THE TROPICAL MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (TMAPS) PROGRAM IN AMERICAN SAMOA: 2018 REPORT

Peter Pyle, Daniel Roche, Zachery Emery, Eric Fishel, Holly Marie Todaro, Margeaux Wayne, Jane Wong, Kim Kayano, Danielle Kaschube, and Lauren Helton

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THE INSTITUTE FOR BIRD POPULATIONS
PO Box 1346
Point Reyes Station, CA 94956

AMERICAN SAMOA GOVERNMENT DEPARTMENT OF MARINE AND WILDLIFE RESOURCES
PO Box 3730
Pago Pago, American Samoa 96799

Polynesian Wattled-Honeyeater, TMAPS Station MALO, Tutila Island, 6 March 2014

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EXECUTIVE SUMMARY

Birds are sensitive indicators of environmental quality and ecosystem health, and are the focus of many regional and continental scale monitoring efforts. Most broad-scale bird monitoring has involved counts of birds to index abundance and estimate trends, but monitoring of demographic rates (including productivity, recruitment, and survival) is needed to infer actual causes of population changes. Application of standardized, constant-effort mist netting and modern capture-recapture analytical techniques is an effective means of monitoring demographic rates of many landbird species. In 1989, a long-term landbird mark-recapture effort was initiated in North America by The Institute for Bird Populations (IBP), with the establishment of the Monitoring Avian Productivity and Survivorship (MAPS) program. The MAPS program is a cooperative network consisting of hundreds of constant-effort mist-netting stations operated across North America during each summer landbird breeding season that has provided demographic data for over 180 landbird species.

Few data exist on the ecology, population status, and conservation needs of landbirds in American Samoa. In collaboration with the Department of Marine and Wildlife Resources (DMWR), we thus initiated a Tropical Monitoring Avian Productivity and Survivorship (TMAPS) program there in 2012. Long-term goals of this project are to provide annual indices of adult population size and post-fledging productivity, provide estimates of adult population densities, adult survival rates, and proportions of residents, relate avian demographic data to weather and habitat, identify proximate and ultimate causes of population change, use monitoring data to inform management, and assess the success of management actions in an adaptive management framework. An additional goal of the American Samoan TMAPS program is to collect data on the Tongan (also know as Shy or Friendly) Ground Dove, from a little-known population on Ofu-Olosega that was listed as Endangered under the USFWS Endangered Species Act in September 2016.

A pilot TMAPS program in American Samoa was initiated on Tutuila Island with the establishment of six TMAPS stations in 2012-2013. During this pilot year, breeding seasonality and an optimal TMAPS season of November-to-March for American Samoa was established. The project has subsequently continued with six stations on Tutuila through the 2018 season (hereafter, "season" refers to November of the year before to March of the seasonal year) and has expanded to include six stations each on Ta'u Island for the 2014-2018 seasons and Ofu and Olosega islands for the 2016-2018 seasons. Each station consisted of a sampling area of about 20 ha, and within the central 8 ha of this area, 10 12-m long, 30-mm mesh, 4-tier nylon mist nets were erected at fixed net sites and operated for three consecutive days, once per month (a "pulse") during November-March, weather permitting. Daily operation of stations followed standardized protocols established by The Institute for Bird Populations for use in the MAPS Program. Molting patterns and age-determination criteria for Samoan landbirds were examined, based on museum specimens and captures for a preliminary manual for use in the field. These preliminary findings were subsequently field-tested, and a final field manual was produced and published in 2017.

Here we provide a comprehensive summary of captures, population-size indices (capture rates), and productivity estimates for these 18 stations operated on Tutuila, Ta'u, and Ofu-Olosega

during the 2018 season. Using standardized data from the 2014-2018 seasons, we also compare capture and vital rates between the three islands and from year to year, analyze population size and productivity by three habitat categories in American Samoa, and we examine population trends, survivorship, and possible demographic causes for trends for five species using mark-recapture analysis.

During the 2018 season, we recorded 115 landbird captures on Tutuila, 115 captures on Ta'u, and 272 captures on Ofu-Olosega, totaling 502 captures overall, of 13 bird species. The most commonly captured species on all thee islands combined were Polynesian Wattled-Honeyeater (236 captures), followed by Pacific Kingfisher (90), Samoan Starling (68), Samoan Shrikebill (31), Polynesian Starling (11), Tongan Ground Dove (7), Crimson-crowned Fruit Dove (5), Jungle Myna (5), Blue-crowned Lorikeet (2), Buff-banded Rail (1), Pacific Imperial Pigeon (1), Pacific Long-tailed Cuckoo (1), and White-rumped Swiftlet (1). The capture total of 502 represents a 37% decrease over the 792 captures during the 2017 season, primarily due to much fewer net-hours on Ta'u, resulting from the inability to operate three stations in 2018, and to reduced effort during and following the passage of Cylcone Gita on 9-10 February 2018.

Using a standard capture-rate index (individual adults per 600 net-hours), estimated population sizes for all species pooled decreased by 13% between the 2017 and 2018 seasons on Tutuila, they were very comparable on Ta'u between the two years, and they increased by 10% on Ofu-Olosega. On Tutuila, population sizes during the 2018 season were comparable to the five-year (2014-2018) mean but on Ta'u and Ofu-Olosega population sizes were lower than the five-year and three-year (2016-2018) means, respectively. Reproductive index for all species pooled, was comparable between the 2017 and 2018 seasons on Tutuila and Ofu-Olosega, but it decreased by 43% on Ta'u, following, however, a substantial increase here between the 2016 and 2017 seasons. These reproductive indices are generally quite low compared to equivalent values among North American landbirds. The 2018 productivity values were lower than the five-season (2014-2018) mean on Tutuila and Ta'u, and comparable to the three-season (2016-2018) mean on Ofu-Olosega.

In order to assess patterns of landbird demography by habitat type, we used our habitat assessment data to define three broad habitat categories among the 18 stations: Coastal Habitat, Lowland Forest, and Upland Forest. Native Samoan species showed differing habitat preferences for breeding adults, with Tongan Ground Doves, Pacific Kingfishers, and Samoan Starlings at higher abundances in Coastal Habitats, whereas Samoan Shrikebills, Polynesian Starlings, and possibly Crimson-crowned Fruit Doves were found at higher abundances in Upland Forests. Polynesian Wattled- Honeyeaters were found at comparable high densities in all forest types. Crimson-crowned Fruit Doves showed higher productivity in the Upland Forests than the other two habitat types, Pacific Kingfisher and Polynesian Wattled-Honeyeater showed higher productivity in Lowland Forests than in the other two habitat types, Tongan Ground Dove showed higher productivity in Coastal Habitats than in the forested habitats, and Blue-crowned Lorikeet, Samoan Shrikebill and the two starlings showed mixed results suggesting that productivity might be comparable within all three habitat types. The varying habitat responses of each species, both in population abundance and productivity, underscores the need to conserve a mosaic of all habitat types in American Samoa.

