of Snails as a Selected Food Item

As mentioned previously, native forests on Sarigan support the healthiest known arboreal snail populations in the Mariana Islands, with densities of the humped tree snail (*Partula gibba*) the highest ever reported for the species (B. Smith, University of Guam, pers. comm.). This species is not only considered of special conservation need by the CNMI (Berger et al. 2005) but is also a candidate for federal listing under the U.S. Endangered Species Act.

As a result of concerns raised by both Barry Smith, University of Guam, and the USFWS, 20 captive Bridled White-eyes will be experimentally assessed to determine what affect (if any) translocated birds may have on native snail populations on Sarigan (refer to Appendix D, *Bridled White-eye Snail Consumption Study* for details). This study will be run and overseen by AZA personnel and include two study groups, both consisting of five samples. Each of these samples will comprise two Bridled White-eyes placed together in a cage and will undergo snail feeding trails over four consecutive days. The first study group will include Bridled White-eyes maintained on a normal captive diet (e.g., papaya and other local fruit, meal and/or wax worms, etc.). The second will consist of white-eyes subjected to a period of reduced food availability prior to the snail feeding trials to simulate a food stress scenario.

Accrued data will be analyzed with a repeated-measures Analysis of Variance (ANOVA) to assess the consumption of snails by both Bridled White-eye test groups over time. The results of this experiment will be used to determine the ultimate feasibility of translocating white-eyes to

Sarigan and may also be used to weigh possible approaches to mitigating for any future deleterious effects.

PLANNING, PREPARATION, AND RELEASE

Preparation for Translocation

In May 2006, AZA personnel began long-term preparation for the translocation of Bridled White-eyes to Sarigan with the capture of 61 individuals on Saipan. During fieldwork on Saipan, applicable methods of capturing and holding white-eyes were determined, tested, and agreed upon. Ultimately, 41 of the captured birds were held and transported to zoos in the United States for placement in captive programs.

The remaining 20 Bridled White-eyes were color banded and experimentally introduced to the islet of Mañagaha, a small, forested sand cay that lies within the coral reef-fringed lagoon that spans the majority of the western side of Saipan, approximately 3 km off the main island's shore. The islet is heavily impacted by humans but the habitat is relatively suitable for a small population of white-eyes. The purpose for the experimental introduction was to assess the feasibility of re-sighting and monitoring a relatively small flock of Bridled White-eyes on an island with which they were assumed to be unfamiliar. Post release monitoring was conducted at specified intervals after the introduction event and birds became progressively difficult to locate. At one week post release, six to eight individuals were re-sighted at the release site, while at both one and three months post release, six individuals were sighted in the release area. At six months post release only four birds were re-sighted, all of which were in a different area of the islet away from the release site. In 2007, three of these translocated birds were recaptured at their original capture site on Saipan.

Methods for Capture and Translocation

Methods are divided into four areas including preparation, capture and handling, translocation and release, and post-release monitoring. Applicable methods from previous translocation plans of avian species in other geographic locations exist (e.g., Rocamora 2002; Rocamora et al. 2002, 2006; Hardcastle 2005; Hardcastle et al. 2005) and have been referred to. Many of the methods and protocol in this plan are relatively specific to location and circumstances of the Northern Mariana Islands, are intended to be flexible, and may be tested and modified at short notice during the process of execution.

Preparation

By CNMI Staff on Saipan Prior to Annual Zoo Staff Arrival (Nate Hawley, USFWS Brown Treesnake [BTS] Program Manager for the CNMI, offered the use of his indoor facilities on the DFW compound for holding and maintaining Bridled White-eyes pre-translocation in 2008. The BTS facilities are air conditioned and quieter than the current open aviary, which should provide an environment of lower stress for the captives. If AZA staff determines that these facilities meet their needs and are beneficial to translocation efforts in 2008, they will be used in place of the open, outdoor aviary).

- Assemble when needed, inspect, and prepare all aviary and field holding cages.
- If the current, open aviary is to be used for holding and maintaining birds pre-translocation, ensure that it is in good repair and acquire any materials as needed for its maintenance.

- Ensure that the CNMI stocks of numbered aluminum USGS bird bands are at adequate quantities, and that color bands have been ordered if need be.
- Identify and select appropriate locations for trapping and arrange permission for access to these sites. If time permits, CNMI biologist will monitor potential trapping sites for the numbers and flight patterns of target species.
- Identify sources of fresh fruit to feed birds held in captivity.
- Acquire the necessary import permit for waxworms, mealworms, crickets, etc, to feed the captive stock.
- Reserve two large field vehicles from a rental agency for zoo staff to use on Saipan (e.g., a full-size van or large SUV and a minivan or smaller SUV).
- Determine the space limits of the helicopter to be used for translocation to Sarigan. (Zoo staff will design boxes that will allow for transport of the maximum number of boxes in the given space, while offering the birds within the best possible protection).

By Zoo Staff Prior to Arrival on Saipan

- Gather and assemble equipment for the capture (mist nets, etc) and transport of Bridled White-eyes.
- Construct the ten boxes necessary for transport of birds to Sarigan (refer to Appendix C, *General Field Protocol for Capture and Collection of Birds*, for details and figures [1A and 1B]) and ship them to Saipan.

Capture and Handling

Refer to Appendix C, *General Field Protocol for Capture and Collection of Birds*, for detailed methods and instruction.

- Set up and place mist net poles at pre-identified capture sites the night prior to netting those sites.
- Before sunrise, mist nets will be placed on preset poles and a temporary field camp set up.
- Nets will be opened at or shortly after sunrise when the crew is prepared to efficiently and safely run them.
- Nets will be run on a 30-minute schedule and all captured birds brought back to the field camp for processing. All birds will be banded with sequentially numbered aluminum leg bands and data will be collected pertaining to weight, wing cord length, tarsus, exposed culmen length, body fat, Body Condition Index (BCI), molt, and breeding status (all measurements will follow Baldwin et al [1931]; for details, refer to Appendix C).
- After processing (see Appendix C for procedural description), all birds that appear fit for translocation will be placed into field holding cages.
- At the conclusion of daily capture sessions (the length of which will be dependant upon a given day's trapping success), nets will be closed and taken down, the field camp disassembled, and occupied field holding cages carefully and quietly placed in vehicles for transport to the translocation aviary facilities.
- Upon return to the DFW compound, birds will be transferred from field holding cages to prepared aviary holding cages (i.e., supplied daily with food and water) within either the outdoor aviary or the BTS facilities to await translocation.

Bridled White-eyes will be captured for a period of up to two weeks (14 days). If possible, 70 birds will be initially captured, from which the healthiest and most robust 50 will be selected for translocation (an evaluation system will be developed to determine which individuals are suitable for translocation, including perhaps setting a limit on percent body weight loss or a minimum weight as described for the translocation of Seychelles White-eyes [Rocamora 2002]). The remaining 20 captive white-eyes will be held and used for a snail consumption experiment to assess the possible affect that translocated birds may have on native snails on Sarigan (refer to Appendix D, *Bridled White-eye Snail Consumption Study* for details). These birds will be returned to the site of capture and released after the conclusion of data collection for the experiment.

During the two-day holding period, the 50 birds chosen for translocation will be blood sampled for later sexing via DNA analysis, screened for parasites and disease through blood smears and fecal samples, and marked with red color bands. If deemed necessary, they will be treated for internal and external parasites as per the recommendations of the ADRWG. Likewise, the 20 radio-transmitters will be activated and attached to selected birds (which will also be marked with additional blue color bands) at the beginning of this two-day period. This will allow the birds to acclimate to the transmitters before translocation, and for staff to observe the birds and correct any ill-effects the units may have upon them.

Translocation and Release

Up to three round trip flights will be necessary to transport Bridled White-eyes, field crew, equipment, and necessary supplies to Sarigan. The Bell 206 *JetRanger* helicopter (operated by *Americopters Saipan*; www.americopters.com) to be used for transport allows only 500 pounds of cargo capacity per flight with pilot and full tank of fuel (Sarigan approaches the flight range limits of this helicopter).

The day prior to translocation, five Bridled White-eyes will be loaded into each of the ten field holding boxes (each provisioned with appropriate food and water) to be used for transport. This process will take approximately two hours for the 50 Bridled White-eyes and will include catching each bird, double checking band numbers, and confirming and recording all weights.

Likewise on the day prior to translocation, a crew of two biologists will depart by helicopter for Sarigan to set up and prepare the field camp, including erecting a small field release aviary for the white-eyes (dimensions and details of the aviary are not yet determined). At 06:00 the next morning, the crew on Saipan will re-provision the field holding boxes as necessary and load them into a vehicle for transport to the *Americopters* helicopter base. At approximately 07:00, the ten boxes will be loaded onto the aircraft, which will then depart with a Wildlife Veterinarian, arriving at Sarigan between 08:30 and 09:00.

Upon arrival at Sarigan, the field holding boxes will be offloaded from the helicopter and the Bridled White-eyes released into the provisioned field release aviary after the aircraft has powered down. Birds will be allowed to acclimate while being observed by the WV before release in the early afternoon. Assuming that all birds have been eating in the field holding boxes and the field aviary, the MAC Working Group feels that releasing them at approximately 13:00 will allow enough time for the birds to acclimate to their new surroundings on Sarigan before nightfall.

***NOTE*:** During the entire process of holding and handling birds, all steps will be taken to maintain a calm environment to minimize their stress.

- At the *Americopters* helicopter base on Saipan, before all flights, new field crew members will be familiarized with all safety procedures for helicopter flight, arrival, and landing.
- The day prior to translocation, two biologists will depart for Sarigan to set up a field camp and field release aviary in preparation for arrival of the Bridled White-eyes. After delivering crew and materials to Sarigan, the helicopter will return to Saipan.
- Approximately 07:00 the next norning, transport boxes will be carefully loaded into the helicopter and secured for flight. The aircraft will then depart with translocatees and Wildlife Veterinarian (WV) for Sarigan.
- Upon arrival at Sarigan, the crew will quickly and carefully unload transport boxes from the helicopter to the shade provided at the field camp. The helicopter will be powered down and the translocatees released into the field release aviary for acclimation and observation.
- After approximately four hours of acclimation, the Bridled White-eyes will be released from the field aviary. The WV will monitor all birds for issues upon release and attempt to care for any birds on site that may be having problems at release.
- After release, the helicopter will depart for its return to Saipan with the WV and any birds that did not fare well during the release.
- Upon the helicopter's arrival at Saipan, the empty transport boxes will be unloaded and the Unmanned Aerial Vehicle (UAV, used for post-release monitoring; refer to Appendix D for details) and supporting equipment loaded onto the aircraft. If time permits, the helicopter will depart with the third biologist for its third and final round trip to Sarigan. If the time is too late in the day for departure, the third trip will be postponed for early the following morning.

