MARIANA AVIFAUNA CONSERVATION (MAC) PROJECT

Post-2008 Translocation Monitoring, a Second Translocation of Bridled White-eyes (*Zosterops conspicillatus*), and On-Site Flight Test of a Prototype Aerial Locator System, Sarigan, 23 March – 13 May 2009

Project Report Number 2

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2009 MAC WORKING GROUP PARTICIPANTS AND ASSOCIATES

This second conservation introduction was a joint effort between the Commonwealth of the Northern Mariana Islands' Division of Fish and Wildlife (CNMI DFW), the U.S. Fish and Wildlife Service (USFWS), the Association of Zoos and Aquariums (AZA), and the U.C. Davis Wildlife Heath Center. The team of researchers that were actively involved as part of the MAC Working Group in 2009 includes:

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A SECOND TRANSLOCATION OF BRIDLED WHITE-EYES TO SARIGAN

CONTENTS

A SECOND TRANSLOCATION OF BRIDLED WHITE-EYES ON SARIGAN

INTRODUCTION

In May 2008, biologists with the MAC Project introduced 50 Bridled White-eyes (*Zosterops conspicillatus*) to the island of Sarigan, CNMI (MAC Working Group 2008, Radley 2008). This translocation served as a pilot effort to develop and refine the techniques necessary for future Conservation Introductions of threatened or endangered avian species within the Mariana archipelago.

The results of this first translocation were to determine the fate of the tentative translocation of another 50 Bridled White-eyes to Sarigan in 2009, meant to augment the founding population. Biologists returned to the island in March 2009 to assess the results of the previous year's translocation and found indisputable evidence of breeding. Thus, 2008's Conservation Introduction of Bridled White-eyes to Sarigan was determined a success and a second translocation scheduled for early May 2009.

While the 2008 translocation was a relatively smooth undertaking (Radley 2008), the 2009 endeavor proved quite the opposite. Typhoon Kujira brought rain and poor visibility to the Northern Mariana Islands, delaying 2009 translocation activities by roughly two days. However, on the afternoon 6 May 50 Bridled White-eyes were released on Sarigan, some on which were resighted during the following seven days (7-13 May) of post-release monitoring.

METHODS AND RESULTS

Study Site

The uninhabited island of Sarigan is an extinct strato-volcano with no recorded history of activity that lies 95 nautical miles north of Saipan (Fig. 1). At approximately 500 ha (5 km^2) in area and 549 meters at its highest elevation, most of the island's shoreline is irregular with steep, rugged, and eroded cliffs created by old lava flows and landslides (Berger et al. 2005). At an elevation of between 100-106 meters lies a plateau to the north and east of the peak that constitutes the island's highest point; on this plateau are situated Sarigan's "upper camp" and the release site (both at 16° 42' N, 145° 47' E; Fig. 2; Radley 2008).

As much as 45% (223 ha) of Sarigan is covered by forest, the remainder consisting of either grass or areas of barren rock. A CNMI Division of Fish and Wildlife (DFW) survey of the island in 2006 indicated that forest cover consisted of approximately 75-90 ha of native forest (34%-40% of total forest cover; Fig. 2) and 133 ha of old coconut plantation or agricultural forest (60% of total forest cover; Martin et al. 2008). Both the upper camp and the release site are located at an interface between grass and barren rock and primarily native forest.

Post-2008 Translocation Follow-up Visit; 23-24 March

On the morning of 23 March 2009, biologists with DFW and USFWS (Paul Radley and Fred Amidon, respectively) departed Saipan by helicopter to assess the status and fate of 50 Bridled White-eyes translocated to Sarigan in May 2008. The biologists arrived on island at approximately 11:30 and by shortly after noon began searching for signs of the founder white-

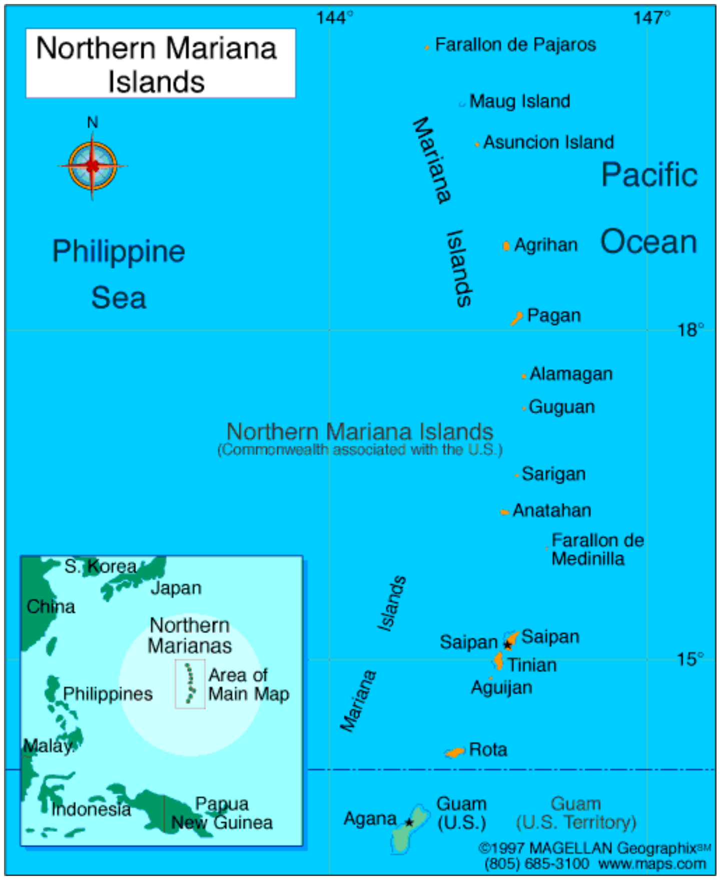

Figure 1. The Northern Mariana Islands (taken from http://www.infoplease.com).

eye population. Weather on Sarigan was overcast and rainy resulting in conditions of poor lighting and visibility.

At 12:20 the first bird was observed in native forest just under 100 meters northwest of the upper camp. The individual was color-banded blue and red, indicating that it had been radio-tagged when released on Sarigan in 2008; it was accompanied by at least three unbanded white-eyes and up to 10 others were heard. After further surveying in the vicinity a red color banded white-eye was observed along with as many as six to 10 unbanded individuals. In all, a few small, active, vocal flocks of perhaps four to 10 white-eyes were encountered, all of which remained mostly in the upper canopy. Poor lighting and dense forest cover prevented good visuals, leading to most detections being counted by ear. Shortly after the first detections of banded and unbanded birds on Sarigan, a recently used Bridled White-eye nest (Fig. 3) was located in native forest approximately 135 meters west/northwest of upper camp. The nest, located 10 feet from the ground in *Aglaia mariannensis*, was taken down for closer inspection and photo documentation (Fig. 3).