We have now gained enough data to calculate more-precise estimates of population trends, productivity, and survival for five native Samoan landbird species. Pacific Kingfisher appears to be declining to a small but significant extent on all three islands, while Samoan Starling is declining significantly on Ofu-Olosega. Samoan Shrikebill populations on both Ta'u and Ofu-Olosega and Polynesian Starling populations on Ta'u are increasing. Populations of Polynesian Wattled-Honeyeater on all islands, Polynesian Starling on Tutuila, and Samoan Starling on Tutuila and Ta'u appear to be stable. The mean survival estimate for 13 species/island estimates among these five species was 0.756, compared with typical survivorship estimates for continental North American species of between 0.5 and 0.6. Higher estimates were generally recorded for Polynesian Wattled-Honeyeater and Samoan Shrikebill and lower estimates were recorded for Pacific Kingfisher and Samoan Starling. Precision for both population trends and survivorship estimates improved over the estimates after the 2017 season. Overall it appears that American Samoan landbirds may maintain population stability through relatively high survival and low productivity, more of a K-selected strategy as compared with North American landbirds.

A notable event during the 2018 season was the passage of Cyclone Gita over American Samoa on 9 February 2018, causing widespread damage, flooding, landslides, and forest destruction. On Tutuila, severe damage and tree fall occurred at most stations, and operations at one station had to be suspended for the season and at two others effort was reduced due to damage and/or access issues. Habitat damage was less severe on Ta'u and Ofu-Olosega though notable at several stations. We responded by fully documenting the damage at each station with photographs and additional post-cyclone habitat assessments to compare with those before damage was incurred, and we plan an analysis of the effects of storm damage on landbird demographics, as we have done for a similar case following a typhoon that struck Saipan.

Clearly our data will enable an examination of bird demography at a community based level, given the differing responses we observed among species on different islands and among different years, as likely related to weather and climate, and the different responses of both breeding population density and productivity to habitat types among and within species and island groups. More data will be required to fully understand these dynamics, and we are confident that, as we accumulate more years of data, not only will the precision of our estimates increase, but we will be able to calculate lambda and survivorship for at least three additional target species, Tongan Ground Dove, Crimson-collared Fruit Dove, and Blue-crowned Lorikeet. We will also be analyzing demographic responses to remote-sensed vegetation greenness, as we have with our TMAPS program in Saipan.

The establishment of the TMAPS Program on Ofu-Olosega has allowed us to gather information on the small population of Tongan Ground Doves residing on these islands. Our capture of 17 individuals and one recapture during the 2016 season, 11 captures and two recaptures during the 2017 season, and 7 captures and one recapture during the 2018 season has enabled us to confirm age and sex criteria for this species in American Samoa and has provided critical information on breeding condition, molt status, biometrics, and weights. Although fewer captures were recorded each year from 2016 to 2018, the capture rates (adults per 600 net hours) did not drop as much, and the low sample sizes are such that the declines cannot yet be considered biologically significant. For all 20 captures of Tongan Ground Doves during the 2017 and 2018 seasons, we collected feather, blood, and/or swab samples to investigate genetic differentiation, pathogens, and diet. Our TMAPS data on this species further allowed us to instigate a separate project on the Tongan Ground Dove to apply remote-tracking technology and to record the vocalizations and assess playback experiments. The results of this project will be reported on in January 2019. This information will be applied to the management of this population, which was listed as Endangered under the USFWS Endangered Species Act in September 2016.

The current sampling protocol is yielding critical data on the population dynamics and habitat use patterns for five target native landbird species on Tutuila, Ta'u, and Ofu-Olosega. Continued data collection should enhance the precision of current estimates and add up to three more target species in which full demographic data can be collected. Our goal is to continue to operate six stations on each of the three island groups during November-March of each season in coming years, to further understand year-to-year and inter-island-group dynamics by collecting a long-term data set, and to examine these dynamics using a community-based approach. We can then begin applying results of these analyses to inform land-management recommendations for habitat conservation or restoration. We look forward to continuing this important work in coming years.

INTRODUCTION

Birds are sensitive indicators of environmental quality and ecosystem health (Morrison 1986, Hutto 1998), and they are the focus of many regional and continental scale monitoring efforts (Gregory et al. 2005, Sauer et al. 2008). Most broad-scale bird monitoring has involved counts of birds to index abundance and estimate trends (Bart 2005), but monitoring of demographic rates (including productivity, recruitment, and survival) is needed to infer actual causes of population changes (DeSante et al. 2005, 2015; Saracco et al. 2008, 2009; Robinson et al. 2009; Rushing et al. 2015). Because demographic rates are directly affected by environmental stressors or management actions, they can more-accurately reflect short-term and local environmental changes (Temple and Wiens 1989, DeSante and George 1994). Demographic data can also be used to identify stages of the life cycle that are most important for limiting bird populations (DeSante et al. 2001, 2015; Holmes 2007; Saracco et al. 2008, 2009) and can be modeled as functions of predictive population analyses to assess the viability of populations (Noon and Sauer 1992; Saracco et al. 2010a, 2010b).

Application of standardized, constant-effort mist netting and modern capture-recapture analytical techniques is an effective means of monitoring demographic rates of many landbird species (DeSante et al. 2005, 2015). In 1989, a long-term landbird mark-recapture effort was initiated in North America by The Institute for Bird Populations (IBP), with the establishment of the Monitoring Avian Productivity and Survivorship (MAPS) program (DeSante 1992). The MAPS program is a cooperative network consisting of hundreds of constant-effort mist-netting stations operated across North America during each summer landbird breeding season (over 1,300 stations overall) that has provided demographic data for over 180 landbird species (DeSante and Kaschube 2007, Saracco et al. 2010b, DeSante et al. 2015). Similar programs exist in Europe, where they are central components of national and international bird-monitoring efforts (e.g., Peach et al. 2004). The MAPS program has been utilized to monitor bird demography by many U.S. federal agencies, including the National Park Service, Department of Defense, USDA Forest Service, and USDI Fish and Wildlife Service.

IBP has also established a "Tropical MAPS" (TMAPS) program to collect similar data on avian vital rates in tropical areas, where breeding may occur year-round. The first TMAPS project was established on Saipan, Commonwealth of the Northern Marianas Islands, in 2008, and has provided important new information on population abundance and trends, breeding and molting seasonality, vital rates, age-determination criteria, molt strategies, morphology, habitat use, and general ecology of the resident landbirds on this island (Radley et al. 2011; Junda et al. 2012; Saracco et al. 2015, 2016).