Post-release Monitoring

Refer to Appendix D, *Post-Translocation Monitoring*, for detailed methods and instruction.

- Radio-tagged birds will be monitored for the first week to ten days post-release at the translocation destination (duration will be dependent upon the quantity of supplies and provisions, especially water).
- The bulk of monitoring effort will employ the use of a UAV to determine daily movements, ranging patterns, and activity of radio-tagged birds.
- Two biologists will attempt to radio-track and alternatively monitor birds on foot following the lead of information gained from the UAV.
- When at all possible, the field crew will attempt to walk in on radio-tagged birds to determine habitat use, behaviors, and health status of tagged individuals (i.e., confirm potential mortalities), as well as re-sight color banded birds.
- When post-release monitoring is completed (or provisions begin to run out) the helicopter will be radioed and all field hands and equipment retrieved and safely returned to Saipan (this process may require more than one round-trip to complete).

EVALUATION AND REPORTING

Measures of Success

The following indicators will measure the success of the translocation of Bridled White-eyes to Sarigan. Achievement of these goals and the processes necessary to do so, will serve as a template for future translocation of other species as part of the MAC project.

- All radio-tagged Bridled White-eyes are successfully tracked and monitored for a week to 10 days post-release (refer to Appendix D, *Post-translocation Monitoring*, for details).
- Further monitoring in November/December 2008 reveals attempted breeding by translocated birds during the first year post-release. Monitoring will consist of one to two weeks of intensive searching in suitable habitat on Sarigan for evidence of nesting by breeding birds.
- February-May 2009: First successful nests found for translocated birds. In this case, "successful nests" are defined as those that fledge at least one chick, and they may be evidenced by a significance presence of unbanded birds in the Bridled White-eye population on Sarigan.
- Population surveys (e.g., VCP surveys along existing transects, mark recapture/resighting, etc) indicate a population of at least 90 Bridled White-eyes on Sarigan by 10-years post release (2018; refer to Appendix F, *Bridled White-eye Population Modeling*, for details). This figure was determined through a Population Viability Analysis (PVA) that assumes an even sex ratio in the translocated population. As relevant data for the Bridled White-eye currently do not exist, the PVA also assumes that vital rates (adult productivity and survivorship of both adults and juveniles) for the species are similar to those of the closely related Silvereye (*Zosterops lateralis*; Kikkawa and Wilson 1983, Brook and Kikkawa 1998) and Japanese White-eye (*Zosterops japonicas*; Guest 1973) (Appendix F).

Reporting of Results

The success of the translocation will be evaluated at the end of the first year, as well as on subsequent monitoring expeditions, by comparing the results obtained with the goals and measures of success for the project. Likely causes of failure or insufficient success will be analyzed and areas of improvement will be identified and incorporated into any additional transfers of the Bridled White-eye or other species.

A specific report for this translocation, highlighting lessons learned from the experience, will be produced at the end of the first (one year post-release) and all subsequent monitoring expeditions. All reports will be made available on the DFW website (available in 2009) and results will be disseminated at pertinent scientific meetings and through the local media. As per recommendation of the IUCN (1998), a minimum of one peer-reviewed, scientific paper will be produced on the results of this project.

TIMELINE OF EVENTS

Pre-translocation

Tentative

Late June 2007	Letter of inquiry submitted to the ADRWG
Mid July 2007	Recommendations received from ADRWG
Mid August 2007	First draft of Bridled White-eye translocation plan completed and circulated to MAC Working Group for review
Early September 2007	MAC Working Group comments on first draft received by Plan co-authors
Late September 2007	Revisions made and second draft sent to MAC Working Group for final review

Mid October 2007	Comments received, revisions made, and completed draft of translocation plan submitted for peer review
Mid November 2007	Comments of peer review received
Late November 2007	Necessary revisions made and final version of Bridled White-eye Translocation Plan circulated to MAC Working Group

Translocation

Tentative

Mid April 2008	Personnel from AZA arrive to collect birds for both translocation and captive breeding
April/May 2008	*Week 1and into Week 2(late April)*: Bridled White-eyes captured and held for transport to Sarigan. *Week 2 (early May)*: Bridled White-eyes translocated to Sarigan and released

Post-translocation

Tentative

Early May 2008	Post-release monitoring of translocated Bridled White-eyes on Sarigan (one week to 10 days)
July 2008	Complete initial translocation report
December 2008	Post-translocation follow-up visit for Bridled White-eye population status and monitoring
February 2009	Post-translocation follow-up visit for signs of breeding activity
May 2009	One year post release monitoring to determine status of Bridled White-eye breeding on Sarigan.
June 2009	MAC Working Group meets and evaluates the success of its first translocation, along with the need for additional releases or changes in methodology. If necessary, current translocation plan is revised.
July 2009	Complete one-year post-release translocation report.

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BRIDLED WHITE-EYE CONSERVATION INTRODUCTION

APPENDICES

Appendix A. Species Profile for the Bridled White-eye (*Zosterops conspicillatus*)

Appendix B. Members of the Avian Disease Recovery Working Group (ADRWG)

Appendix C. General Field Protocol for Collection and Capture of Birds

Appendix D. Bridled White-eye Snail Consumption Study

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Appendix F. Bridled White-eye Population Modeling

Appendix A. Species Profile for the Bridled White-eye (*Zosterops conspicillatus*)

Compiled by: Fred Amidon, USFWS, Honolulu, Hawaii, and Gary A. Michael, Curator of Birds, and Zoltan S. Gyimesi, DVM, Associate Veterinarian, Louisville Zoological Garden, Louisville, Kentucky.

Order: Passeriformes
Family: Zosteropidae
Local Names: *nosa* (Chamorro), *litchogh* (Carolinean)

Description: A sexually monomorphic forest bird for which the name (white-eye) is derived from the white ring of feathers circling the eyes, a characteristic of all members of the avian Family Zosteropidae. The head, back, and wings of the Saipan subspecies (*Z. c. saypani*) are olive green and underparts are pale yellowish-white (Baker 1951). Legs and feet are olive-gray and the bill is blackish gray (Marshall 1949, Baker 1951).

Table 1. Average wing (mean = 52 mm), tail (mean = 38 mm), exposed culmen, tarsus (mean = 18 mm), and weight of the Bridled White-eye (*n* = 29) collected on Saipan and Tinian. Adapted from Baker (1951).

Island	Wing (mm)	Tail (mm)	Exposed Culmen (mm)	Tarsus (mm)	Weight (grams)
Tinian (*n* = 23)	51 (50-53)	38 (35-41)	12 (12-13)	18 (17-18)	-
Saipan (*n* = 6)	54 (52-55)	37 (35-39)	13 (13-15)	18 (17-19)	-

Distribution and Status: The Saipan subspecies of the Bridled White-eye is endemic to the Mariana Islands and is common on the islands of Saipan, Tinian, and Aguiguan, Commonwealth of the Northern Mariana Islands. The total populations of Bridled White-eyes on Saipan, Tinian, and Aguiguan were reported in 1982 to be approximately 229,000, 241,000 and 7,000 birds, respectively (Engbring *et al*. 1986). Although DFW and USFWS personnel have conducted bird surveys on these islands since 1982, total population estimates for the Bridled White-eye have not been calculated as yet from the survey data. The Guam subspecies (*Z. c. conspicillatus*) is now believed to be extinct (Wiles et al. 2003).

Habitat: The Bridled White-eye is a habitat generalist. Although found primarily in forested areas (Stott 1947; Engbring et al. 1986; Craig 1989, 1996), Bridled White-eyes occur in a variety of habitat types, including native limestone forest, *Leucaena leucocephala* thickets, *Casuarina* forest, beach strand, swordgrass savannah, and suburban areas. Research on nesting densities in native limestone forest and introduced *Leucaena leucocephala* thickets indicate that the Saipan subspecies nests predominately in these thickets (Sachtleben 2005).

Food and Feed Habits: While the Bridled White-eye appears to feed primarily on insects, they have been observed also foraging on the fruits of *Momordica charantia*, *Passiflora foetaeda*, *Jasminum marianum*, *Premna obtusifolia*, *Ficus* spp., *Melanolepis multiglandulosa*, *Artocarpus* spp., *Pipturus argenteus*, *Lantana camara*, *Carica papaya*, and *Muntingia calabura* (Engbring et al. 1986; Craig 1989, 1996). In 2007, consumption of the fruits of *Coccinia grandis* was evident in the droppings of all Bridled White-eyes captured on Saipan (H. Roberts, Mamphis Zoo, pers. comm.). They also have been observed probing flowers (presumably to feed on nectar) of *Operculina vetricosa*, *Erythrina variegata*, *Pisonia grandis*, *Cynometra ramiflora*, *Premna obtusifolia*, *Psychotria mariana*, *Morinda citrifolia*, *Hibiscus tiliaceus*, and *Albizia lebbeck*; eating the flowers of *Mikania scandens*, *Jasminum marianum*, *Pisonia grandis*, *Cynometra ramiflora*, and *Leucaena leucocphala*; and eating the seeds of *Momordica charantia* and *Bidens pilosa* (Engbring et al. 1986; Craig 1989, 1996).

Bridled White-eyes have been observed foraging in 23 species of tree (Table 2) on Saipan, primarily by gleaning insects from leaves and branches in the outer canopy of limestone and *Leucaena leucocephala* forests (Craig 1989, 1996). However, they have also been observed hovering and sallying for insects and probing flowers (likely for nectar), bark, and dead and rolled leaves (Craig 1989). In addition, the subspecies has been observed foraging in the understory of forests, on the ground, and in *Bidens pilosa* and *Miscanthus floridulus* (Craig 1989, 1996).

Behavior: Bridled White-eyes are reported to make several vocalizations. The most common is a call that Pratt et al. (1987) describe as a high-pitched *tszeeip*, often rapidly uttered and organized into a loose song. They have also been observed producing a scolding alarm call, often in response to the presence of Collared Kingfishers (*Halcyon chloris*; Marshall 1946, Craig 1996).