Having quickly accomplished their goal, and because weather conditions continued to deteriorate, the biologists returned to Saipan mid-morning the next day (24 March). Given the fact that breeding by the founder population of Bridled White-eyes had obviously occurred on

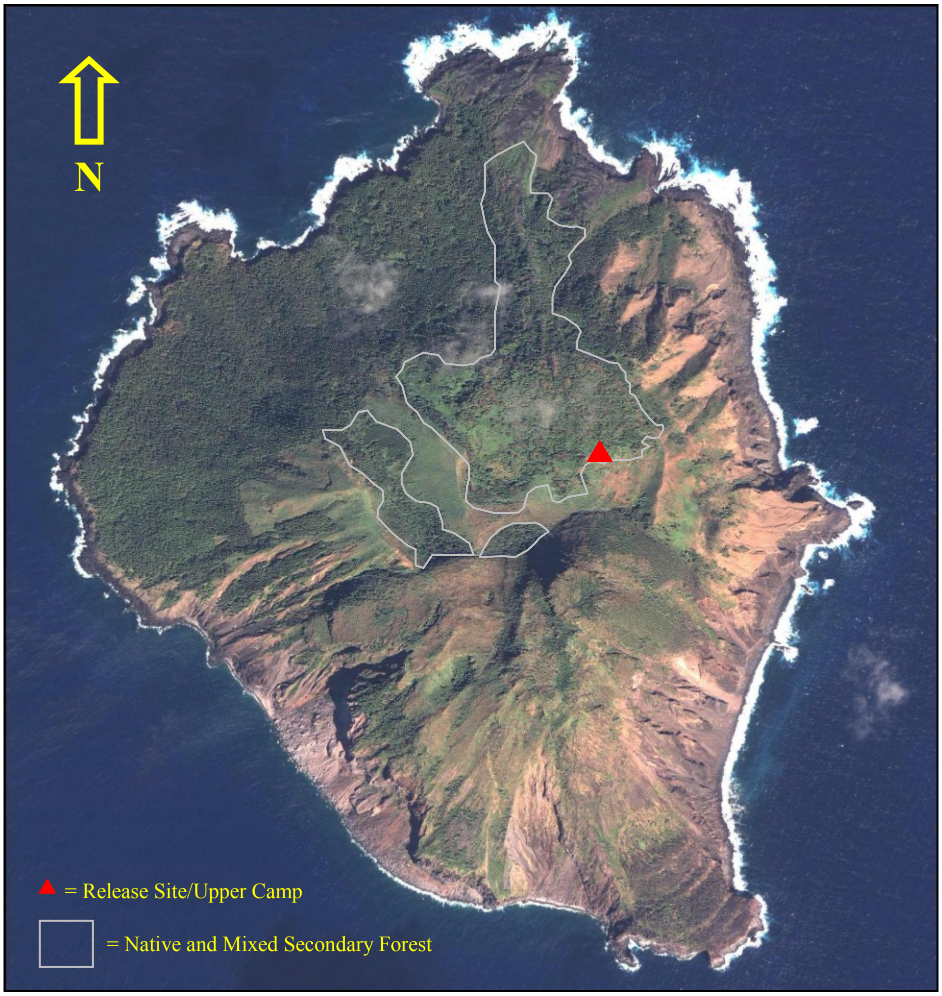

Figure 2. The location of native and mixed secondary forest, the 2009 release site and upper camp on Sarigan, CNMI.

Sarigan, the MAC Working Group determined the 2008 translocation a success; at least in the short-term. The working group decided to commence with the second translocation of Bridled White-eyes to Sarigan in May.

Pre-Translocation 2009

To meet the 2009 goal of the MAC Project's captive breeding program, AZA staff were on the island of Tinian (the next island south of Saipan; Fig. 1) between 18 April and 4 May to capture Tinian Monarchs (*Monarcha takatsukasae*) and Rufous Fantails (*Rhipidura rufifrons*); thus, Bridled White-eyes translocated in 2009 were likewise captured on this island. Between 23 and 25 April, 63 white-eyes were captured on Navy leased land just to the east (at approximately 15° 3' N, 145° 38' E) of Tinian's American Memorial/Hinode Shrine, a location suggested by Navy biologist Scott Vogt (pers. comm., Herb Roberts, MAC Working Group). All birds were weighed at capture (mean = 8.0 grams; range = 7.1 – 9.4 grams; *n* = 63), marked with numbered aluminum leg bands, and assessed for health issues.

Figure 3. Recently used Bridled White-eye nest on Sarigan, CNMI, 23 March 2009.

To reduce stress upon captive Bridled White-eyes, a new, smaller holding container was devised by P. Luscomb (Honolulu Zoo, Honolulu, Hawaii) for 2009 that held fewer birds at one time (for more details refer to Appendix A). White-eyes were maintained on a mix of fresh fruit (banana and papaya), *ZuPreem* (Shawnee, Kansas) Avian Maintenance Fruit Blend parakeet pellets, and liquid nectar (*Nektar-Plus*; *Nekton*, Pforzheim, Germany). Birds held for translocation had blood drawn for the purpose of sexing. As Greg Massey (Avian Wildlife Veterinarian, Wildlife Health Center, UC Davis, California) lacked the necessary personnel, pathogen screening could not be conducted in 2009. Because all samples tested in 2008 had proved negative for the presence of blood parasites (Radley 2008), foregoing the screening white-eyes in 2009 was deemed passable by the MAC Working Group. Blood samples collected for sexing were sent to both the molecular lab of the veterinary hospital at the St. Louis Zoo, and *Avian Biotech International* (Tallahassee, Florida) for analysis. Compared to the sex ratio of white-eyes introduced in 2008 (1:1.5; 20 females/29 males; Radley 2008), 2009's translocation was heavily skewed towards males; 16 females vs. 34 males for a ratio of 1:2.1. (These figures were used to revise the population model originally presented in MAC Working Group [2008]; refer to Appendix B for details).

Preparation for Translocation

As originally planned, white-eyes were to be translocated directly from Tinian to Sarigan on 4 May. Mirroring 2008, the white-eyes, accompanied by an AZA affiliated Wildlife Veterinarian, would be flown to the island via helicopter in early morning. The aircraft would be met by two DFW biologists (P. Radley and Rachel Rounds) and researcher John Burt (University of

Washington; see "*On-Site Flight Testing of UAV*" below) who were to arrive the previous day (3 May) to prep the release site and set field camp for post-release monitoring activities (both at the same locations as 2008; Radley 2008). Translocatees would be given plenty of time to recover from the flight and acclimate prior to release. However, unseasonably inclement weather bringing low overcast and heavy rains to the Northern Mariana Islands prevented helicopter travel, delayed translocation, and required that plans be revised.