In August 2012, in collaboration with the Department of Marine and Wildlife Resources (DMWR), IBP established a TMAPS program in American Samoa. This effort aims to provide baseline data on landbird populations of American Samoa and a foundation for informing conservation strategies for its indigenous insular avifauna. Long-term goals are to: (1) provide annual indices of adult population size and post-fledging productivity (from constant-effort capture data); (2) provide annual estimates and trends of adult population size, adult survival rates, and proportions of residents in the adult population using capture-recapture analyses; (3)

relate avian demographic data to seasonal weather patterns and habitat, including the effects of cyclones such as Gita that passed through Samoa in February 2018; (4) identify proximate and ultimate causes of population change; (5) use monitoring data to inform management; and (6) assess the success of any management actions in an adaptive management framework. In order to estimate productivity and recruitment, accurate criteria for determining each captured bird's age is needed, which in turn relies on knowledge of molting seasons and strategies.

A pilot program was initiated on Tutuila Island in 2012-2013, in which breeding seasonality and an optimal TMAPS season of November-to-March for American Samoa was established. The project has subsequently continued on Tutuila through the 2017-2018 season (hereafter, e.g., "2018 season" refers to November 2017 - March 2018), has expanded to include Ta'u Island for each of the 2014-2018 seasons, and was expanded again to Ofu and Olosega islands for the 2016-2018 seasons. The initial establishment of TMAPS stations and summaries of capture data from all TMAPS stations from 2012 through the 2017 season were described by Pyle et al. (2012, 2013, 2014, 2015a, 2016a, 2017a). During this period, molting patterns and age-determination criteria for Samoan landbirds were examined, based on museum specimens and captures, for a preliminary manual for use in the field (Pyle 2014a). These preliminary findings were subsequently field-tested (Pyle et al. 2016b) and a final field manual was produced and published in 2017 (Pyle 2017b). A primary goal of the new stations on Ofu-Olosega was to collect data on the Tongan (also know as Shy or Friendly) Ground Dove (see below and Appendix 1 for scientific names), of a little-known population that was listed as an Endangered Species under the USFWS Endangered Species Act in September 2016 (Rosa 2007, USFWS 2015, 2016).

Here we provide a comprehensive summary of captures and indices of population size (capture rates) and productivity for stations operated on Tutuila, Ta'u, and Ofu-Olosega during the 2018 season. Using standardized data from the 2014-2018 seasons, we also compare capture and vital rates between the three islands and from year to year, analyze population size and productivity by three habitat categories in American Samoa, and we examine population trends, survivorship, and possible demographic causes for trends for five species using mark-recapture analysis.

STUDY AREAS AND METHODS

In July 2012 to August 2013 we established and operated eight TMAPS stations in typical habitats utilized by landbirds on Tutuila, American Samoa (Pyle et al. 2012, 2013). In November 2013, four of these stations were re-established on Tutuila and two additional stations were newly established to replace other stations due to encroaching development and/or access problems (Pyle et al. 2014). These final six stations (Vatia, Tula, Amalau, Mount Alava, Malota, and Malaeloa) were then operated during each of the 2014-2018 seasons Pyle et al. (2015a, 2016a, 2017a; this report). Locations of all 10 stations on Tutuila are shown in Figure 1, and descriptions and a summary of effort for each of the active six stations during the 2018 season are given in Table 1. On Ta'u, six stations (Aokuso, Saunoa, Usu Nua, Fala'a, NPAS - Laufuti Stream, and NPAS- Luamaa) were established in November 2013 and each station was operated during each of the 2014-2017 seasons (Pyle et al. 2014, 2015a, 2016a, 2017a; this report). Due to bad weather in November 2017 (we were unable to get a truck to Ta'u) only three of the six stations, Aokuso, Saunoa, and Fala'a, could be operated during the 2018 season. The locations of these six stations are shown in Figure 2, and descriptions and a summary of effort for each station during the 2018 season are given in Table 2. In November 2015, six new stations were established on Ofu-Olosega islands, four on Ofu (Tumu Lower, NPAS - Southeast, Toaga Beach, and Tumu Upper) and two on Olosega (Sili and Oge Beach), and these six stations were operated during each of the 2016-2018 seasons (Pyle et al. 2016a, 2017a; this report). The locations of these six stations are shown in Figure 3, and descriptions and a summary of effort for each station during the 2018 season are given in Table 3. The three stations marked "NPAS," two on Ta'u and one on Ofu islands, are located in the National Park of American Samoa, although we were unable to operate the two NPAS stations on Ta'u in 2018. Each of these 18 stations have been operated for each of the 2013-2018 seasons in a consistent and standardized manner.

Each station consists of a sampling area of about 20 ha. Within the central 8 ha of this area, 10 12-m long, 30-mm mesh, 4-tier nylon mist nets were erected at fixed net sites (DeSante et al. 2017). Each station was operated for three consecutive days, once per month (a "pulse"), weather permitting, following standardized banding data-collection protocols established by The Institute for Bird Populations for use in the MAPS Program (DeSante et al. 2017). Logistical considerations during the 2018 season resulted in effort varying among stations in the three island groups, from two to four pulses at the Tutuila stations to three pulses at the Ta'u and Ofu-Olosega stations (Tables 1-3). Mist-netting effort data (i.e., the number and timing of net-hours on each day of operation) were collected in a standardized manner by recording net-opening, net-checking, and net-closing times to the nearest 10 minutes. We aimed to operate nets for six morning hours per day, beginning at local sunrise. Inclement weather (especially heavy rain) sometimes truncated operation on a particular day. Although make-up effort was attemoted, such weather conditions and other logistical considerations resulted in variable effort among stations, ranging from 413 to 551 net hours per station during the 2018 season (Tables 1-3). This was especially the case during and following the passage of Cyclone Gita on 9-10 February 2018. Station operation was carried out by IBP biologists and assistant technicians. In 2018 these included Emery, Fishel, Roche, Todaro, Wayne, and Wong. All banders were trained in TMAPS protocols and supervised locally by Kayano, and data collection was further supervised remotely by Helton and Pyle.