Like many of the white-eyes in the family Zosteropidae, the Saipan subspecies is gregarious and often observed flocking. These flocks typically consists of family groups of 3 to 5 individuals or larger flocks of 10 to 40 individuals, though larger flocks do often occur at flowering and fruiting trees (Craig 1989, 1996). No interspecific aggression has been noted as initiated by Bridled White-eyes and the only interspecific interactions noted for the species (aside from scolding Collared Kingfishers) was of an individual foraging with a rufous fantail (Craig 1996).

Breeding: Bridled White-eyes likely breed year-round with distinct peaks during different portions of the year. Sachtleben (2005) reported nesting on Saipan from February to June with a distinct peak in February and March. Craig (1996) reported breeding in January, February, August, and October and recorded food begging by juveniles year-round. On Tinian, Yamashina (1932) reported collecting three active nests in January.

Nesting: Nests are typically composed of fine roots and fibers, a small quantity of cotton wool, and feathers (Yamashina 1932). Sachtleben (pers. comm., 2005) recorded the dimensions of 87

Bridled White-eye nests on Saipan, reporting a mean nest height of 49 mm (range = 35-70 mm) a mean cup depth of 33 mm (range = 23-41 mm), a mean cup diameter of 40 mm (range = 32-48), and a mean outer nest diameter of 61 mm (range = 51-72 mm).

Bridled White-eyes have been reported building nests on ten tree species, six vine species, and one herbaceous species (Table 2). In 2004, Sachtleben (pers. comm., 2005) documented the site characteristics of 115 Bridled White-eye nests on Saipan, reporting a mean nest height of 2.3 m (range = 0.7 – 5.2 m), a mean nest tree height of 4.3 m (range = 1.2-10.8 m), and a mean distance of nests from the boles of nest trees of 42 cm (range = 0 - 263 cm). Sachtleben (pers. comm. 2005) reported that the mean number of branches used for nest support was 3 (range = 1-7) and that the mean diameter of these branches was 2 mm (range = 1-6 mm).

Eggs, Incubation, Hatching, Growth, and Development: Clutch sizes range from 1 to 3 pale blue eggs (Yamashina 1932). Egg laying ranges from 2 to 3 days and incubation from 9 to 12 days (Sachtleben 2005), and fledging occurs 11 to 14 days post-hatching (Sachtleben 2005). The duration of post-fledging parental care is unknown. Sachtleben (pers. comm., 2005) described chick growth for the Bridled White-eye as follows:

Day 0: Chicks approximately 1.5 cm (1 – 2cm) in length, naked, with light-medium pink skin and two “tufts” of downy feathers on their head (appearance-wise, a cross between horns and eyebrows).

Day 1: Approximately 2 cm long, and naked with medium-dark pink skin. Little change from Day 0.

Day 3: Approximately 2.5 cm (2 – 3cm) long, medium-dark pink skin, wing pins 2 – 5 mm in length, head and back pins visible under skin but not erupted or barely so, two tufts on the head either remaining or no longer present.

Day 4: Approximately 3.5 cm long, medium-light pink skin, back pins 1 – 2 mm in length, and wing pins ≥3 mm long.

Day 6: Approximately 3.5 cm (3 – 4 cm) long, wing pins 6 – 7 mm in length, feathers possibly erupted from wing pins greenish and approximately 1 – 2 mm in length. Back pins 2 – 4 mm in length, feathers possibly erupted from back pins greenish and approximately 1 – 2 mm in length, head pins 3 - 4 mm long, white belly feathers in 2 lines, exposed skin light or medium pink, and eyes still closed or cracking open.

Day 8: Approximately 4.5 cm long, fully feathered, olive grey-green, and eyes opened.

Day 9: Approximately 4 – 4.5 cm long, mostly feathered, olive grey-green, eyes opened, and wing feathers dark grey.

Day 10: Approximately 5 – 5.5 cm long, fully feathered, wings dark grey and back grey-green.

Day 12: Approximately 5 – 5.5 cm long, greenish and fully feathered, belly appearing downy, and often perching on rim of the nest. Chicks will force-fledge at this age and fly well.

Threats: The Bridled White-eye is abundant and widespread on the islands of Saipan, Tinian, and Aguiguan, and is not currently considered threatened or endangered by the Federal or Commonwealth governments. The primary threats to the species are newly introduced predators and possible diseases, such as the Brown Treesnake and West Nile Virus, respectively

Table 2. Plant species utilized by Saipan bridled white-eyes for foraging and nesting.

Plant Type	Species	Status	Foraging	Nesting
Trees	*Acacia confuse*	Introduced	x[a]	
	Aidia cochinchinensis	Native		x[c]
	Albizia lebbeck	Introduced	x[b]	x[c]
	Artocarpus spp.	Native	x[a]	
	Barringtonia asiatica	Native	x[a]	
	Bruguiera gymnorrhiza	Native	x[a]	
	Carica papaya	Introduced	x[b]	
	Ceiba pentandra	Introduced	x[a]	
	Cocos nucifera	Introduced	x[a]	
	Cynometra ramiflora	Native	x[a]	x[c]
	Erythrina variegata	Native	x[a]	
	Eugenia spp.	Native		x[c]
	Ficus spp.	Native	x[a]	
	Guamia mariannae	Native	x[a]	x[c]
	Hernandia spp.	Native	x[a]	
	Hibiscus tiliaceus	Native	x[a]	
	Lantana camara	Introduced	x[b]	
	Leucaena leucocephala	Introduced	x[a]	x[c]
	Maytenus thompsonii	Native		x[c]
	Melanolepis multiglandualosa	Native	x[a]	x[c]
	Morinda citrifolia	Native	x[a]	
	Muntingia calabura	Introduced		
	Neisosperma oppositifolia	Native	x[a]	
	Ochrosia mariannensis	Native	x[a]	
	Persea americana	Introduced	x[a]	
	Pipturus argenteus	Native		
	Pisonia spp.	Native	x[a]	
	Premna obtusifolia	Native	x[a]	x[c]
	Psychotria mariana	Native	x[b]	x[c]
	Randia cochinchinensis	Native	x[a]	
	Samanea saman	Introduced	x[a]	
Vines	*Abrus precatorius*	Introduced		x[c]
	Bauhinia ssp.	Introduced		x[c]
	Coccinia grandis	Introduced		
	Colubrina asiatica	Introduced	x[d]	x[c]
	Dioscorea spp.	Introduced		x[c]
	Jasminum marianum	Native	x[b]	x[c]
	Mikania scandens	Introduced	x[b]	
	Momordica charantia	Introduced	x[b]	
	Operculina vetricosa	Introduced	x[b]	
	Passiflora foetaeda	Introduced	x[a]	x[c]
Herbs	*Bidens pilosa*	Introduced	x[a]	
	Capsicum frutescens	Introduced		x[c]
Grass	*Miscanthus floridulus*	Introduced	x[b]	

[a] Craig 1989; [b] Craig 1996; [c] T. Sachtleben, pers. comm., 2005, [d] H. Roberts, pers. comm., 2007,

Research Needed: Studies of Bridled White-eye population ecology.

BASIC HUSBANDRY GUIDELINES

The Bridled White-eye was introduced to aviculture with the collection of specimens on Saipan, May 2006. The flock was divided and distributed between the Sedgwick County Zoo, Wichita, Kansas, and the Louisville Zoological Garden, Louisville, Kentucky. Basic husbandry guidelines were prepared based more so upon the captive management of related species in the genus *Zosterops* than upon the limited experience with captive Bridled White-eyes.

Acquisition and Acclimation: The Bridled White-eye is a flocking species and is best acclimated and maintained in captivity in groups. Being monomorphic and gregarious, the chance of potential pair formation is increased within groups, and the exhibit value to guests of a naturally behaving flock of active, vocal birds is markedly improved over the display of a single bird or pair. Although not recommended, if it is necessary to maintain a single bird, it should be held in a minimum-sized enclosure of 3 ft. x 2 ft. x 2 ft. The side and rear walls should be solid and the ceiling panel padded softly to avoid head and facial trauma. A mirror is recommended to create the illusion of a cagemate for the lone bird. Otherwise, enclosures need to be large enough to accommodate small to large groups, permit flight, and avoid overcrowding; large walk-in type enclosures 1/2inch width aviary mesh are ideal. Regardless of the enclosure type, cover should be provided (e.g., visual barriers in association with perches) so individuals can retreat from flock members as needed. As the species can at times roost and forage close to the ground, live potted plants can provide refuge and foraging opportunities.

Although generally peaceful, Bridled White-eyes can display extreme aggression, a behavior that is not typically observed during short-term acclimation periods. Aggressive behavior is observed more readily between birds maintained in cramped quarters over a long-term period or between territorial nesting pairs and the general flock. Intraspecific agonistic behavior is often expressed subtly; repeated gaping and beak snapping and appeasement display (feathers fluffed, mock begging) are cause for concern. Excessive allopreening resulting in feather loss (usually around the head and neck) may indicate that the enclosure is too small or has too few perches or hiding spots for the number of individuals housed. If behavioral problems persist, the birds may be kept in two smaller groups and then be reacquainted once they are transferred to a larger, more enriched environment.

Banding and Weighing: It is recommended that birds be banded with brightly colored bands in combinations that facilitate identification from a distance. To avoid disturbing family groups and attracting the attention of cagemates to hidden nest sites, nestlings should not be banded. Birds can be easily trapped in the aviary with food-baited traps and banded with open (butt-end) bands.

Accurate weights are essential to aid in health management. Captured birds should be quickly transferred from the trap to a smooth, soft bag, and then to a scale that measures to 0.1 gram. A less intrusive method of weighing birds in the aviary is to use a postal letter scale with a brightly lit number read-out panel. If a small container of food is placed at the scale, birds will quickly overcome their fear of the instrument, allowing an individual bird’s weight to be read from a distance when it lands on the scale. At the Louisville Zoo, captive weight ranged between 6.8 and 9.3 grams, with a mean male weight of 7.9 grams and a mean female mass of 7.7 grams.

Holding Temperature: The recommended minimum and maximum temperatures at which to hold Bridled White-eyes in captivity are 60 and 95 degrees Fahrenheit. At acquisition, white-eyes should be maintained at about 80-85 degrees Fahrenheit. When transferred within a facility, birds should be provided with a heat lamp at the destination. In general, the species benefits from a heated light source while in captivity provided they have free access to and from a basking area. Sunbathing has not been documented in the wild, but captive individuals have regularly been observed basking under heat lamps.