Of 63 Bridled White-eyes captured and maintained on Tinian, 11 were released while tentatively being prepped for translocation on 3 May because of excessive weight loss (more than 20% since date of capture), leaving 52 birds for translocation. In addition to an aluminum leg band, these individuals were marked on the opposite leg with a yellow color-band to distinguish them from white-eyes translocated in 2008 (Radley 2008). As birds were being prepped, AZA staff was notified that conditions would very likely not allow a flight the next morning. Given the circumstances, it was decided to divvy accordingly the 52 remaining birds amongst the six transport boxes (which, aside from minor modifications, were essentially identical to those used in 2008) following 2008 protocol, with birds to be radio-tagged kept separate from the others (MAC Working Group 2008, Radley 2008). No birds were radio-tagged on 3 May; instead, transmitters would be activated and attached early the next morning if weather permitted the translocation to take place.

The most important factor was the successful release of Bridled White-eyes on Sarigan. Thus, at the first window of opportunity prior to his departure from the CNMI, Wildlife Veterinarian (WV) G. Massey would fly to the island with the white-eyes and hard release them. The DFW biologists would arrive as soon as possible thereafter to carry out post-release monitoring work.

Early the morning of 4 May it was obvious that poor weather conditions would preclude the day's scheduled translocation activities. As the long term forecast likewise looked untenable, AZA personnel determined the white-eyes should be transported to Saipan via the local carrier (*Freedom Air*) to await translocation from there. As all remaining AZA crew were scheduled to depart the CNMI no later than early morning of 6 May (approximately 04:00 local time), it was necessary to cease activities on Tinian, pack up all equipment and ship it to Saipan for storage.

With translocation cancelled for the day, AZA staff arrived at the Tinian airport by 06:30 intent on making the first flight to Saipan at 07:00. By approximately 09:30 the Bridled White-eyes destined for Sarigan made the 10 minute, inter-island flight. The WV and white-eyes were met at the terminal by P. Radley and transported to the DFW compound where the birds were housed in the air conditioned Brown Treesnake (BTS) lab facilities. The birds were maintained at the BTS facilities until eventual translocation on the afternoon of 6 May.

On the morning of 5 May a number of white-eyes were apparently not faring well in the six transport boxes; with eight to nine birds per box, increased competition deterred many from getting the food they needed. However, the alternate holding containers (Appendix A) were on Tinian awaiting sea transport to Saipan early the next morning. To remedy the situation, P. Radley flew to Tinian via helicopter to retrieve enough holding containers for 52 Bridled White-eyes. By mid-afternoon on 5 May, all birds were comfortably settled in these containers and eating well. While moving birds from transport boxes to the alternate holding containers they were weighed and assessed for overall health; as a result, two more birds were released (on Saipan) because of excessive weight loss, leaving 50 for translocation to Sarigan.

Shortly after the remaining AZA staff departed Saipan early the morning of 6 May the weather broke and translocation was on. However, now that AZA staff was gone, all prep activities (including feeding, transferring birds to transport boxes, etc.) were left to DFW biologists P. Radley and R. Rounds, who lacked some of the necessary equipment, training, and expertise. Likewise, the two biologists, assisted by J. Burt, would need to attach radio transmitters and transport the Bridled White-eyes to the *Americopters* heliport for translocation. At this point, the MAC Working Group decided that the birds would be hard released on Sarigan by P. Radley, whom would return to Saipan immediately afterwards. Both DFW biologists and J. Burt would then travel to the island to commence post-release monitoring activities on 7 May, weather permitting.

Radio Transmitter Attachment

Following 2008 protocol, the intent in 2009 was to radio-tag up to 20 of the Bridled White-eyes destined for Sarigan (Radley 2008). To increase the likelihood of tagging more birds than the previous year (n = 14; Radley 2008), lighter weight radio transmitters were purchased in early 2009 from *Blackburn Transmitters* (Nacogdoches, TX). Known for making the smallest VHF radio transmitters on the market, the units purchased from *Blackburn* weighed 0.3 grams; 0.06 grams lighter than those produced by *Holohil Systems Ltd.* (Carp, Ontario, Canada) used in 2008 (Radley 2008). (*Blackburn* produces a transmitter weighing a mere 0.25 grams, but battery life is estimated at far too low for the MAC Project's needs). In total, 15 new 151 Mhz VHF units were purchased from Blackburn to add to five unused 148 Mhz *Holohil* units remaining from the 2008 translocation.

Bridled White-eyes to be radio-tagged were selected on 3 May by AZA staff as they prepped birds for the tentative translocation. Based upon the preparation for the 2008 translocation, 7.0 grams was set as the minimum acceptable weight for choosing candidates for radio-tagging in 2009 (Radley 2008); this left 21 of the 52 white-eyes considered suitable for transmitter attachment (mean = 7.2 grams; range = 7.0–8.0 grams). From these 21 birds, 14 were chosen as the most robust based upon a combination of two criteria: 1) the percentage of weight loss since capture; and 2) whether birds had continued to lose weight after capture or if weights stabilized or even showed an increase (capture weights were subsequently taken on 3 and 5 May). To later identify white-eyes that had been radio-tagged in 2009, AZA staff added a green color-band to their already yellow-banded leg. The release of two birds on 5 May as a result of excessive weight loss (bringing the total to be translocated to 50) did not affect the 14 chosen for radio-tagging.

After all non-radio-tagged white-eyes were transferred to transport boxes and fed, P. Radley and R. Rounds attached the radio transmitters that J. Burt had activated and tested while birds were being prepped. Radio transmitters were adhered with *Krazy-Glue* (Columbus, Ohio) to trimmed feathers of the inter-scapular regions of the 14 individuals following Johnson et al. (1991; also refer to MAC Working Group 2008 and Radley 2008). Glued radio-tagged were allowed to set for several minutes before birds were placed into transport boxes.

Translocation

Transport and Release on Sarigan

At approximately 13:10 on 6 May, P. Radley and R. Rounds arrived at the *Americopters* heliport on Saipan with the six transport boxes containing 50 Bridled White-eyes for translocation to Sarigan. As the aircraft was already prepped for flight, the boxes were placed in the back seat (with cushion removed) of the Bell 206 *JetRanger* helicopter and secured with bungee cords and cargo netting by the flight crew. At approximately 13:25, the helicopter departed with the birds and P. Radley for Sarigan.

At 14:30 the helicopter landed at its destination and was powered down; weather conditions were low broken overcast and quite breezy. After the aircraft was shut down, the transport boxes were removed and gently placed on the ground at the edge of the landing zone. As weather conditions were unpredictable for helicopter flight, the birds were allowed only a brief time to calm and acclimate before release. Between 14:40 and 14:45 the transport boxes were opened and the white-eyes carefully flushed out; most birds flew off rapidly and strong, but four fluttered and scurried into the surrounding brush and dense vine cover. As these four individuals would likely not survive the flight, and there would be no MAC project veterinary assistance upon their arrival, it was decided not to recapture them for return to Saipan.