For this report we follow updated taxonomy and species order of Gill and Donsker (2018), which has resulted in changes to some common and scientific species names of landbirds from earlier reports. The following updated taxonomy and names (along with previously used names) are included for landbirds in this report:

Tongan Ground Dove, *Alopecoenas stairi* (formerly Shy Ground-Dove or Friendly Ground-Dove, *Gallicolumba stairi*)
Many-colored Fruit Dove, *Ptilinopus perousii*
Crimson-crowned Fruit Dove, *Ptilinopus porphyraceus* (formerly Purple-crowned Fruit Dove)
Pacific Imperial Pigeon, *Ducula pacifica* (formerly Pacific Pigeon)
Pacific Long-tailed Cuckoo, *Urodynamis taitensis* (formerly Long-tailed Cuckoo, *Eudynamys taitensis*)
White-rumped Swiftlet, *Aerodramus spodiopygius*
Pacific Kingfisher, *Todiramphus sacer* (formerly Collared Kingfisher, *T. chloris*)

Blue-crowned Lorikeet, *Vini australis* (formerly Blue-crowned Lori)
Cardinal Myzomela, *Myzomela cardinalis* (formerly Cardinal Honeyeater)
Polynesian Wattled-Honeyeater, *Foulehaio carunculata* (formerly Wattled Honeyeater)
Samoan Shrikebill, *Clytorhynchus powelli* (following Pratt 2010, who split this from Fiji Shrikebill, *C. vitiensis*)
Red-vented Bulbul, *Pycnonotus cafer*
Polynesian Starling, *Aplonis tabuensis*
Samoan Starling, *Aplonis atrifusca*
Common Myna. *Acridotheres tristis*
Jungle Myna, *Acridotheres fuscus*

With few exceptions, all birds captured were identified to species, age, and sex based on criteria outlined by Pyle (2014a) and Pyle et al. (2016b, 2017b). Unbanded birds were banded with USGS/BRD numbered aluminum leg bands and recaptured birds (those that had been banded previously) were fully processed. Birds were released immediately upon capture and before being banded or processed if situations arose where bird safety would be compromised. The following data were taken on all birds captured, including recaptures, according to MAPS guidelines (DeSante et al. 2017):

- capture code (newly banded, recaptured, band changed, unbanded)
- band number
- species
- age, how aged, and molt-plumage code (see below)
- sex (if possible to determine) and how sexed (if applicable)
- extent of skull pneumaticization
- breeding condition of adults (i.e., extent of cloacal protuberance or brood patch)
- extent of juvenal plumage in young birds
- extent of body and flight-feather molt
- extent of primary-feather wear
- presence of molt limits and plumage characteristics
- wing chord
- fat class and body mass
- date and time of capture (net-run time)
- station and net site where captured
- any pertinent notes.

In addition, for all captures of Tongan Ground Doves, blood, cloacal-swab, and feather samples were obtained using widely used methods. Detailed molt data and images were obtained for most captures, to continue documenting molt strategies and ageing and sexing criteria for American Samoan landbirds (Pyle 2014a; Pyle et al. 2016b, 2017b). These data and images were examined by Pyle to assess accuracy of age determinations and to maintain seasonal criteria for acceptable age coding (Pyle et al. 2017b). Because breeding can occur year-round in American Samoa and the peak breeding season spans the end of the calendar year (December/January), the calendar-year-based ageing system used for MAPS (DeSante et al. 2017) could not be used for this program. Instead, we aged birds according to the molt-plumage (WRP) system following Wolfe et al. (2010) and Johnson et al. (2011); see also Pyle (2014b), Pyle et al. (2015b, 2017b), and Johnson and Wolfe (2018) for details. Our system was modified to reflect the molt and plumage strategies found for our captured species in American Samoa (Pyle et al. 2017b). In addition, first-cycle birds were scored as either greater than or less than six months of age, based on skull and feather-wear data. A final determination of age for productivity analyses, young or adult, was determined through a combination of the WRP designation and whether or not first-cycle birds were at least six months of age (Pyle et al. 2017b).

Breeding status of each species seen, heard, or captured at each TMAPS station on each day of operation was recorded, using techniques similar to those employed for breeding bird atlas projects, as confirmed breeder, likely breeder, or non-breeder (DeSante et al. 2017). Habitat data were collected for each station following Nott et al. (2003), and using the vegetation classification system of Viereck et al. (1992). For this report we broadly categorized habitat at the 18 stations, based on these assessment data, as either *Coastal Habitat*, *Lowland Forest*, or *Upland Forest* (Tables 1-3). We verified banding data by running all records through a series of specialized computer programs to (1) check the validity of all codes entered and the ranges of all numerical data, (2) compare station, date, and net fields from the banding data with those from the effort and breeding status data, (3) cross-check species, age, and sex determinations against data such as skull pneumatization and breeding characters indicative of age and sex, and (4) detect unusual or duplicate band numbers, unusual band sizes, or recaptures indicating inconsistent species, age, or sex determinations. Discrepancies or suspicious data identified by these programs were corrected by hand, if necessary. We used wing chord, body mass, fat content, date and station of capture, and pertinent plumage criteria as supplementary information for correct final determinations of species, age, and sex (Pyle et al. 2016b, 2017b). As mentioned above, photographs of most captures were examined to provide additional verification of age and sex determinations.

For each species and for all species pooled, we calculated (1) numbers of newly banded birds, recaptured birds, and birds released unbanded; (2) numbers and capture rates of individual birds at each station (birds per 600 net-hours, a standard unit for between-station or regional comparisons; DeSante et al. 2017); and (3) the ratio of young to adult birds representing a reproductive index (Peach et al. 1996). We used these standardized indices to make comparisons of bird dynamics between stations and among the three islands and all three habitat groups. Using capture-mark-recapture (CMR) models, we estimated population change (λ; where $\lambda<1$ indicates a declining population and $\lambda>1$ indicates an increasing population) by applying Pradel reverse-time CMR models to MAPS data (Pradel 1996). We also estimated monthly survival (φ; the probability an adult bird will survive and return from one pulse to the next), recapture probability (*p*; the probability that an adult bird that did survive will return to the area where it was present in the previous pulse), and proportion of residents (τ; the estimated proportion adult birds captured that were resident to the station), using Cormack-Jolly-Seber (CJS) models that account for the presence of transient (White and Burnham. 1999, Nott and DeSante 2002, Hines et al. 2003). For each of these parameters we considered several models as outlined by DeSante et al. (2015) and weighted the results using the Akaike's Information Criteria (*AIC*). We present model average results (i.e. the mean of each parameter weighted by the *AICc)*. Yearly estimates of survival (monthly survival, φ, to the power 12) were also presented for ease of comparison to annual survival estimates normally presented in the literature. We ran all CMR models with

Program MARK (White and Burnham 1999), using the RMark package (Laake and Rexstad 2008), in version 3.4.1 of the statistical package R (R Development Core Team 2017). Estimates were based on six years of station operation on Tutuila (25 pulses during the 2013-2018 seasons), five years of operation on Ta'u (18 pulses during the 2014-2018 seasons), and three years of operation on Ofu-Olosega (10 pulses during the 2016-2018 seasons). Estimates were generated for five target species for which at least two between-pulse recaptures were recorded, and calculated survival and recapture probabilities were realistic (neither 0.0 or 1.0).