Light: Access to natural light or full-spectrum artificial light is recommended, as intensity and duration influence health and behavior. Captive white-eyes can benefit from exposure to continuous light during the acclimation period until they are observed eating in their new surroundings. This prolonged exposure to light promotes eating and drinking, and allows familiarization with the immediate environment. This is especially important when birds are housed in large enclosures with multiple feeding stations and cover. For long-term management, 12 to 13 hour of light exposure is recommended for breeding.

Food and Feeding: The Bridled White-eye prefers high protein and high fat diets, is a highly active forager and easily conditioned to captive diets. They will readily take to a diet of waxworm moth (*Galleria mellonella*) larvae, peanut butter, and ripe papaya, along with a variety of other foods including appropriately sized commercially available insects, fruits, pelleted foods, and nectar. In nature, Bridled White-eyes have been observed foraging near the ground but will seldom do so in captivity. Thus, food and nectar should be offered on elevated platforms in multiple locations. For ease of later capture, it is recommended that food be regularly presented in some variation of a food trap.

In general, fruit should be diced and pellets moistened in cool water or fruit juice. Papaya can be offered in large slices as it will be shared by flock members. Offering parasite-covered live plants serves not only as another alternative source of food for Bridled White-eyes, but also as a source for passive enrichment as the species naturally forages on foliage for invertebrates. A constant supply of soft-bodied small insects is essential during chick rearing and it is advisable to plan ahead to identify sources to ensure an adequate supply, as the nutritional value of commercially available stock is marginal. Although not highly nutritious, waxworm larvae appear to be a good source of energy for active white-eyes. Calcium and other minerals can be delivered to the birds by lightly spraying water on the larvae and dusting them with powdered supplements. Alternatively, liquid supplements can be injected directly into individual larvae or insect based food with needle and syringe. Food and nectar should be offered twice daily to reduce the risk of spoilage, as unconsumed nectar is a source for bacteria, especially at higher temperatures.

Housing and General Environmental Considerations: White-eyes in the genus *Zosterops* are generally easy to maintain in captivity and are desirable as display birds because of their active, vocal, and non-aggressive nature. However, they are a challenge to breed in mixed-species settings. Bird collection managers seldom have the luxury or inclination to devote exhibit space exclusively to this species for the purpose of breeding. The keys to a successful physical layout for the species are inoffensive cagemates, thick plantings, and areas for pairs to isolate themselves to establish nest territories.

Large planted aviaries are ideal. The various environments these spaces provide allow Bridled White-eyes to display their full range of flock behaviors and are large enough for mated pairs to isolate themselves for nesting. Species in the genus *Zosterops* are inoffensive nesting birds and are readily disturbed from the nest. Thus, regardless of enclosure size, cagemates should not be known to prey upon eggs and chicks of other birds. In more modest-sized enclosures of approximately 400 square feet, small flocks can be maintained but breeding may be reduced as the result of overcrowding amongst flock members. However, with careful observation pairs can be identified and if needed, relocated to single-pair housing for the nesting season to avoid their attempted domination of available resources. Otherwise, social dynamics can become strained and the resulting territorial squabbles can result in nest failure.

General precautions should be taken when introducing Bridled White-eyes to aviary settings. A gradual introduction is recommended and a pen placed within the aviary will provide the new birds the opportunity to adjust and acclimate. The permanent food trap previously described can be used temporarily for this purpose. It is recommended that white-eyes not be introduced into aviaries when resident birds are nesting and after these birds have been observed exhibiting aggression towards their cagemates. Health issues have been documented at the Louisville Zoo during the initial acclimation period. Thus, new birds should be closely observed and initially weighed during this period to evaluate their health while housed in the introduction pen. When introducing white-eyes to glassed enclosures, the glass should be covered to prevent injuries from collision (similar precautions should be taken to protect young during the fledging period). In larger exhibits, white-eyes can distance themselves from visitors and keepers, making detailed observations difficult. Cautions should be taken as birds may choose nest sites at heights within the space that prevent careful monitoring and that place any eggs and fledglings at risk.

White-eyes enjoy bathing and prefer to do so in wet foliage. As birds prefer taller plants and avoid bathing at pools and in small plants on the exhibit floor, tall aviary plantings should be rinsed daily to create bathing opportunities.

Captive Behavior: Captive white-eyes in the genus *Zosterops* are generally inoffensive, active, vocal, and are suitable for inclusion in mixed species aviaries, making them excellent subjects for public display. Most negative behavior associated with captive white-eyes is intraspecific in nature and usually occurs during the nesting season or when too many birds are confined within too small a space. Allopreening is a defining behavioral trait of the genus and may serve to alleviate stress. Birds in cramped quarters or other potentially stressful environments will over-preen flock mates resulting in feather loss, mostly on the head and neck. Intraspecific aggression has been observed during courtship, nesting, and rearing of fledglings.

Pair Formation, Nesting, and Chick Rearing: The formation of pairs and the long-term maintenance of pair bonds are easily observed in captive birds. While Bridled White-eyes have not been bred in captivity, the behaviors of related species are comparable and provide a basis for managing the Saipan subspecies. Generally, a pair will allopreen and move within the flock close to one another, often eat together, and loaf and roost together. Although the captive nesting season has not yet been determined for the Bridled White-eye, captive Japanese

(*Zoseterops japonica*) and Oriental white-eyes (*Zosterops palpebrosa*) have been observed nesting throughout the year (G. Michael, pers. comm.). Nests of these two species are built of fine plant fibers, including palms, grasses, and Spanish moss, and animal hair when offered by zoo staff. These species typically locate their nests high above the ground in discreet locations amongst thick live or artificial foliage and both have accepted small, woven artificial nest cups. Based upon the high-flying behavior of Bridled White-eyes observed at the Louisville Zoo, it is likely that they too would nest high within an aviary (G. Michael, pers. comm.). Some species of White-eye have been documented completing entire breeding events, from nest building to fledging young, in less than one month. Pairs tend to choose quiet, densely planted areas for nesting, reducing their chances of being detected and disturbed by flock or cage mates. As white-eyes often abandon their nests, staff should take care to keep disturbances to a minimum.

White-eye chicks leave the nest between 11 and 14 days post-hatching and are usually incapable of flight for several days, making them especially vulnerable to exposure and predation. Young birds generally stay high in dense foliage to safely develop their flying skills and independence. However, some young move low to the exhibit floor area where they are less well tended by shy parents and are at risk of being injured. Thus, the aviary floor and understory foliage should be checked twice daily when chicks are likely to leave the nest, and water features should be emptied to prevent drowning. Optimally, young debilitated birds should be transferred to a brooder to complete further rearing. At this stage, the young birds are easily conditioned to being fed insects, pellets, and fruits from the hand. Once flighted, the youngsters can be banded and reintroduced to the flock through the use of the dual-purpose, permanent food trap and introduction pen.

Banding Offspring: At approximately two months of age, white-eye fledglings should be banded with a combination of open metal and brightly colored plastic bands. Fledglings can easily be captured at the permanent food trap they learn to follow their parents to feed. It is important to use metal bands, as they are less likely to fall off birds' legs as the plastic ones. The brightly colored plastic bands are easily distinguished at a distance, but soften with age and fade in color with exposure to sunlight. The combination of band types provides the caretaker ease in identification and a means to permanently identify individual birds.

Management of Juveniles: Generally, parent birds will actively feed young white-eyes for about two weeks post-fledging. During this time the fledglings begin to flutter amongst lofty perches to develop their flight skills. Because parents appear reluctant to feed offspring on the ground, when necessary young should be placed a minimum of ten feet above the ground on a perch near a regular food station. If parents do not tend to it within one hour, the youngster should be removed, hand-reared, and reintroduced to the flock as previously described. Generally, however, siblings remain aloft and often perch very close together near their parents and the nest. Thus, it is recommended that young birds be maintained with their parents for a minimum of two months. Birds in the wild likely travel in family groups within flocks and this activity may be important to the social development of the young. At one or two months of age, young birds can be captured at the food trap and banded.

Health Management: Available health information specific to Bridled White-eyes is scant due to the short time the species has been maintained in North American collections. However, existing veterinary information on the health care of other small passerines is likely applicable to this species.

Mortalities have occurred during stressful events (e.g., during shipment to zoos and post-shipment quarantine). One bird was lost as a result of a disseminated bacterial infection (septicemia), while several others have died due to gastrointestinal yeast infections (ventricular candidiasis). Due to the latter condition, it may be prudent to prophylactically treat birds with an antifungal drug during predicted times of stress. Nystatin can be safely dosed to orally treat groups of birds in an aviary. Mortalities have also been associated with air sac mite infections (S. Wilson, personal communication). Affected birds do not necessarily exhibit respiratory cues and may simply be found dead. Treatment can be attempted with ivermectin but infections can be a challenge to eliminate.

Fecal examinations have revealed cestodes (tapeworms) and coccidia. Cestodes are not uncommon in insectivorous passerines and can be treated with praziquantel. Two different species of coccidia (both likely *Isospora* sp.) have been identified in Bridled White-eyes (E.C. Greiner, personal communication). Via blood smear analysis, a red blood cell parasite (*Haemoproteus zosterops*) has also been identified in wild-caught Bridled White-eyes (E.C. Greiner, personal communication). Infections are likely self-limiting and treatment is typically not necessary.

Bridled White-eyes have been safely anesthetized with inhalant isoflurane anesthesia. Blood can be obtained from the right jugular vein for DNA sexing or hematology (see Table 1 for some hematology data for *Zosterops* sp.). Given the small size of these birds, safe venipuncture requires careful blood volume calculation and good post-phlebotomy hemostasis. Adult male Bridled White-eyes at the Louisville Zoo have ranged in mass from 6.8 - 9.3 grams (mean = 7.9 gram), while adult females have ranged from 6.2 - 8.9 grams (mean = 7.7 gram).

Table 3. Hematology reference ranges for Japanese white-eyes (*Zosterops japonica*) and Oriental white-eyes (*Zosterops palpebrosa*) sampled at the Louisville Zoological Garden.

Test	Mean	Standard Deviation	Minimum	Maximum	N
Hematocrit (%)	49.84	+/- 5.186	37	59	25
White Blood Cell Count ($x10^3$/µl)	10.23	+/- 4.977	2.6	25.5	23
Heterophils ($x10^3$/µl)	2.656	+/- 3.349	0.315	14.79	23
Lymphocytes ($x10^3$/µl)	4.338	+/- 3.809	0.402	14.34	23
Monocytes ($x10^3$/µl)	0.635	+/- 1.084	0.0	4.973	23
Eosinophils ($x10^3$/µl)	0.103	+/- 0.206	0.0	0.765	23
Basophils ($x10^3$/µl)	2.495	+/- 1.319	0.089	4.802	23

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Appendix C. General Field Protocol for Capture and Collection of Birds

Compiled By: Peter Luscomb, General Curator, Honolulu Zoo, Honolulu, Hawaii.