After all the white-eyes were released the transport boxes were re-secured in the back seat of the helicopter for return to Saipan; the aircraft arrived at the *Americopters* heliport at approximately 16:05. Upon arrival back at the DFW compound, P. Radley closely inspected the transport boxes that had held the radio-tagged white-eyes and removed transmitters that had been dropped by/pulled off the birds in transit to Sarigan; all but one of the 14 deployed units were collected. The mass of trimmed feathers still tightly glued to each transmitter indicated that the units had been well secured to the birds and that a certain force was likely necessary to dislodge them. However, no other marks gave evidence to what may have pulled the transmitters from the white-eyes.

Post-Translocation Monitoring

The following morning (7 May), P. Radley and R. Rounds returned to *Americopters* heliport at 06:30 to depart for nearly a week of post-release monitoring on Sarigan. Not only was the intent to monitor the Bridled White-eyes released the previous day, but also to get a better feel for the status of the founder population introduced in 2008 (Radley 2008). Another goal of the monitoring trip was on-site flight testing of the Unmanned Aerial Vehicle (UAV) devised by J. Burt that was to serve as the primary component of an aerial locator system (MAC Working Group 2008). The system was originally intended for use during the 2008 translocation but was not completed on time because of a few unforeseen electronic glitches (Radley 2008).

The DFW biologists and their equipment arrived at Sarigan's upper camp at approximately 07:40 on 7 May. The biologists set camp as the helicopter returned to Saipan to transport J. Burt and the UAV to the island on a second flight; the aircraft arrived again at upper camp at approximately 10:15. After helping J. Burt get settled, P. Radley and R. Rounds searched for the one transmitter that managed to stay on the white-eye it was attached to upon release. The feather clad transmitter was found within 10 minutes, hanging in brush just off the helicopter landing zone about 20-30 meters from where the birds were released; thus ended all ground based telemetry operations for the 2009 translocation.

Visual Observations

As the 14 radio transmitters failed to remain on the birds they were attached to, all monitoring of Bridled White-eyes on Sarigan in 2009 was based upon visual observations of color banded individuals. As time was limited, searches for color banded and unbanded birds were confined to areas of relatively suitable habitat (native and mixed secondary forest [Fig. 2]) on the upper plateau and the island's northern slope. Visual searches were carried out from early to late morning on 8-12 May and in the late afternoon hours on 7-11 May. As white-eyes were generally less active in the afternoons, search effort was combined with clearing and opening up transects and trails from the previous year and establishing new ones to cover as much area as possible. On 10 and 11 May these transects were systematically surveyed; P. Radley and R. Rounds stopped to look, listen, and record observations white-eyes every 20-30 meters. Lastly, on 12 May the two biologists spent the morning and early afternoon searching for white-eyes in the native and mixed secondary forest on the northern slope below the upper plateau.

On the morning of 9 May an attempt was made to mist net Bridled White-eyes in native forest north of upper camp to assess individual health and fitness, and to individually color band any unbanded birds captured. However, as white-eyes tended to stay high in the canopy (well above our 10 ft. high nets) and move around a great deal, no birds were captured in approximately 2 hrs of effort with two mist net sets. As the effort required for capturing birds on Sarigan yielded no results and kept the biologists relatively tied down to one area, the decision was made to abandon mist netting for the 2009 monitoring period so that more birds could be resighted.

During five days of intensive searching, Bridled White-eyes were detected (both singly and in small flocks of up to six) in 33 separate locations on Sarigan (Fig. 4). By far, the majority of detections (all but two) were concentrated on the upper plateau to the north and east of camp (Fig. 4). Detections at these locations (by either sight or sound) were acquired for as many as 86 white-eyes (Table 1). As there was simply no way to determine if birds were being counted multiple times, this value is by no means an estimate of the white-eye population on island; an accurate estimate is not possible with the data collected. While it is very likely that birds were undercounted, the value for the number of birds detected (n = 86) is equally likely inflated.

Table 1. Band status of Bridled White-eyes detected on Sarigan 7-12 may 2009.

Color Banded		**Unbanded**	**Unknown**
R/R-B (08)	**Y/Y-G (09)**		
4/3	8/1	8	62

Of the 86 detections, seven were of birds introduced in 2008 (color banded Red and Red-Blue [R/R-B; Table 1]), nine of birds introduced in 2009 (color banded Yellow and Yellow-Green [Y/Y-G; Table 1]), eight of confirmed unbanded birds, and 62 unknown (i.e., not seen but