Because Tongan Ground Doves were listed as a Federally Endangered Species in 2016, we collected samples of blood and feathers, took buccal (cheek), tracheal (throat), and cloacal swabs, and collected excrement opportunistically. Blood samples will be used for gender confirmation and molecular genetic, pathogen, and contamination studies. For each bird no more than 250 ul (0.2 cc) of blood was drawn from the brachial vein of the underwing following the protocols of Owen (2011). This represents well below the 1100 ul limit based on current guidelines requiring that < 1% of bird's weight in blood should be collected. Blood was stored on Nobuto strips (2 ea. per bird sampled), FTA Cards (2 ea.) and in Longmire buffer solution (1 ea.). Buccal, tracheal, and cloacal swabs were taken and stored in vials with 70% alcohol solution. Up to two rectrices and several breast or underpart feathers were collected and stored in dry envelopes following IBP protocols developed in 2008. These sampling protocols have each proven effective for genetic, isotopic, and pathogenic analyses when stored at room temperature for extended periods (Handel et al. 2006, Owen 2011, Keeler et al. 2012, Williams et al. 2016). Two biologists were present for all blood and swab sampling, one to hold the bird and the second to take the samples. Opportunistic fecal samples were also collected in order to study diet (Ralph et al. 1985). Blood and feather samples were collected only once per individual whereas swab and fecal samples were collected for both new captures and recaptures.

RESULTS

Landbird captures

Number of net-hours, a measure of effort, totaled 2493.37 on Tutuila, 1195.00 on Ta'u, and 2322.33 on Ofu-Olosega (Tables 1-3). Overall, we banded 81 birds on Tutuila, 81 birds on Ta'u, and 174 birds on Ofu-Olosega; we recaptured 26 birds on Tutuila, 30 birds on Ta'u and 89 birds on Ofu-Olosega; and 8 birds on Tutuila, 4 birds on Ta'u, and 9 birds on Ofu-Olosega were released unbanded (Table 4). We therefore recorded a total of 115 captures on Tutuila, 115 captures on Ta'u, 272 captures on Ofu-Olosega, and 502 captures overall (Table 4). This represents a 36.1% decrease over the 792 captures during the 2017 season (see below regarding capture rates); this was due in large part to not operating three stations on Ta'u and to down time due to cylcone-related inclement weather during the 2018 season. Thirteen species were captured during the 2018 season (see Appendix for scientific names), 7 on Tutuila, 8 on Ta'u, and 10 on Ofu-Olosega. These captures included one species, Buff-banded Rail, that is a non-target species in our TMAPS Program.

The most commonly captured species on all thee islands combined were Polynesian Wattled-Honeyeater (236 captures), followed by Pacific Kingfisher (90), Samoan Starling (68), Samoan Shrikebill (31), Polynesian Starling (11), Tongan Ground Dove (7), Crimson-crowned Fruit Dove (5), Jungle Myna (5), Blue-crowned Lorikeet (2), Buff-banded Rail (1), Pacific Imperial

Pigeon (1), Pacific Long-tailed Cuckoo (1), and White-rumped Swiftlet (1). Species captured in previous years but not during the 2016 season have included White-tailed Tropicbird, Pacific Golden-Plover, White Tern, Purple Swamphen, Many-colored Fruit Dove, Cardinal Myzomela, Red-vented Bulbul, and Common Myna (see Appendix for scientific names).

Summaries of captures of each species during the TMAPS 2018 season (November 2017 through March 2018) are provided for each station on Tutuila (Table 5), Ta'u (Table 6), and Ofu-Olosega (Table 7). On Tutuila (Table 5), when all species were pooled, the highest numbers of captures were recorded at the Malota station (33 captures), followed by Tula (29), Malaeloa (20), Vatia and Mount Alava (13 each), and Amalau (7). Species richness was highest at Malota, and Malaeloa (5 each) followed by Vatia and Amalau (4 each), Mount Alava (3), and Tula (2). On Ta'u (Table 6), the highest numbers of captures were recorded at Aokuso and Saunoa (42 each), followed by Fala'a (31), and species richness was highest at Saunoa (7) followed by Fala'a (5) and Aokuso (4). On Ofu-Olosega (Table 7), the highest numbers of captures were recorded at NPAS - Southeast (52), followed by Tumu Lower (50), Tumu Upper (46), Sili (45), Toaga Beach (40), and Oge Beach (39), and species richness was highest at Tumu Lower and Toaga Beach (6 each), followed by Sili (5), and NPAS - Southeast, Tumu Upper, and Oge Beach (4 each).

Landbird capture rates

Because of variation in the number of net-hours among islands and stations (Tables 1-3), it is best to compare overall population densities in terms of individual adults captured per 600 net-hours (Tables 4, 8-10). Among the three islands (Table 4), capture rate for all stations combined was low on Tutuila (20.2 adults per 600 net-hours), higher on Ta'u (41.2), and yet higher on Ofu-Olosega (47.5). Captures of young birds also were lowest on Tutuila (3.9 young per 600 net-hours), followed by Ta'u (10.0) and Ofu-Olosega (12.7), and reproductive success followed suit, being lowest on Tutuila (0.19 young per adult), followed by Ta'u (0.24), and Ofu-Olosega (0.34).

Among stations on each island, adult capture rates followed somewhat similar but not identical orders to those for number of captures (above). On Tutuila (Table 8), when all species were pooled, adult capture rates were highest at Malota (30.6 adults per 600 net-hours), followed by Tula (25.8), Vatia (21.7), Mount Alava (16.3), Amalau (13.9), and Malaeloa (12.7). Captures of young on Tutuila showed a different order among stations, being highest at Malota (7.1 young per 600 net-hours), followed by Vatia (6.5), Tula (5.1), Mount Alava (3.0), Malaeloa (1.0), and Amalau, which captured no young birds (0.0). Reproductive index showed more variation among stations, being highest at Vatia (0.30 young/adult), followed by Malota (0.25), Tula (0.20), Mount Alava (0.18), Malaeloa (0.08), and Amalau (0.00).

On Ta'u (Table 9), adult capture rates were highest at Aokuso (54.7 adults per 600 net-hours), followed by Saunoa (36.5) and Fala'a (36.0). Capture rates of young followed the same order than those of adults, being highest at Aokuso (15.1 young per 600 net-hours), followed by Saunoa (9.7), and Fa'ala (6.3), as did reproductive success, highest at Aokuso (0.28 young per adult), followed by Saunoa (0.27), and Fa'ala (0.17)

On Ofu-Olosega (Table 10), adult capture rates were highest at Tumu Upper (60.7 adults per 600 net-hours), followed by Toaga Beach (48.1), Tumu Lower (47.6), Sili (46.8), NPAS - Southeast

(38.8), and Oge Beach (35.4). Capture rates of young were highest at Tumu Lower (16.9 young per 600 net-hours), followed by NPAS - Southeast (14.4), Toaga Beach (13.0), Sili (11.7), Oge Beach (11.3), and Tumu Upper (8.4). Reproductive index was highest at NPAS - Southeast (0.37 young per adult), followed by Tumu Lower (0.36), Oge Beach (0.32), Toaga Beach (0.27), Sili (0.25), and Tumu Upper (0.14).