Mist Nets and Trapping

The Bridled White-eye (*Zosterops conspicillatus*) will be captured and collected with both 30 mm and 38 mm mesh size mist nets. Nets will vary in length from six to 12 meters and will be supported either with poles or an overhead rope and pulley system. All nets used will be labeled with the name and permit number of the primary permit holder.

The primary objective of this project is to collect 100 Bridled White-eye on Saipan for translocation to Sarigan. As the species is commonly found in large flocks (Craig 1989, 1996) they could potentially be caught very quickly. Blood samples will be collected and sent to the Saint Louis Zoo, Saint Louis, Missouri, for DNA analysis and sexing. Although trapping efforts will first focus on white-eyes, the trapping team will collect other species necessary to the MAC Project's captive programs.

***Opening Nets* –** Nets will be opened only during day light hours and typically one hour after sunrise to give birds an opportunity to eat prior to capture. If feeding techniques develop to the extent that the target species reliably takes food while held in field holding cages, nets may be opened prior to sunrise. However, nets will be opened only when adequate staff is available to properly monitor them, and all nets will be closed at sunset. When open, an "open net indicator" (e.g., a red tag or clothes pin with the net number) will be placed on the net in a location closest to the trail that approaches it. At the end of the day as nets are closed for the evening, these indicator tags will be collected from each closed net and counted. This method serves as a means to assure that the status of all nets are accounted for by the field crew (i.e., that none are left open overnight).

***Closing Nets* –** At any time that a net cannot be properly monitored it will be closed. Nets will be monitored on a schedule insuring that any birds caught in them will not be adversely affected (e.g., extreme entanglement). As birds left in mist nets for long periods of time are susceptible to hypothermia, heat stress, respiratory stress (due to constriction), and predation, all nets will be checked at least every 30 minutes. If any nets are in direct sunlight (e.g., on a hot day), if it is raining, or if there are strong winds, they will be checked more frequently. When moisture is noticed on the nets they will be shaken and dried as much as possible. If rain begins, any nets that cannot be monitored continuously will be closed. Likewise, if wind levels exceed 10-15 mph the condition of netted birds will be closely monitored and nets closed if necessary.

***Net Sanitation* –** All nets will be sanitized prior to use in the field by soaking them for 10 minutes in a solution of 30 cc bleach per one gallon of water. Sanitized nets will then be rinsed in clear water and allowed to air dry. When a captured bird is found to have lesions (suspected to be pox) the area of the net in which it was caught will be sprayed with a disinfectant (quaternary ammonium), kept moist for 10 minutes, then rinsed with water and dried.

***Net Security* –** Nets will be closely monitored to ensure that none get into the hands of people unauthorized to have or use them. When trapping at locations in close proximity to human habitation all nets will be removed from the field at the end of daily operations to prevent their theft overnight. Net poles and lines, however, may be left in place to reduce morning set up time. An accurate count will be kept of nets in use and those that are collected when trapping activities are completed.

Trap Lines and Field Camp

Setting Trap-Lines – Nets will be placed in locations that intersect the target species' flight patterns, including areas they use in general movement from one location to another (i.e., a flyway or corridor) or to access some destination (i.e. a food resource or roost site). Multiple nets are typically organized into a "trap-line" with individual nets set up in a series that one person can easily manage. The time it takes a person to walk all nets being operated will not exceed 15 minutes.

As each net is set up it will be given a "number" consisting of two digits, beginning with a letter and ending with a number (e.g., net *A1*). The letter indicates the general field location of the net and the number represents the actual net. Over the course of daily trapping nets will be monitored to determine the overall effectiveness of their placement and location in regards to catching targeted species. During the period of field collection the crew will monitor the daily activities and concentrations of birds in and around the trapping area to determine locations that may be more conducive to efficient capture rates. Thus, if nets are not catching targeted species in acceptable numbers where originally placed they will be moved to locations that appear to be potentially more profitable.

Monitoring Trap-Lines – Trap-lines will be checked or ran every half hour. If two crewmembers are working a station only one trap-line will be set, but if three or more personnel are working two lines can be set. Crew leaders will always ensure that enough hands are available to run nets on a 30-minute basis and still be able to process and care for all birds collected.

Setting a Field Camp – Once an appropriate location for trapping has been found, a field or base camp will be set up in an adjacent area close enough to facilitate proper net monitoring. The camp will consist of an area for processing birds and another for holding those that are captured. To minimize the disturbance and stress to birds being held, the holding tent will be set up a slight distance away from that used for processing. Both areas will be covered with tarps in a manner that will provide protection from the elements.

Minimizing Impacts on Vegetation – Whenever nets and field camps are set up care will be taken to minimize the impact upon local vegetation. A minimal amount of vegetation will be cleared and whenever possible will instead be pulled back with ropes to create net lanes. When determining potential net placement sites, vegetation will be identified in proposed net lanes to determine if any endangered plant species might be impacted and lanes adjusted accordingly to minimize impacts to such species.

Bird Capture, Handling, and Holding

Removing Birds From Nets **–** Methods for extracting birds from mist nets will follow Ralph et al. (1993). All personnel involved in working nets and trapping birds will be aware of what species can potentially be encountered and the conservation status of each. Every time an active net is approached, crewmembers will first determine what is caught and then remove birds by a method of triage; endangered species first, target species second, endemic species third, and non-native species last. The order of extracting different bird groups from nets will vary depending upon trapping locale and species encountered. All measures will be taken to minimize the stress and potential harm to endangered and/or endemic species.

Handling – Birds will be removed from nets as soon as possible and placed into bird holding bags labeled with information pertaining to species, net number, and time of capture. To minimize stress to captured birds noise will be kept to a minimum, bird bags will be kept dry and out of direct sunlight, and excess movement of bags with occupants will be controlled. ***All measures will be taken to protect captured birds***. Upon return to base camp after a net-run, bird bags will be hung on a specified line under a suspended tarp for processing.

Processing – Handling and processing procedures will be planned for well before birds are captured with crew and all equipment at hand and ready. A time limit will be placed on all activities to ensure that birds are not stressed by over-exposure to handling. Upon removal from holding bags, birds will be banded and data will be collected pertaining to weight, wing cord length, tarsus, exposed culmen length, body fat, Body Condition Index (BCI), molt, and breeding status (presence of cloacal protuberance or brood patch; all measurements will follow Baldwin et al. [1931]). Once processing is complete and all data collected, captured birds will be placed into an appropriate holding cage prepared with food, water, and floor paper. The holding cages will be placed in an isolated area under a tarp and all disturbances to them kept to a minimum.

Field Holding Boxes – Each Bridled White-eye field holding box (Figure 1A and 1B) measures 45.7 cm wide × 35.6 cm deep × 20.3 cm high and is constructed of plywood that is 9 mm thick for two sides and 6 mm thick for the top and bottom. One of the 20.3 cm × 35.6 cm sides of the box is open and secured with 6 mm welded wire or hardware cloth and mosquito screen, and then covered by a cloth drape to provide the occupants with a sense of security (Figure 1A). The opposite side has a hinged door made of 9 mm plywood with a 10.2 cm high × 14.2 cm wide opening cut into its center (Figure 1B). This opening is covered with a ~30 cm long cloth tube that can be tied off and is used to place birds into the box. The inner roof of the box is covered with foam to prevent head injuries and a series of four perches are evenly spaced approximately 5 cm from the floor. Each box has a removable sub floor to aide in cleaning.

A sliding door with an opening of 7.6 cm × 10.2 cm is situated on one of the plywood side-walls of each holding box and is used to extract birds from within (Figure 1A). When removing birds from the box, a net is placed over the sliding door, which is then raised exposing the opening to the box's occupants. If the net is held a short distance away from the box, the birds within will typically fly out the door opening and into the net. However, if necessary, placing ones hand into the box via the cloth tube will generally be enough incentive to encourage any birds remaining within to exit through the side opening and into the net. This system greatly reduces stress on captive birds and minimizes their potential harm when trying to capture them from the box by hand. These same field holding cages will be used to transport Bridled white-eyes to Sarigan.

Figure 1A and 1B. Field holding box for Bridled White-eyes on Saipan (photos: Paul Radley).

Transport to Holding Facility – Birds will be transported in the field holding cages to the animal holding facility as often as possible, ideally at 10:00, 14:00, and 17:00 daily. The cages will be carried quietly and in a manner to minimize jostling of and disturbance to the occupants, and will be placed onto the back seat of the transport vehicle out of direct sunlight. Optimally, the transport vehicle will be air conditioned or at the very least well ventilated and will not be allowed to exceed 80 degrees F.

Animal Holding Facility – When new birds are brought to the animal holding facility, quarantine cages will be prepared with food, water, and paper placed on the floor of each. The new birds will then be moved into these cages and their band numbers recorded on the proper cage card. Once at the holding facility, all Bridled White-eyes will be blood sampled (following established zoo protocol) for the purpose of sex identification.

NOTE: The current Animal Holding Facility is comprised of an open, outdoor aviary. However, Nate Hawley, USFWS Brown Treesnake (BTS) Program Manager for the CNMI, offered the use of his indoor facilities on the DFW compound for holding and maintaining Bridled White-eyes pre-translocation in 2008. The BTS facilities are air conditioned and quieter than the current open aviary, which should provide an environment of lower stress for the captives. If AZA staff determines that these facilities meet their needs and are beneficial to translocation efforts in 2008, they will be used in place of the aviary.

Collecting Blood Samples – Exposing the underside of the wing and cleaning the skin around the brachial vein with a cotton ball or swab soaked in isopropyl alcohol will begin the process. Then the brachial vein will be pricked with a 25-gauge hypodermic needle (alternatively a toe nail may be clipped) and the bead of blood that wells up will be drawn into a heparinized microhematocrit tube. Once the blood sample (~25 microliters) has been collected, a moderate amount of pressure will be placed over the puncture site for at least 30 seconds (or until bleeding has otherwise stopped) using a clean cotton ball or swab. The blood in the microhematocrit tube will be blown into a flip-top tube pre-charged with 0.5 ml of a lysis buffer (only one microhematocrit tube sample of blood will be placed in each tube of buffer). The pre-charged tube will then be capped and shaken vigorously. This tube of buffered blood will be labeled with date, species, location, etc., in replication of the corresponding information recorded in the field log.