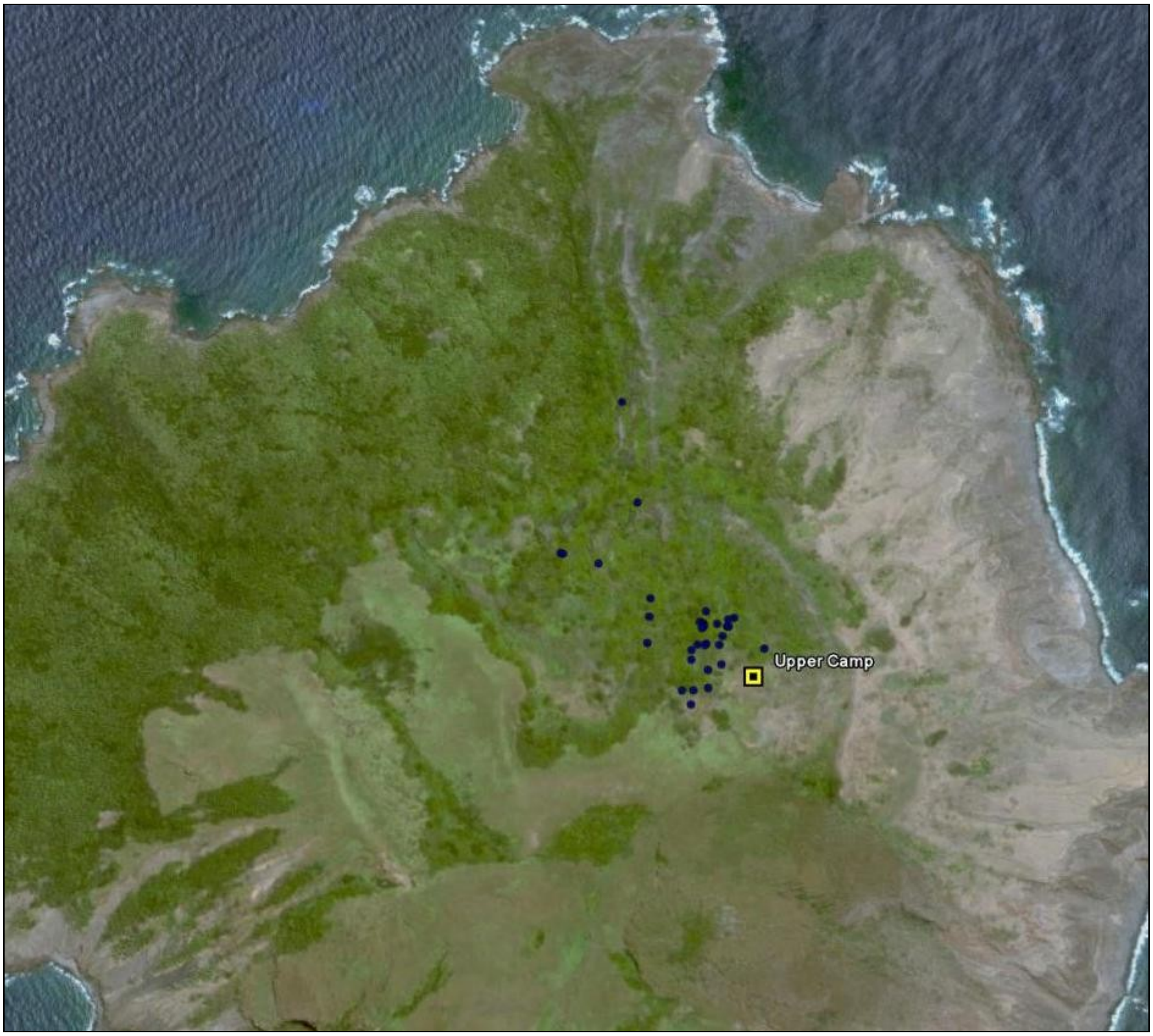

Figure 4. The 33 location (blue dots) of detections for 86 Bridled White-eyes on Sarigan, 7-12 May 2009. Upper camp is denoted by the yellow and black square.

detected by ear; Table 1). (Again, it is not possible to determine if these numbers are the result of counting birds multiple times). Two white-eyes released in 2008 (one color banded Red and the other Red-Blue) were observed feeding fledged juveniles.

On-Site Flight Test of an Aerial Locator System

Between the afternoon of 7 May and the morning of 10 May, J. Burt flight-tested a low-cost aerial locator/tracking system he developed to remotely monitor radio-tagged Bridled White-eyes on Sarigan; P. Radley and R. Rounds assisted. The system consisted of an autopilot controlled electric powered model glider (constituting the UAV), mounted with a radio tracking (RT) pod (Appendix C). Flight testing occurred either in the morning or mid-to-late afternoons upon the return of R. Radley and R. Rounds from daily Bridled White-eyes surveys and population assessment. Along with successfully locating two radio transmitters specifically placed by John Burt for system testing (lat./long. locations for the two units were determined with handheld GPS for comparison with system results) the UAV demonstrated that it could fly (with RDF pod removed) in relatively high winds of 20-30 knots. For full details of the aerial locator system and flight test results, refer to Appendix C.

RECOMMENDATIONS FOR IMPROVEMENT

While both preparing for and executing the introduction of Bridled White-eyes to Sarigan in 2009, the MAC Working Group identified several issues that require revision and improvement. These improvements will be implemented in future such avian conservation efforts in the CNMI.

- Compared to 2008, mean weight loss of Bridled White-eyes held and maintained for translocation was considerably high in 2009 (9% [n = 75] vs. 16% [n = 63], respectively). More insect food (at least 2 gm of insects/bird/day) will need to be acquired and on hand for future conservation introduction efforts and the feasibility of a potential alternative high fat/protein food item needs to be investigated and assessed.
- To prevent physical trauma (e.g., scraped ceres) that may be a result of aggression and competition between captives: 1) birds will be provided extra food; 2) curtains will be placed in boxes to provide birds with some freedom from visual contact with one another; 3) staff will monitor the birds more closely and individual captives will be moved when necessary; 4) multiple feeding stations will be made available in every cage.
- Mold build-up was an issue in the new Bridled White-eye holding containers (Appendix A). Steps to prevent this will include: 1) placement of a large ventilation opening in the front door; 2) assurance that nectar tubes do not leak before use; 3) necessary modification to the designated bird room (use a dehumidifier, install an ozonator or hepa filter and a fan to increase circulation); 4) extra holding containers on hand to allow more frequent cleaning of those in use.
- Transport boxes will be modified to facilitate easier cleaning if/when birds are held in them longer than anticipated. Modifications will include a sliding front door allowing easier access for feeding and cleaning, and a sliding, false floor to easily remove food bowls.
- To address flooding of transport boxes with nectar resulting from the use of conventional nectar tubes, AZA will look into using "flat drink bottles" (similar to those at http://armstrongplastics.com.au/homewares/images/Flat-Drink-Bottle.jpg). These plastic bottles are laid horizontally on the floor of the transport box or cage and employ small holes in the upper surface to dispense fluid to captive birds. Birds will be acclimated to this method before being placed in the transport boxes.
- The actual transfer of birds to the target island will be staged at least one week prior to when AZA staff is scheduled to leave the CNMI, allowing flexibility for unforeseen issues and variables that may delay the translocation (i.e., inclement weather). Arrangements will be made with *Americoprters* to provide the option of flying any one day over the first week plus of trapping effort; as soon as birds are captured and ready they will be translocated. Additionally, trained staff will be available to care for birds for at least one week from the

time the last bird is caught until they are translocated. If possible it is preferred not to move birds from island of capture to Saipan prior to translocation (e.g., Bridled White-eyes transported to Saipan from Tinian, prior to translocation to Sarigan). However, proper holding cages must be available on Saipan in the event that such procedure is necessary.

- The cause of premature transmitter shedding must be determined before the next translocation. Likewise, a more effective method of attaching transmitters must be discussed and determined, such as the viability of adhering units directly to the skin. Other species (e.g., Japanese White-eyes [*Zosterops japonicus*] in Hawaii) will be used as surrogates to test suggested options.
- The feasibility of additional field help for the purpose of tracking and monitoring the translocatees post-release should be assessed and determine.
- The feasibility of acquiring data loggers to assist tracking radio-tagged birds post-release should be assessed and considered.
- Translocatees should be individually color banded with unique color combinations to avoid multiple counts of those that are detected visually, to better determine population status, and gain additional information pertaining to territoriality and movements about the target island.

ACKNOWLEDGEMENTS

The AZA provided all funds to support the field collection of birds on Tinian for introduction to Sarigan and USFWS provided the funds (via both Wildlife Restoration and State Wildlife Grants) necessary for translocation and all post-release monitoring activities. Curt Kessler, USFWS, assisted in transporting necessary equipment and supplies from Tinian to Saipan in short notice. *Americopters Saipan* was responsible for transporting supplies, equipment, personnel, and Bridled White-eyes from to Sarigan from Saipan. Nate Hawley, USFWS, gave AZA full access to his Brown Treesnake lab facilities as needed during their work on Saipan. Laura Williams gave of her time and assisted however and whenever necessary.