Between-year and between-island comparisons

To compare overall capture rates between 2017 and 2018 and among all three island groups, we present estimates of adult population size and reproductive success during each of the 2017 and 2018 seasons individually and for the 2014-2018 seasons pooled on Tutuila and Ta'u and 2016-2018 seasons pooled on Ofu-Olosega (Table 11). On Tutuila, adult population size decreased by 13% between 2017 and 2018 (from 23.25 to 20.05 adults per 600 net-hours) but the 2018 value was comparable with the mean for 2014-2018 (20.05). Reproductive success was similar in both 2017 and 2018 (0.19 young/adult each), lower than the mean for 2014-2018 (0.23). All species showed lower population sizes in 2018 than in 2017, indicting that the decrease appeared to be a species-wide phenomenon. Between-year changes in reproductive success were more varied, being higher in 2017 for Crimson-crowned Fruit Dove and Pacific Kingfisher but higher in 2018 for Polynesian Wattled-Honeyeater and the two starlings. Reproductive indices for these five species in 2018 were generally similar to those of 2014-2018 pooled.

On Ta'u, we only include data from the three stations operated in 2018 (Aokuso, Saunoa, and Fala'a) in Table 11, to best compare 2018 values with those of previous years. Adult population size was very similar between 2017 and 2018 (41.01 and 41.18 adults per 600 net hours, respectively) but reproductive index decreased by 43% between the two years, from 0.42 to 0.24 young/adult (Table 11). Population sizes during the two years were slightly lower than that of the 2014-2018 mean (47.06 adults/600 net-hours) while the mean reproductive success for 2014-2018 (0.28) was closer to the lower value of 2018. These between-year patterns were generally similar among all species, although, notably, both population size and reproductive success of Polynesian Wattled-Honeyeater was higher in 2018 than in 2017.

On Ofu-Olosega, adult population size increased between 2017 and 2018 (by 10.4%, from 41.42 to 45.73 adults per 600 net hours) while reproductive index showed virtually no change, 0.29 and 0.28 young/adult, respectively (Table 11). These values in 2018 were comparable with those for 2016-2018 combined (47.13 and 0.29, respectively). The increase in adults captured between 2017 and 2018 appears largely to be driven by that of Polynesian Wattled-Honeyeater (32% increase), with the rest of the species showing comparable values or lower values in 2018 than in 2017. Tongan Ground Dove showed a decrease in adult capture rate of 28.6%, from 2.17 to 1.55 adults per 600 net-hours, with that of the 2016-2018 seasons combined being in between (0.190). Although there was little overall difference in productivity of all species pooled between the two years, there was substantial variation among species. Pacific Kingfisher, Samoan Shrikebill, and Samoan Starling showed substantial decreases between the two years while Polynesian Wattled-Honeyeater showed a substantial increase (Table 11). Tongan Ground Dove showed a slight decrease in productivity between 2017 (0.30) and 2018 (0.26), and both of these indices were lower than the 2016-2018 mean (0.34), but due to low sample sizes in captures of this species, these values can be considered comparable.

Adult capture rates for all species pooled during the five seasons combined (2014-2018) were much lower on Tutuila (20.05 adults per 600 net-hours) than they were on Ta'u (47.06) (Table 11). Reproductive index during these five years was also lower on Tutuila (0.23 young/adult) than on Ta'u (0.28). Although data from Ofu-Olosega were only collected in 2016-2018, a comparison of all values in Table 11 indicates that population sizes (47.13 adults/600 net-hours) and productivity (0.29 young/adult) there are closer to those of Ta'u than those of Tutuila.

Among landbird species captured on two or more islands, population sizes showed variable differences, Crimson-crowned Fruit Dove and Polynesian Starling being captured at higher rates on Tutuila; Samoan Shrikebill and Samoan Starling showing higher rates on Ta'u; and Pacific Kingfisher showing a higher rate on Ofu-Olosega. Capture rates of adult Polynesian Wattled-Honeyeaters were comparable on Ta'u and Ofu-Olosega and lower on Tutuila. Adult capture rates may not reflect those of the islands overall as they depend highly on specific locations of stations. However, reproductive success, being based on a proportion, may be more indicative of island-specific differences. Crimson-crowned Fruit Dove and Pacific Kingfisher showed higher or comparably high productivity on Tutuila than on the other two islands; Polynesian Starling showed higher productivity on Ta'u than on the other two islands, and Polynesian Wattled-Honeyeater and Samoan Starling showed higher productivity on Ofu-Olosega than on the other two islands; productivity for Samoan Shrikebill was similar on Ta'u and Ofu-Olosega.

Capture rates and productivity by habitat

In order to assess patterns of landbird demography by habitat type, we used our habitat assessment data to define three broad habitat categories among the 18 stations, Coastal Habitat, Lowland Forest, and Upland Forest (Tables 1-3, 12). Stations of each category were found on all three island groups. We made two comparisons, using data collected during the 2014-2018 seasons from 12 stations on Tutuila and Ta'u and using data collected during the 2016-2018 seasons from 18 stations on all three island groups (Table 12). For all species pooled, adult capture rates were reasonably comparable among habitat types in both time-series analyses, although rates were lower in Upland Forests than in the lower-elevation habitats on Tutuila and Ta'u during 2014-2018 seasons and they were higher in the coastal habitats than in the higher-elevation habitats on all three island groups during the 2016-2018 seasons. In both time-series analyses, productivity was highest in the Lowland Forests and lower in Coastal Habitats and Upland Forests, which in turn appeared comparable to each other in productivity index (Table 12).

Each species appeared to show differing habitat preferences. Tongan Ground Doves, Pacific Kingfishers, and Samoan Starlings were clearly found at higher abundances in Coastal Habitats, followed by lowland forests, and showing lowest abundances in Upland Forests. Samoan Shrikebills, Polynesian Starlings, and possibly Crimson-crowned Fruit Doves showed a different pattern, generally being found at higher abundances in Upland and Lowland forests and lower in Coastal Habitats. Blue-crowned Lorikeet shows an interesting pattern of less abundance in Lowland Forests than the other two habitat types, whereas Cardinal Myzomelas may be found most commonly in Lowland Forests on Tutuila. Finally, Polynesian Wattled- Honeyeaters were found at comparable high densities in all forest types.