Quarantine Cages for Bridled White-eyes – Quarantine cages for Bridled White-eyes will be 91.4 cm wide × 70 cm deep × 50.8 cm high and constructed of 13 mm × 2.5 cm welded wire or hardware cloth. Cages will consist of two compartments, each with two perches and a curtain hung between them. If need be, the cages will be covered with cloth or burlap to provide more security for the occupants.

An alternative white-eye cage that may be used will measure 70 cm × 70 cm × 30.5 cm. Each compartment will measure 30.5 cm × 70 cm × 30.5 cm with the sides, top, and bottom reinforced with fiberglass with panels. The back and middle partition walls will be made of aluminum window screen framing covered with shade cloth and the front of the cage will be covered with 13 mm × 2.5 cm hardware cloth. Each compartment will have two perches, the front one low and the back one high. A curtain will be hung from the top of the cage and placed between the two perches to provide the occupants with an area of security.

Feeding Bridled White-eyes in Quarantine – Birds in quarantine will be provided some of or all of the following: water, *Nectar Plus*, papaya and orange slices, *Zupreem* cockatiel mix, *Pretty Bird Soft Bill Select* pellet foods, mixed greens, meal worms and waxworms.

Handling Birds in Quarantine – Each cage will be checked at least twice a day to ensure the health and welfare of all birds being held. The morning routine will consist of: removing all food and water containers; documenting food and water consumption (weight or volume); changing cage papers; documenting fecal output (# of droppings and % urates); cleaning all food and water containers in hot soapy water; disinfecting all containers by dipping in a 30 cc bleach/1 gal water solution for 10 minutes, rinsing them in clean water, and then allowing them to air dry; providing fresh food and water; and monitoring all birds to determine if they are feeding. The afternoon routine will consist of: rechecking all of the birds in the cages; providing additional food and water if necessary. Any birds that show signs of "Sick Bird Syndrome" will be placed in an isolated cage and a veterinarian will be notified.

Sick Bird Syndrome – This term refers to a constellation of signs that may indicate a wide range of avian health issues, including stress associated with handling or captivity, or other more serious medical problems. Symptoms can include a "fluffed" or "puffed" appearance, drooped wings, closed or partially closed eyelids, raised crown feathers, open-mouth breathing, and tail-bobbing motions during respiration. Since it will be assumed that all birds captured are healthy, the following protocol will be used whenever a bird develops signs of "Sick Bird Syndrome." If at any time a bird exhibits any of the described symptoms it will be placed into an isolation holding cage that is provisioned with food and water. The ailing bird will be monitored every 30 minutes and if signs of the "Syndrome" persist, or if the bird has not eaten within 2 hours of capture, release will be considered.

Health Management – All birds will be given a basic health review by the avian veterinarian and only those in good health will be retained for translocation. Those that are found to be in poor condition will be returned to the area of the net in which they were caught for release; no additional medical tests or treatments will be performed on these birds. Birds will continue to be monitored while in captivity and only those that do not show signs of ill health will be considered and prepared for translocation.

Field Crew Staffing

The field crew will consist of a crew leader, experienced field workers, and inexperienced field workers. At any time that nets are set up in the field someone will be designated as a crew leader at that site and will be responsible for all field activities and ensure that all protocol and permit conditions are being met. Experienced field workers are defined as persons who can work independently and have the following knowledge:

- All conditions of the permit being worked under.
- Awareness of all endangered/threatened species that can potentially be caught at each site.
- Principles of triage in removing birds from nets.
- Methods of safely extracting birds from nets.
- Methods of properly handling birds.

Crew Training

Inexperienced workers will work with those who are experienced in capturing and handling birds and will not be allowed to handle endangered or endemic species until they have sufficient experience. They will be allowed to extract common introduced species from nets under the supervision of someone with experience. All persons working nets will be properly trained (this will be verified by the primary permittee) before being allowed to extract birds from nets without supervision.

Work Assignments

All staff will be rotated between the assignments of transporter and field crew. Once trapping activities begin, birds that are in captivity will require daily care. The transporter will be responsible for driving the field crew to the field site in the morning, then proceeding to the bird holding facility to care for captive birds. Upon completion of this vital chore they will return to the field and assist with field activities. The field crew will be responsible for setting up and managing all trapping activities.

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Appendix D. Bridled White-eye Snail Consumption Study

Compiled by: Fred Amidon, Wildlife Biologist, USFWS, Honolulu, Hawaii, and Paul Radley, Ornithologist/Wildlife Biologist, CNMI DFW, Saipan, MP.

Peer review of an earlier draft of the Bridled White-eye Conservation Introduction Plan revealed concerns about possible impacts that an introduction of the species to Sarigan may have upon the island's snail populations. To assess this potential we developed the following experimental study, based upon study designs outlined by Avery et al. 2001, 2005; Cummings et al. 2002; Hile and Tordoff 2005; and Linz et al. 2006. The intent of this study is to determine if Bridled White-eye's will eat snails, specifically *Partula gibba,* which is a candidate for listing under the Endangered Species Act (ESA).

Study Design

This study will include two study groups, each consisting of five samples. One study group will include Bridled White-eye's maintained on a normal captive diet (e.g., papaya and other local fruit, meal and/or wax worms, etc.) before and after snail feeding trials. The second study group will include Bridled White-eyes subjected to a period of reduced food availability prior to the snail feeding trials to simulate a food stress scenario. Each sample will consist of two Bridled White-eyes placed together in a cage, and each sample in each study group will undergo snail feeding trails over four consecutive days.

During each feeding trial, a pair of white-eyes will be presented with two bowls of snails. Each bowl will be the same as that utilized for normal feeding and each will be placed in the same location within the cage as during normal feeding. One bowl will include four snails 1-4 mm long and the other bowl will include four snails 4-7mm long. Seven millimeters was selected as the largest snail size because the mean bill length of a Bridled White-eye is 10.4 mm (SE = 0.07; *n* = 36; USFWS, unpubl.data). Thus, it is expected that snails larger than 7 mm may be difficult for white-eyes to swallow.

The primary snail of concern is *Partula gibba*. However, the size classes available of this species vary depending on the time of year and breeding season (B. Smith, pers. comm. 2008). Therefore, to ensure that all potential size classes are available for the study, both *Succinea* and *Elasmius* spp. will be used as surrogates for small *Partula gibba*. All three of these species are arboreal, use similar habitats, and may be encountered by Bridled White-eyes during foraging. It is possible that Bridled White-eyes may prefer one snail species over another. To help account for this potential preference each size class bowl will include more than one species during a feeding trial, if possible. In addition, the size, species, and number of snails presented to white-eyes will be recorded before and after each trial to help assess if size and species are selected for during the trials.

Study Execution

Snail Collection – *Partula gibba*, *Succinea* sp. and *Elasmius* sp will be collected in the following size classes from Sarigan prior to the arrival of AZA biologists on Saipan to capture Bridled White-eyes for the purpose of translocation.

1. *1-4 mm Size Class* – Collect and maintain a total of 120 *Elasmius* and *Succinea* spp. in this size class (4 snails per trial day x 3 trial days x 10 bridled white-eye pairs = 120).
2. *4-7 mm Size Class* – Collect and maintain a total of 120 *Succinea* sp.and *Partula gibba* in this size class (4 snails per trial day x 3 trial days x 10 bridled white-eye pairs = 120).

Bird Collection – Collect and maintain 20 Bridled White-eyes (separate from those that will be translocated, pending the outcome of this experiment). Ideally, the sexes will be represented equally but sexing the birds prior to this study may not be feasible. Therefore, each bird will be individually marked, weighed, and measured, and randomly assigned to a test group so that equal numbers of larger and smaller birds will be allocated to each group. It is expected that the larger birds will likely be one sex while the smaller birds will be another sex. If the original sample of birds was collected randomly, then it is expected that this should result in close to equal sex ratios in each test group. Additionally, feather or blood samples will be collected for genetic sexing.

Test Subject Acclimation – White-eyes will be placed in pairs in holding cages and allowed to acclimate for four days. During this period, a normal captive diet and water will be provided regularly. In addition, the captive diet will be placed in two bowls in predefined locations within the cage.

Snail Feeding Trial Procedures – The procedures for conducting each feeding trail are outlined below by study group. (These procedures may be modified or augmented as deemed necessary during the course of the experiment.)

Study Group 1 – Regular Food Availability

1. Provide regular food and water until 7 am
2. At 7 am remove regular food and wait one hour
3. Identify, measure and place four snails in each size class in a feeding bowl. If possible, place two species in a given size class in a bowl.
4. At 8 am add a bowl of snails in each size class to the cage. The location of each bowl will be randomly selected among the two positions utilized for bowls containing regular food.
5. Wait and observe for three hours
6. Remove snails and return regular food
7. Record the species, size, and number of snails remaining in each bowl
8. Repeat steps 1 to 6 for four days

Study Group 2 – Reduced Food Availability

1. Provide regular food and water until 7 pm the day before the first day of the experiment
2. Remove regular food at 7 pm but maintain water
3. Identify, measure and place four snails in each size class in a feeding bowl. If possible, place two species in a given size class in a bowl.
4. At 10 am add a bowl of snails in each size class to the cage. The location of each bowl will be randomly selected among the two positions utilized for bowls containing regular food.
5. Wait and observe for three hours
6. Remove snails and return regular food
7. Record the species, size, and number of snails remaining in each bowl

8. Remove regular food at 7 pm but maintain water
9. Repeat steps 3 to 8 for four days

Data Analysis

A repeated measures Analysis of Variance (ANOVA) will be run to assess consumption of snails by both Bridled White-eye test groups over time.

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Appendix E. Post-Translocation Monitoring

Compiled by: Paul Radley, Ornithologist/Wildlife Biologist, CNMI DFW, Saipan, MP, and John Burt, Research Scientist, Psychology Department, University of Washington, Seattle, Washington.

Various sources cite the importance and value of post-release monitoring as an integral component of translocation based conservation management (e.g., Scott and Carpenter 1987, IUCN 1998, Sarrazin and Barbault 1996, Woodford and Rossiter 1996, Fisher and Lindenmayer 2000, Pierre 2003). Some also point out that monitoring of released individuals all too often does not occur, leading to the unknown status and fates (and causes thereof) of many translocated populations (Wolf et al. 1996, Woodford and Rossiter 1996, Fisher and Lindenmayer 2000, Pierre 2003). This lack of data and necessary documentation in turn leads to a poor understanding of variables affecting the success or failure of translocation efforts, providing no information upon which to base future decisions and methodological adjustments (Scott and Carpenter 1987, Woodford and Rossiter 1996, Clarke and Schedvin 1997).