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Appendix A: Details of New Bridled White-eye Holding Container

Compiled by: Peter Luscomb, General Curator, Honolulu Zoo, Honolulu, Hawaii

In 2008, concerns were raised about the cages used to hold Bridled White-eyes prior to translocation resulting from elevated stress levels, two mortalities, and incidences of cage induces physical trauma in that year's captives (Radley 2008). To address the issue, a new, smaller cage was devised to hold fewer birds at a time, thus reducing stress upon the occupants (Fig. 1, 2, and 3).

The new collapsible container was designed to hold only three birds at a time. It was constructed of 6 mm *Sintra* PVC foam board (*Alcan Composites*, Glasgow, Kentucky; http://www.alcancompositesusa.com/prod_sintra.html) and measured 23 cm wide by 20 cm high by 40.5 cm deep. To allow collapsibility, the top, bottom, and walls were assembled on site and held in place with to adjustable nylon straps; the same straps used to hold the components in a bundle when the container was broken down (Fig. 1). The front wall was solid with two 2.5 cm ventilation/viewing holes and slid up to give full access to the inside of the container (Fig. 2A). The left side wall (when viewing from the front) is solid with seven 2.5 ventilation holes along the top, while the right has four likewise placed ventilation holes and a 7.5 cm by 10.5 cm sliding access door opening (Fig. 1B). The door opening is positioned along the top of the wall panel and 8 cm from the back end of the container (Fig. 1B). The top and bottom panels of the container are solid while cut into the back panel is a 15.5 cm by 11 cm square hole to allow better ventilation and lighting (Fig. 2B); all ventilation, viewing, and lighting holes are covered by securely by fine mosquito mesh/screen.

Inside the container were two perches (6 mm in diameter) positioned 5 cm above the floor and 10 cm from each end (Fig. 2B). A 9 mm hole was placed in the right wall panel 2.5 cm about the front perch to allow access for a nectar container tube (Fig. 2). The bottom of the container held a removable false floor constructed of 3 mm thick *Sintra* PVC board (Fig. 2B).

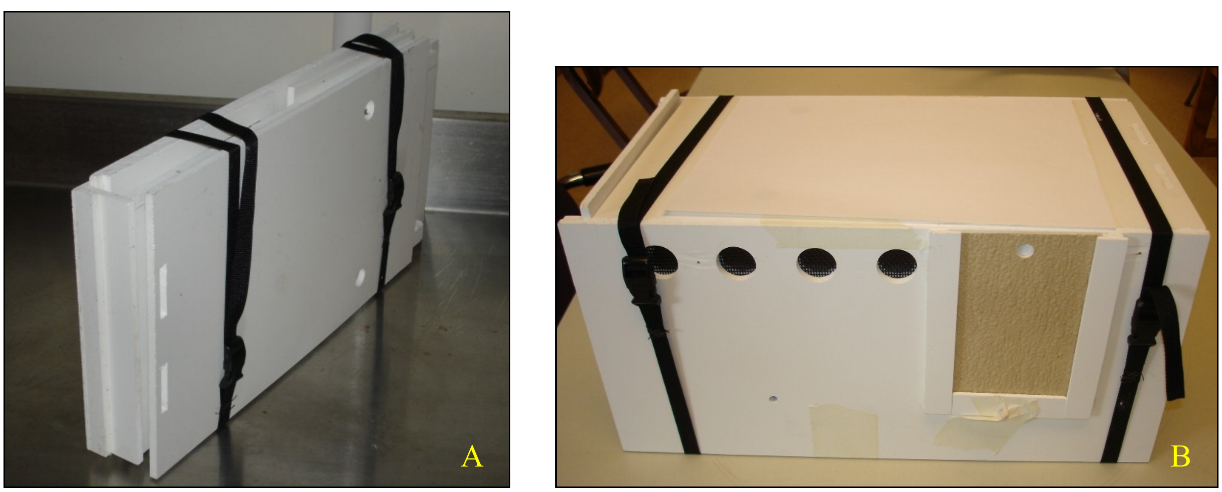

Figure 1. Details of the Bridled White-eye holding containers used on Tinian, April 2009: A) collapsed; B) assembled view of the right side.

Figure 2. Details of the Bridled White-eye holding containers used on Tinian, April 2009: A) front closed with nectar container attached; B) front open, detailing the perches, back ventilation opening, and 3 mm thick *Sintra* PVC false floor.

Figure 3. Bridled White-eye containers assembled and in use on Tinian, April 2009.

Appendix B. A Revised Bridled White-eye Population Model

Compiled by: Paul Radley, Ornithologist/Wildlife Biologist, CNMI DFW, Saipan, MP

In the original Bridled White-eye conservation introduction plan (MAC Working Group 2008), we presented a tentative 30 yr model for the population that would be the result of the tentative translocation. As vital rates data needed to develop a population model specific to the Bridled White-eye were (and still are) lacking, we substituted necessary data from the closely related Silvereye (*Zosterops lateralis*; Kikkawa and Wilson 1983, Brook and Kikkawa 1998) to facilitate model development (MAC Working Group 2008). While the age at first breeding for Bridled White-eye is unknown (as is first year and adult survival), the Silvereye begins breeding after one year and exhibits a breeding success of 3.1 fledglings per nest (Kikkawa and Wilson 1983). Kikkawa and Wilson (1983) reported an average juvenile survival of 47% (range: 41-54%) for the Silvereye, and Brook and Kikkawa (1998) reported an annual adult survival of 61% for the species.

In the original conservation plan we assumed a 1:1 sex ratio (50% [25] of the 50 white-eyes introduced being female) to allow an estimate of the projected population over 30 yrs in a best-case scenario (MAC Working Group 2008). However, we can now revise this model as the sex ratios of birds introduced in 2008 and 2009 are known: 1:1.5 in 2008, with 20 females and 29 males (Radley 2008); 1:2.1 in 2009, with 16 females and 34 males.

Model Development

Monitoring of the two cohorts of Bridled White-eyes translocated to Sarigan is expected to occur at yearly intervals. As the peak in white-eye breeding cycle may likely occurred prior to the expected post-release monitoring periods in 2008 and 2009 (May or late in the dry season), we developed a post-breeding population model for female white-eyes on the island.

Based on available literature for other *Zosterops* species we assumed that Bridled White-eyes can produce at least two broods a year, one of which likely occurs in the dry season and the other in the wet season. Due to the opportunity for multiple nesting attempts throughout the year we did not use nesting success estimates in the model; instead we used estimates based upon the 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% of the offspring were female. To keep the model simple (and because necessary data are lacking) we did not include post-release survival in our model. The unavailability of environmental or demographic stochasticity data likewise precluded the inclusion of these variables. 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 in MAC Working Group (2008).