Productivity also showed different patterns by habitat type among species, and also showed different patterns than population abundance within species. Crimson-crowned Fruit Doves showed higher productivity in the Upland Forests than the other two habitat types, Pacific Kingfisher and Polynesian Wattled-Honeyeater showed higher productivity in Lowland Forests than in the other two habitat types, and Tongan Ground Dove showed higher productivity in Coastal Habitats than in the forested habitats. The remaining four species with adequate productivity data, Blue-crowned Lorikeet, Samoan Shrikebill and the two starlings, showed mixed results, suggesting that productivity might be comparable within all three habitat types.

Population trends and survivorship

Estimates of population trend (lambda, λ) monthly and annual adult survival rates (φ), recapture probability (p), and proportion of residents (τ), using monthly recapture data from the 2013-2018 seasons on all three island-groups, are shown in Table 13 and Figure 4. Four other target species, Tongan Ground Dove, Crimson-crowned Fruit Dove, Blue-crowned Lorikeet, and Cardinal Myzomela, had sufficient capture and recapture data for both analyses but these resulted in survivorship or recapture values of either 0.0 or 1.0, which are unrealistic and indicate that more data are needed to produce valid estimates.

Lambda (λ) values of < 1.0 indicate declining populations and those > 1.0 indicate increasing populations (Table 13); significance of the changes can be assessed by whether or not confidence intervals cross 1.0 in Figure 4A. Most species-specific values were similar among the three islands, varying more between species. Pacific Kingfisher appears to be consistently declining by a similar small margin (λ = 0.991-0.992) with declines on all three islands being significant or nearly significant (Fig. 4A). Polynesian Wattled-Honeyeater showed more-or-less stable populations on all three islands (λ = 0.996-0.999) with little between-year variation in indicators and non-significant trends (Fig. 4A). Samoan Shrikebill showed significant increases on both Ta'u and Ofu-Olosega (λ = 1.060-1.062; Fig. 4A). Polynesian Starling also showed increases on both Tutuila and Ta'u (λ = 1.011-1.019), with that of Ta'u being significant. Samoan Starling showed stable population trends on Tutuila and Ta'u (Table 13, Fig. 4) but a significant decline on Ofu-Olosega (λ = 0.974; Fig. 4A). Standard-error bars (Fig. 4) are much smaller as compared with those after the 2017 season (Pyle et al. 2017a), indicating increases in the precision of our lambda estimates.

Survivorship estimates, using transient models on monthly (pulse) recapture data for the five species, are shown in Table 13. Annual (yearly) estimates extrapolated from the monthly estimates are also shown in Table 13, along with confidence intervals in Figure 4B. Annual (yearly) survival estimates were relatively high, with values ranging from 0.600 (Samoan Starling on Tutuila) to 0.948 (Polynesian Starling on Ta'u). The mean estimate for the 13 species/island estimates was 0.756. Higher estimates were generally recorded for Polynesian Wattled-Honeyeater and Samoan Shrikebill and lower estimates were generally recorded for Pacific Kingfisher and Samoan Starling; however, variably high ranges in variation for Samoan Shrikebill and the two starling species (Fig. 4B) indicate low precision for these estimates. We anticipate the precision of these estimates to improve after more years of data are collected.

Recapture probabilities ranged from a low of 0.012 (Samoan Starling on Ta'u) to a high of 0.219 (Pacific Kingfisher on Ta'u and Ofu-Olosega) with a mean of 0.90, and proportion of residents ranged from a low of 0.639 (Samoan Starling on Ofu-Olosega) to a high of 0.948 (Polynesian

Wattled-Honeyeater on Tutuila), with a mean of 0.789.

DISCUSSION

During the 2018 season, we recorded 115 captures on Tutuila, 115 captures on Ta'u, and 272 captures on Ofu-Olosega, totaling 502 captures overall, of 13 bird species. This represents a 37% decrease over the 792 captures during the 2017 season. Most of this decrease in captures was due to much fewer net-hours on Ta'u (1195 during the 2018 season vs. 2767 during the 2017 season), resulting from the inability to operate three stations in 2018, and to reduced effort during and following the passage of Cylcone Gita on 9-10 February 2018 (see below). Ta'u has previously been the island group with the highest numbers of captures so the missed data collection from three stations there this season impacted the overall capture totals.

Using a standard capture-rate index (individual adults per 600 net-hours), estimated population sizes for all species pooled decreased by 13% between the 2017 and 2018 seasons on Tutuila, they were very comparable on Ta'u between the two years, and they increased by 10% on Ofu-Olosega. On Tutuila, population sizes during the 2018 season were comparable to the five-year (2014-2018) mean but lower than the five-year and three-year (2016-2018) means on Ta'u and Ofu-Olosega, respectively. Reproductive index for all species pooled, was comparable between the 2017 and 2018 seasons on Tutuila and Ofu-Olosega, but it decreased by 43% on Ta'u, following, however, a substantial increase here between the 2016 and 2017 seasons (Pyle et al. 2017a). These reproductive indices are generally quite low compared to equivalent values among North American landbirds (DeSante et al. 2015). The 2018 productivity values were lower than the five-season (2014-2018) mean on Tutuila and Ta'u, and comparable to the three-season (2016-2018) mean on Ofu-Olosega.

These values indicate how between-year landbird population dynamics can vary from island to island and from year to year. In addition, the dynamic also varied among species within each island-group. On Tutuila and Ofu-Olosega, most of the species followed the overall between-season differences in population size and productivity noted above, indicating island-wide effects on population-size dynamics. However, on Ta'u, population sizes showed more variability, with several departing from the changes in all species pooled. On all three islands, furthermore, changes in productivity values departed substantially from the overall patterns, in both directions, for many species. Our data thus indicate that landbird dynamics are clearly complex and operate on season-specific, island-specific, and species-specific bases.

In order to assess patterns of landbird demography by habitat type, we used our habitat assessment data to define three broad habitat categories among the 18 stations, Coastal Habitat, Lowland Forest, and Upland Forest. For all species pooled, adult capture rates were reasonably comparable among the three habitat types, whereas productivity was higher in the Lowland Forests than in Coastal Habitats and Upland Forests. Native Samoan species showed differing habitat preferences for breeding adults, with Tongan Ground Doves, Pacific Kingfishers, and Samoan Starlings at higher abundances in Coastal Habitats, whereas Samoan Shrikebills, Polynesian Starlings, and possibly Crimson-crowned Fruit Doves were found at higher abundances in Upland Forests. Polynesian Wattled- Honeyeaters were found at comparable high densities in all forest types. Productivity also showed different patterns by habitat type among species, and also showed different patterns than population abundance within species: Crimson-crowned Fruit Doves showed higher productivity in the Upland Forests than the other two habitat types, Pacific Kingfisher and Polynesian Wattled-Honeyeater showed higher productivity in Lowland Forests than in the other two habitat types, Tongan Ground Dove showed higher productivity in Coastal Habitats than in the forested habitats, and Blue-crowned Lorikeet, Samoan Shrikebill and the two starlings showed mixed results suggesting that productivity might be comparable within all three habitat types.