All 50 Bridled White-eyes (*Zosterops conspicillatus*) released on Sarigan in 2008 will be marked with a red color band and up to 20 (40%) will be equipped with 0.35-gram 148 Mhz VHF radio transmitters (model LB-2N; Holohil Systems Ltd., Carp, Ontario, Canada), the mass of each equaling 4.6% of the species mean body mass (7.6 grams, range = 6.5 – 9.5 grams, n = 60; P. Luscomb, unpublished data) on Saipan. Transmitters will be super-glued to the interscapular region of birds (Figure 1) following Johnson et al. (1991) and will be deployed on only the healthiest, most robust individuals in an attempt to reduce potential mortality. To visually distinguish between individuals and to attempt to gage the potential of mortality to birds wearing transmitters, those that are radio-tagged will be marked with an additional blue color band.

Figure 1. Holohil LB-2N radio transmitter deployed on Bridled White-eye, Saipan, 2007 (photos: Greg Massey).

One transmitter was deployed on a Bridled White-eye of suitable mass on Saipan in early June 2007 to test the attachment technique and to gain insight of what an individual of the species may do upon release. The bird was released approximately 1 km from the location of its capture (where it was located the next day), then tracked on foot and “walked in on” (i.e., located by homing in) for eight days with no indication of any ill effects caused by the transmitter. Even when biologists were at the location of the transmitter signal, the bird's location could not be confirmed visually because of thick foliage but was determined to be in good health by extensive motion and oscillation of the signal. The transmitter emitted a strong signal for 17 days, five days over that which Holohil Systems Ltd. states as the expected for the model LB-2N (mean = 12 days, range 8-15 days; http://www.holohil.com).

Tracking of tagged birds on Sarigan will be undertaken by several means. All on-foot, ground based telemetry will be accomplished with handheld R-1000 telemetry receivers (Communications Specialists Inc., Orange, California) and soft, RA-14K "Rubber Ducky" H-antennas (Telonics Inc., Mesa, Arizona). In development is a proposed Aerial Locator System involving an unmanned aerial vehicle (UAV) in the form of an autopilot-controlled, electric powered sailplane equipped with the necessary telemetry and directional equipment (collaborator: John Burt, University of Washington, Seattle, Washington. Refer to *Aerial Locator System*, below).

Radio-tagged birds will be followed with the UAV to estimate habitat used by the translocated population, their movement patterns, and any potential mortalities. Radio signals from individuals that strongly indicated mortality (a constant, apparently unmoving signal) will be "walked in on" and investigated for possible salvage, terrain permitting. When possible, attempts will be made to re-sight color banded individuals. For all individuals or flocks located visually, the UTM coordinates will be collected with GPS. The number of individuals in each of these flocks will be recorded along with the habitat they are located in. In areas of terrain too difficult or dangerous to access on foot, transmitters will be located by triangulation from permanent telemetry receiver sites to augment (if necessary) the locational information acquired by the UAV.

As Bridled White-eyes are a strongly gregarious and flocking species, we feel that radio-tagging 20% of the release population will serve as a good sample of the activities of the majority of the entire population released on Sarigan. At approximately six months post-translocation (December 2008), another monitoring attempt will be made (dependent upon funding) to re-sight color banded birds, search for evidence of possible breeding, and assess the overall population with standardized surveys (e.g., Variable Circular Plot or VCP [Engbring et al. 1986], mark-recapture and color band re-sighting, etc). In combination with a suitable transect survey, mist-netting efforts may be attempted to gather information on overall physical condition of translocated Bridled White-eyes, along with potential survival and recruitment data. However, the feasibility of using mist nets (whether pole mounted or aerial) will be dependent upon island topography and the field crew's ability to traverse it.

A translocation follow-up survey will also be conducted in approximately February 2009 to search for signs of Bridled White-eye breeding activity on Sarigan. In May 2009, one-year post-release monitoring will be conducted to determine and confirm the status of white-eye breeding on the island. The timing and duration of these follow-up visits in 2009 will be primarily dependent upon weather and funding.

Aerial Locator System

The greatest challenge of monitoring radio-tagged Bridled White-eyes on Sarigan post-release will be locating them daily over the uninhabited, roadless island's rugged, volcanic terrain. For this purpose, an autonomous aerial tracking platform (in the form of a UAV) will be deployed that will facilitate the rapid and effective location of all radio-tagged birds.

The aerial locator system consists of an electric powered, autopilot-controlled sailplane equipped with a Radio Direction Finding (RDF) system. The RDF system determines the compass direction (relative to the location of the plane) of every radio transmitter pulse that it receives. Transmitter direction angles and plane position are sent via radio modem to the ground station, where a PC laptop will use these data to calculate the tagged bird locations and display them on a map.

The powered sailplane (Cularis model, Multiplex Modelsports USA, Poway, California) that will serve as the tracking platform will be fitted with an efficient and powerful electric motor and high capacity batteries. This high performance model is capable of staying aloft for more than ½ hour, and should be operable in winds up to 20 mph. It is also very rugged, relatively inexpensive, and all parts of the plane are pre-made and replaceable. A second complete flight-ready *Cularis* and a set of replacement parts will be on hand at all times while tracking on Sarigan in case of damage to or loss of the original.

The aircraft's autopilot system (model MP1028; Micropilot, Stony Mountain, Manitoba, Canada), with onboard inertial sensors and GPS, can be programmed on the ground to fly missions with multiple waypoints, communicate with the ground station, and can be commanded (via the radio modem) to abort the mission and return the launch point. The onboard RDF payload includes a scanning VHF FM radio receiver (model R302-2; Hamtronics, Inc., Hilton, Ney York), four custom built antennas, a modified *Doppler* direction finder (Picodopp; Santa Barbara Automation, Santa Barbara, California), and a radio modem (model 9Xtend; Maxstream, Inc., Lindon, Utah).

While aloft, the scanning frequency of the radio receiver can be programmed via the ground station. This function enables the operator to manually set an individual transmitter frequency, sample enough bearings to locate it, then switch to and locate another active transmitter frequency. The plane will be programmed to fly several transits of the island to locate as many of the transmitters as possible before returning to the base station for a freshly charged battery.

The base station will employ an omnidirectional antenna attached to a boom, a radio modem to receive the aerial RDF data and transmit commands to the tracking platform, and a PC laptop running software that calculates transmitter locations and plots them on a map display.

A typical aerial locator mission will involve launching the sailplane via manual radio-control, switching it to autopilot, and then monitoring the aircraft as it flies a fixed course that circumnavigates the island to locate the radio-tagged Bridled White-eyes. At the end of each mission (which will either occur when all transmitters are located or the motor batteries have run down) the sailplane will be commanded to the launch point, the autopilot switched off upon arrival, and landed manually with radio-control.

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Appendix F. Bridled White-eye Population Modeling

Compiled by: Fred Amidon, Wildlife Biologist, USFWS, Honolulu, Hawaii

The primary objective of the MAC Project's first conservation introduction is to establish a viable population of Bridled White-eyes on the Northern Mariana island of Sarigan. During the peer review of the draft of this plan we received suggestions that population modeling be incorporated into the planning and monitoring aspects of the translocation plan. At this time, the vital rates information needed to develop a population model specific to the Bridled White-eye are unavailable. Although Sachtleben (2005) did estimate nesting success (19% using the Mayfield method) on Saipan, the number of fledglings that survived to become adults, along with annual adult survival, is unknown. Therefore, we reviewed available literature to obtain vital rates information for other *Zosterops* spp. (specifically the Silvereye [*Zosterops lateralis*] and the Japanese White-eye [*Zosterops japonicas*]) to support model development.

The Bridled White-eye is believed to breed year-round with distinct peaks in breeding during different times of the year. Sachtleben (2005) recorded nesting from February to June with a distinct peak in nesting in February/March on Saipan. Craig (1996) recorded breeding in January, February, August, and October, and recorded food begging by juveniles year-round. Clutch sizes range from one to three eggs, while egg laying ranged from two to three days and incubation from nine to 12 days (Yamashina 1932, Sachtleben 2005). Fledging occurs 11 to 14 days after hatching (Sachtleben 2005) but the post-fledging parental care period is unknown. Kikkawa and Wilson (1983) reported approximately a two week period for the Silvereye and Guest (1973) reported a 15-20 day period for the Japanese White-eye. The number of times the Bridled White-eye can successfully breed in a year is also unknown. However, Kikkawa and Wilson (1983) reported that 49% (n=48), 41% (n=40), and 9% (n=9) of Silvereye pairs produced one, two, and three clutches, respectively. Guest (1973) also reported that Japanese White-eye pairs can fledge up to three broods a year but that two broods were more common. The number of fledglings produced per pair of Silvereyes a year also averaged 2.9 (Kikkawa and Wilson 1983).

While the age at first breeding in the Bridled White-eye is unknown, as is first year and adult survival, the Silvereye and Japanese White-eye both begin breeding after one year (Guest 1973, Kikkawa and Wilson 1983). Kikkawa and Wilson (1983) reported that average juvenile survival was 47% (range: 41-54%) for the Silvereye, and Brook and Kikkawa (1998) reported an annual adult survival of 61% for this species.

The Population Model

The translocation of 50 Bridled White-eyes will occur in May 2008 and subsequent monitoring is expected at yearly intervals. Based on available data, a peak in white-eye breeding cycle may occur prior to the expected post-release monitoring period (May or late in the dry season). Therefore, we developed a post-breeding population model for the female population of Bridled White-eyes on Sarigan.