Results

An initial run of the model for 2008 using the vital rates data from the Silvereye and an introduced female population of 20 showed a steadily increasing population over the 30-yr period (Fig. 1). The population growth rate (*lambda*) was estimated to be 1.04 and the projected population of females at 10, 20, and 30 years was 39, 57, and 83, respectively.

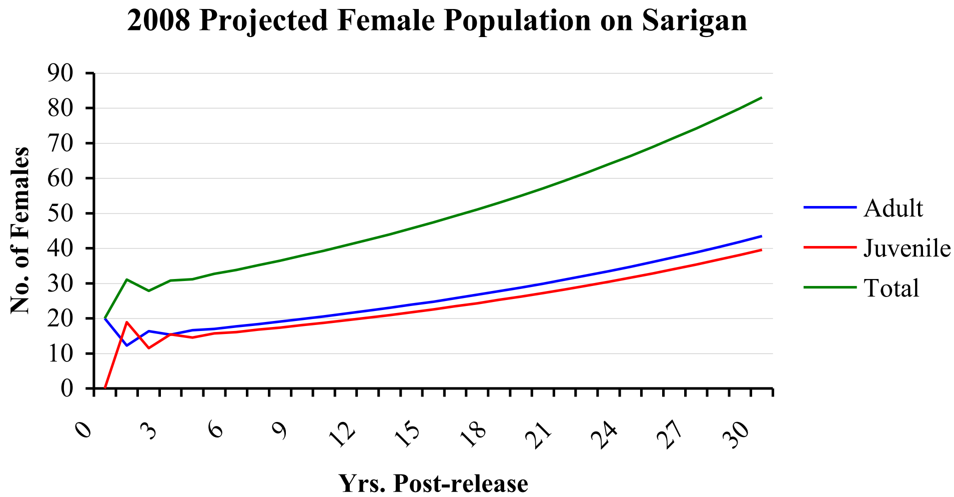

Figure 1. A 30 year projected female Bridled White-eye population on Sarigan after the original conservation introduction in 2008.

With the addition of 16 females in 2009, the projected female population over 30 yrs showed a substantial increase from that estimated in 2008 (Fig. 2). The population growth rate remained at 1.04, but projected female populations at 10, 20, and 30 years nearly doubled with 70, 101, and 147, respectively.

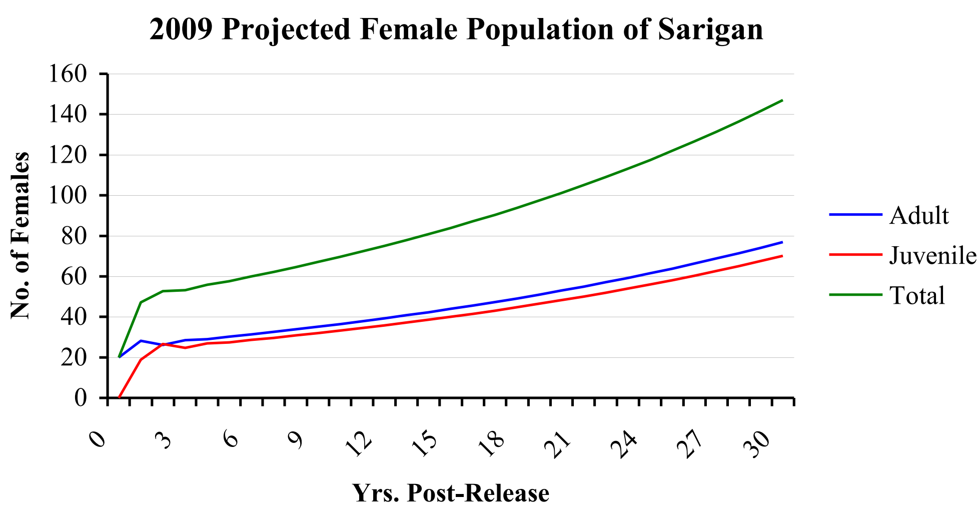

Figure 2. The 30 year projected female Bridled White-eye population on Sarigan after a second translocation in 2009.

Assuming that vital rates of both Bridled White-eyes and Silvereyes are similar, and that no catastrophic or stochastic events occur, the total female population on Sarigan should experience more than a five-fold increase in 30 years over the estimated adult female population (*n* = 28) on island immediately after translocation in 2009. However, only yearly population monitoring focusing on survival, recruitment, and reproduction will shed light on the long term viability of the current population and serve to direct any necessary management actions.

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Appendix C: Deployment of a Prototype Radio Tracking System on Sarigan.

Compiled by: John Burt, Department of Psychology, University of Washington, Seattle, Washington

J. Burt launching aircraft with radio tracking pod attached. The ground station laptop computer is housed in the shade box to the right.

In May 2009, CNMI DFW and the University of Washington deployed a low-cost aerial tracking/locator system initially developed to monitor radio-tagged Bridled White-eyes translocated to Sarigan. The system was a fully functional prototype, specifically designed as a radio tracking tool for use in extremely remote environments with difficult terrain, under a variety of weather conditions. The tracking system consisted of an autopilot controlled electric powered sailplane (serving as an Unmanned Aerial Vehicle or UAV) mounted with a radio tracking (RT) pod capable of scanning up to 50 separate radio-tag frequencies. After a manual launch, the aircraft was capable of fully autonomous flight along a pre-programmed route. The RT pod detected radio transmitter signals and calculated the angle to each unit, allowing us to triangulate positions after multiple signals had been received. A radio modem on the plane allowed us to control flights and to receive flight data and the RT pod output.

In the May 2009 deployment, system tracking accuracy and range were tested by placing two radio transmitters at known ground locations during a flight (transmitter locations were determined with handheld GPS). A preliminary analysis of tracking test data indicates that the tracking pod was able to detect and locate the extremely light and low powered radio transmitters we used. The range of detection was approximately 250m, with a much greater range likely using more powerful tags. Although location accuracy was approximately 50-100m, higher accuracy is likely with further post flight processing.

Goals and Methods

One of the challenges of the MAC Working Groups (2008) Bridled White-eye conservation introduction project was the implementation of a method for regularly (~once per day) locating radio-tagged birds across Sarigan's rugged volcanic terrain, which is completely undeveloped (i.e., no roads, trails, etc). The experience of trained field biologists indicated that it can take hours of bushwhacking to cover 100-200 m of some terrain on the island.

One proposed solution for this dilemma was to employ an autonomous aerial tracking platform to locate all tagged individuals daily (weather permitting) by simply flying over the habitat. Such a system could eliminate or enhance ground tracking efforts and could be used in many other similarly difficult radio tracking scenarios. Therefore, a fully functional prototype aerial tracking system was designed and constructed to be used for post-translocation monitoring of Bridled White-eyes on Sarigan.

The aerial platform (i.e., UAV) consisted of an electric motor powered sailpane (*Cularis* model, Multiplex Modelsports USA, Poway, California; www.multiplexusa.com) controlled by autopilot (*Paparazzi* open source autopilot; https://launchpad.net/paparazzi, http://ppzuav.com/osc/catalog; Fig. 1). This autopilot was capable of fully autonomous flight (with take-off and landing under manual control for safety purposes), and could be programmed to fly any route desired. During flight, the UAV maintained continuous contact with a ground station laptop computer via radio modem (*9Xtend*; www.digi.com) link (Fig. 2). The radio link allowed the pilot/operator to adjust course waypoints in-flight and instruct the UAV to return to a "home" position at the end of a "mission." The radio link was also used to transmit radio-tag location data to the ground station.

Figure 1. *Cularis* sailplane (UAV) with mounted radio tracking (RT) pod as test flown on Sarigan, May 2009.

Figure 2. Gound station setup with radio modem antenna and laptop computer shade-box, Sarigan, May 2009.

A custom built RT pod mounted onto the top of the UAV fuselage (Fig. 1). The pod contained a very sensitive radio receiver that could be programmed to tune into a repeating sequence of VHF radio transmitter frequencies. The receiver output fed into a custom radio direction finder (RDF) device (*PicoDopp* RDF, Santa Barbara, California; www.silcom.com/~pelican2), that output the compass direction (relative to the plane's position) of every tracking transmitter signal received. Each transmitter signal compass direction was transmitted to the ground station (as well as being stored on a data logger incorporated into the UAV). Radio-tag positions were determined by combining several transmitter signal compass direction determinations collected with the UAV at different locations.

In brief, a "typical" locator mission involved launching the UAV under manual control, switching it to autopilot and monitoring the aircraft as it flew a fixed course circumnavigating the island. Afterwards, the UAV was switched to manual control for landing. After a flight, a few minutes were required to analyze the tracking data collected and estimate the position of any transmitters that were detected. A portable solar panel was used to recharge motor and laptop batteries for subsequent flights.

List of Equipment Provided to CNMI DFW

- Two complete (partially disassembled) *Cularis* sailplanes. Each includes: Paparazzi Tiny 2.11 autopilot, infra-red horizon sensors for attitude control, brushless motor and speed controller, control servos, 9Xtend radio modem and antenna, *Berg **4L*** radio control receiver (www.castlecreations.com).
- *Futaba* 7CAP radio control transmitter (http://www.futaba-rc.com).
- Radio tracking (RT) pod. Pod includes: custom made collapsible four-antenna rig and pod shell, *Hamtronics* R302 transmitter signal receiver (www.hamtronics.com), *PicoDopp* direction finder device, custom made board to manage receiver channel control and *PicoDopp* direction finding output.
- Two roll-up solar panels (*Powerfilm* R15-1200; http://www.powerfilmsolar.com) and custom PVC frame and mounting hardware.
- *Asus* EEE-PC 701 "netbook" loaded with *Paparazzi* autopilot ground station software, including storage case, extra backup battery, AC charger, and DC charger.
- Ground station radio modem box and antenna cable, telescoping antenna pole, fiberglass mounting rod, plastic hammer, and guy wire kit.
- Ground station "netbook" shade box (custom made) and mounting tripod, and weight sack to hang below tripod for stability in wind.
- One small portable folding stool.
- Battery charging station (tackle box), containing: switch harness, cables, lithium polymer battery chargers, an assortment of lithium polymer batteries for battery backup, aircraft motor power, and aircraft equipment power.

Summary of Flight Testing

Prior to project deployment on Sarigan, J. Burt had worked for about 1.5 years on the design, construction, and testing of all the components of the aerial tracking/locator system (including tracking pod, UAV, autopilot system, solar charging rig, tracking analysis software, etc). As originally intended in 2009, he was to operate the system to track translocated radio-tagged Bridled White-eyes from 4-10 May. However, unseasonably inclement weather delayed translocation activities and prevented field crew travel to Sarigan before 7 May, allowing only approximately 3.5 days for J. Burt to radio track white-eyes. As a further setback, all 14 transmitters deployed had been dropped by the birds during or shortly after translocation on 6 May. Thus, all testing of the RT pod and direction finding system was conducted with the use of two 148 Mhz LB-2N radio transmitters produced by *Holohil Systems Ltd*. (Radley 2008).

On the morning of 7 May, J. Burt arrived on Sarigan with the components of the aerial locator system. After settling in, he spent the afternoon scouting the clearing on the plateau to the south of the island's upper camp for a location suitable for UAV launch and landing. Upon locating a site, he assembled and installed the ground station, then returned to camp to assemble the solar charging station.

At 10:00 on 8 May the UAV was tested on-site for the first time on Sarigan. The aircraft was flown without the RT pod and with a flight plan that circled it over the plateau in a triangular pattern. Flight duration was approximately 10 min., at the end of which the UAV experienced a rough landing resultant of a downdraft at the landing zone. Afterwards, the flight plan was re-calibrated and minor damage to the UAV airframe repaired. That afternoon, J. Burt assembled and tested the RT pod, the receiver in which was debugged of false direction angles by tuning the pod components in a specific sequence.

A second test flight (again without RT pod) was conducted the afternoon of 8 May, with a digital camera in video recording mode mounted on the UAV. The flight was similar to the morning attempt, but it occurred at a slightly lower altitude and with revised route waypoints. The craft was landed in a field of swordgrass with no damage experienced.

On the morning of 9 May, J. Burt prepared the UAV for flight with RT pod attached and acquired GPS coordinates for two radio transmitters that were placed as high as possible in low trees in the vicinity of the flight zone on the plateau. High winds in the morning and early afternoon delayed test flight until the late afternoon when wind velocity diminished considerably (it was discovered that the RT pod increased drag on the UAV, thus increasing the risk of stalling). The RT pod test flight was a success; the UAV detected and located the two test transmitters and flew the flight route as planned, then was landed in swordgrass near the base station for easy retrieval.

On the afternoon of 10 May, J. Burt had intended to try a second flight with RT pod attached, but high winds intervened. Although flight conditions were ideal in the early morning, neither DFW biologist Paul Radley and Rachel Rounds were able to provide J. Burt with necessary field assistance. (Based upon J. Burt's experience on Sarigan to this point, he determined that it should be possible to fly the UAV with RT pod most any day at of shortly after dawn). Regardless, despite 20 knot winds in the afternoon, a flight test was attempted without the RT pod; however, the digital camera in video recording mode was once again attached. This flight successfully demonstrated the ability of the UAV to fly in extremely marginal conditions, albeit without the RT pod.

Another RT pod flight was attempted early the morning of 11 May but was it was cancelled because of extremely high winds. J. Burt spent the remainder of the morning packing his gear and departed Sarigan mid-morning.

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