Based on available literature for other *Zosterops* species we assumed that Bridled White-eyes can produce at least two broods a year, with one likely occurring in the dry season and one in the wet season. Due to the opportunity for multiple nesting attempts throughout the year we decided not to use nesting success estimates in the model. Instead we used estimates based upon number of fledglings per female per year. We also assumed that Bridled White-eyes bred after the first year, that juvenile survival was lower than adult survival, and that adult survival was similar between years. Finally, we also assumed that 50% (25) of the 50 released birds were females (this will be updated after information on the sex of each bird released is obtained) and that 50% of the offspring were female. Because the population is being established by translocated individuals we could also incorporate post-release survival. However, to keep the model as simple as possible we did not include post-release survival in this initial model (this variable can be incorporated at a later time). We also did not include environmental or demographic stochasticity because such information is not available. We did assume that density dependence was not a factor for the time frame being considered for population monitoring (10 years) and thus did not include it in this model. The basic population model is outlined as follows.

$$\text{Female Population}_{t+1} = A_{t+1} + J_{t+1}$$

$$A_{t+1} = (A_t)(a) + (J_t)(j)$$
$$J_{t+1} = (A_{t+1})(b)$$

A = Number of Adult Females
J = Number of Juvenile Females
a = Annual Adult Survival Rate
j = Annual Juvenile Survival Rate
b = Number of Female Fledglings Produced Per Female

The model was created in *Microsoft Excel*. Initially we used adult survival (61%, Brook and Kikkawa 1998), juvenile survival (47%, Kikkawa and Wilson 1983), and breeding success (3.1 fledglings per pair, Kikkawa and Wilson 1983) for the Silvereye to develop and test the model. We then incrementally modified each of the vital rates to determine which had the most impact on the population growth rate. We also identified a 10-year population goal (100 females) for the Sarigan population model to determine the vital rates necessary to achieve this population goal. We identified these optimal vital rates by using *Excel's Solver* Add-in. We also ran a series of iterations of the model to explore the effects of varying breeding success, juvenile survival, and adult survival while keeping the same 10-yr population goal.

Results and Conclusions

An initial run of the model using the vital rates data from the Silvereye showed a steadily increasing population over the 30-yr period projected (Figure 1). The population growth rate was estimated to be 1.03 and projected population of females for the first 10, 20, and 30 years was 45, 59, and 79 females respectively. Though only a small increase in population, we can expect that if Bridled White-eyes on Sarigan show similar vital rates to the Silvereye the population on the island is expected to increase.

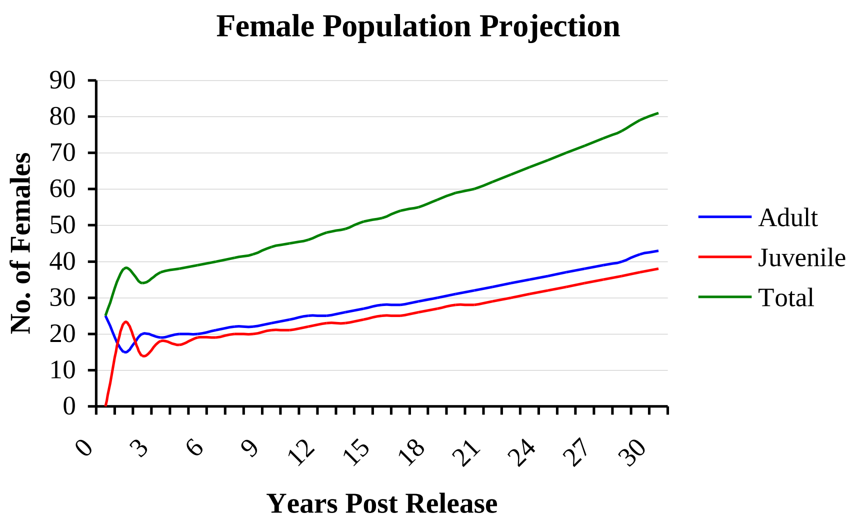

Figure 1. Model projection of female Bridled White-eye population on Sarigan using vital rates information from the Silvereye.

Next, we made incremental changes in each vital rate to determine what effect it would have on the population growth rate (Figure 2). As the high average slope for population growth rate versus adult indicates (Figure 2), a change in this vital rate will have a much greater effect on the population growth rate. The rate for juvenile survival had the second highest sensitivity while breeding success had the least sensitivity. Therefore increasing adult survival has the greatest impact on the growth and long-term sustainability of the population.

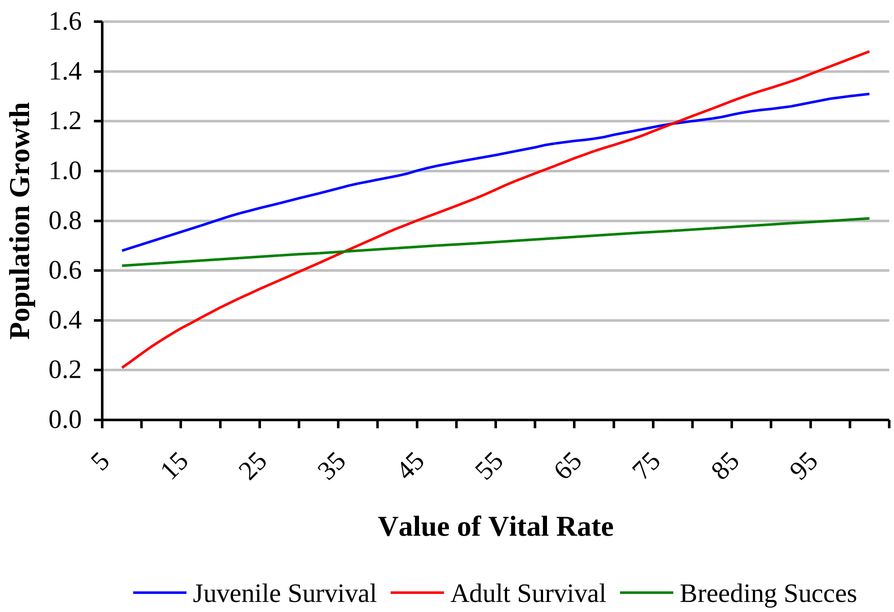

Figure 2. The effects of changing vital rates on population growth for the Bridled White-eye using vital rates information from the Silvereye.

When we set the population goal to 100 females in 10 years the optimal vital rates were estimated to be 3 fledglings per female, 50% juvenile survival, and 67% adult survival. The population growth rate was also estimated to be 1.11 and the 20 and 30 year female population projections were estimated to be 295 and 870, respectively (Figure 3). The juvenile and adult survival values are all slightly higher than the estimates we used from the Silvereye but certainly within the range of other tropical and island species (Table 1; Johnston et al. 1997, Morton and Stutchbury 2000, Simon et al. 2001, Norris and McCulloch 2003, Armstrong et al. 2005, Dimond and Armstrong 2007). Therefore, obtaining similar survival rates for the Bridled White-eye appears achievable though we will have to determine if predator management is needed to help achieve similar rates on Sarigan. The estimated number of fledglings per female was actually higher than many of the estimates for other species (Table 1). However, the estimates we obtained from other species were primarily from species of conservation concern. Therefore, these reported estimates of reproductive success may be lower than expected for species that are not conservation concern. In any case, it is clear that a high reproductive success for Bridled White-eyes is needed if juvenile and adult survival is found to be low.

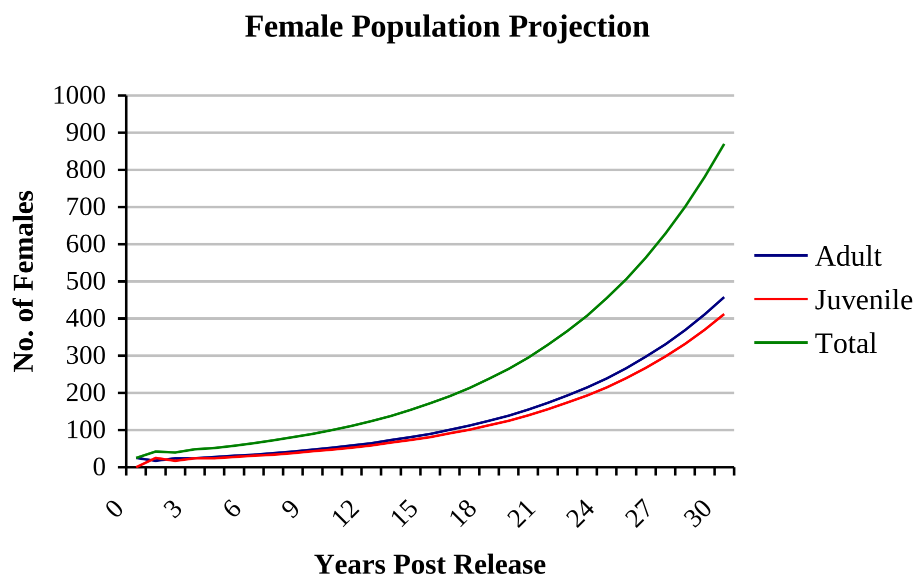

Figure 3. Model projection of female Bridled White-eye population on Sarigan using optimized vital rates for achieving a 10-yr population goal of 100 females.

Population Model and Monitoring

The first year monitoring is expected to provide two important pieces of information for use in a population model. First, annual survival of the birds released in May 2008 can be calculated. Second, we can obtain an estimate of recruitment into the adult population if we can determine the number of un-banded individuals in the population. This information can then be entered into a second iteration of the model to forecast the population trajectory and help identify if additional management is needed.

Table 1. Demographic information for tropical and island birds.

Species	Adult Survival	Juvenile Survival	Fledgling Per Female	Citation
Saddleback (*Philesturnus rufusater*)	0.88 (male) 0.90 (female)	0.63	2.6	Armstrong et al. 2005
Seychelles Magpie Robin (*Copsychus sechellarum*)	0.92	0.40–0.72	1.4	Norris and McCulloch 2003
New Zealand Robin (*Petroica longipes*)	0.80	-	2.3	Dimond and Armstrong 2007
Akohekohe (*Palmeria dolei*)	0.95	-	1.4	Simon et al. 2001
Dusky Antbird (*Cercomacra tyrannina*)	0.82	-	-	Morton and Stutchbury 2000
White-flanked Antwren (*Myrmotherula axillaries*)	0.85	-	-	Johnston et al. 1997
Bananaquit (*Coereba flaveola*)	0.65	-	-	Johnston et al. 1997

The second year and all subsequent monitoring will primarily focus on obtaining adult survival estimates as assessing recruitment into the adult population will be more difficult as the population grows. At this time little is known about molt patterns and development of the Bridled White-eye to help age captured birds. Therefore, identifying juveniles from adults will be challenging unless they were recently fledged. This will make it difficult to obtain timely estimates of juvenile survival for population modeling as sample sizes may be low until effective measures of aging birds are developed. Also, as the species can breed year-round, it will be difficult to assess breeding success as the logistics of year-round monitoring on Sarigan make this unlikely. However, as noted above, population growth is most sensitive to changes in adult survival. Therefore, by monitoring annual adult survival we can identify if subsequent management is needed to increase this important vital rate. Also, by estimating the Bridled White-eye population annually and monitoring adult survival we can infer recruitment rates and thus assess if management is needed and, when implemented, if it is effective.

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