The varying habitat responses of each species, both in population abundance and productivity, underscores the need to conserve a mosaic of all habitat types in American Samoa. This may be most important for Tongan Ground Doves, Pacific Kingfishers, and Samoan Starlings, as coastal habitats are generally those most impacted in Samoa and other Pacific islands. It should be noted that variation in productivity values may indicate post-juvenile dispersal patterns as well as immediate local productivity, juveniles potentially seeking out non-natal habitats for protection or nutritional reasons, as is found in North American landbirds (DeSante et al. 2015). More years of data collection in American Samoa will enable us to examine patterns in yearling proportions (those of one-year old vs. older breeders) as compared with patterns in post-juveniles, shedding more light on this question.

We have now gained enough data to calculate relatively precise estimates of population trend (lambda, λ) monthly and annual adult survival rates, recapture probability, and proportion of residents, for five native Samoan landbird species using monthly recapture data from the 2014-2018 seasons. Lambda values indicate that Pacific Kingfisher on all three islands, and Samoan Starling on Ofu-Olosega are declining, Samoan Shrikebill populations on both Ta'u and Ofu-Olosega and Polynesian Starling populations on Ta'u are increasing, and populations of Polynesian Wattled-Honeyeater on all islands, Polynesian Starling on Tutuila, and Samoan Starling on Tutuila and Ta'u are stable. Standard-error bars for lambda values are much smaller as compared with those after the 2017 season (Pyle et al. 2017a), indicating increases in the precision of our lambda estimates.

The mean survival estimate for 13 species/island estimates among these five species was 0.756, compared with typical survivorship estimates for continental North American species of between 0.5 and 0.6 (DeSante et al. 2015). Higher estimates were generally recorded for Polynesian Wattled-Honeyeater and Samoan Shrikebill and lower estimates were recorded for Pacific Kingfisher and Samoan Starling; however, variably high ranges in variation for some species indicate low precision for these estimates. Precision improved over the estimates after the 2017 season (Pyle et al. 2017a) and we anticipate their continued improvement after more years of data are collected. The mean recapture probability was 0.90, and the mean proportion of residents was 0.789. Compared to data from North American MAPS stations (DeSante et al. 2015), these are generally low and high values, respectively. High proportion of residents is expected in insular landbird populations but the low capture probabilities is of interest and may suggest net-avoidance or large territories in these populations.

Overall it appears that American Samoan landbirds may maintain population stability through relatively high survival and low productivity, more of a K-selected strategy as compared with

North American landbirds. This is perhaps not surprising on a tropical island, where risks of mortality are low, such as those associated with harsh weather or the need for migration, as occur in North America.

A notable event during the 2018 season was the passage of Cyclone Gita over American Samoa on 9 February 2018, causing widespread damage, flooding, landslides, and forest destruction. On 9-10 February, rainfall in Pago Pago exceeded 155 mm (6 in). On Tutuila, severe damage and tree fall occurred at most stations, but especially at Malota and Amalau, where the vast majority of the canopy and sub-canopy was denuded or destroyed and large trees fell throughout the station area. Operations at Amalau had to be suspended for the season, and the February pulses were missed at Malota and Vatia due to damage and/or access issues. Damage was less severe on Ta'u and Ofu-Olosega, although the canopy was denuded and there was substantial flooding at Tumu Upper and Tumu Lower stations on Ofu. We responded by fully documenting the damage at each station (where possible) with photographs and additional post-cyclone habitat assessments to compare with those before damage was incurred. We will also be performing additional assessments during the 2019 season and examining remote-sensed information to further assess changes caused by Cyclone Gita. We plan an analysis of the effects of storm damage on landbird demographics, as we have done for a similar case in Saipan (Helton et al. 2018).

Clearly our data will enable an examination of bird demography at a community based level, given the differing responses we observed among species on different islands and among different years, as likely related to weather and climate, and the different responses of both breeding population density and productivity to habitat types among and within species and island groups. More data will be required to fully understand these dynamics, and we are confident that, as we accumulate more years of data, not only will the precision of our estimates increase, but we will be able to calculate lambda and survivorship for at least three additional target species, Tongan Ground Dove, Crimson-collared Fruit Dove, and Blue-crowned Lorikeet. We have enough data following the 2018 season to analyze demographic responses to remote-sensed vegetation greenness, as we have with our TMAPS program in Saipan (Saracco et al. 2016), and we plan an analysis for publication to be submitted in 2019.

The establishment of the TMAPS Program on Ofu-Olosega has greatly increased our data set on landbird captures in American Samoa. A corollary goal of the establishment of these stations is to gather information on the small population of Tongan Ground Doves residing on these islands. Our capture of 17 individuals and one recapture during the 2016 season, 11 captures and two recaptures during the 2017 season, and 7 captures and one recapture during the 2018 season has enabled us to confirm age and sex criteria for this species in American Samoa (Pyle et al. 2016b, 2017b), and has provided critical information on breeding condition, molt strategies, biometrics, and weights for this Endangered species. Although fewer captures were recorded each year from 2016 to 2018, the capture rates (adults per 600 net hours) did not drop as much, and the low sample sizes are such that the declines cannot yet be considered biologically significant. For all 20 captures of Tongan Ground Doves during the 2017 and 2018 seasons we collected feather, blood, and/or swab samples to investigate genetic differentiation, pathogens, and diet. Our TMAPS data on this species further allowed us to instigate a separate project on the Tongan Ground Dove to apply remote-tracking technology and to record the vocalizations and assess playback experiments covering the period January - December 2018. Our goals for this project will include: 1) assessing the best remote-tracking methodologies to use on Tongan Ground-Doves; 2) assessing whether or not playback methodologies can be employed to allow target capture and better population surveying; and 3) collecting preliminary data on other natural-history aspects of Tongan Ground-Doves on Ofu and Olosega Islands. The results of this project will be reported on in January 2019. This information will be applied to the management of this population, which was listed as Endangered under the USFWS Endangered Species Act in September 2016 (Rosa 2007; USFWS 2015, 2016).

The current TMAPS sampling protocol is yielding critical data on the population dynamics and habitat use patterns for five target native landbird species on Tutuila, Ta'u, and Ofu-Olosega. Continued data collection should enhance the precision of current estimates and add up to three more target species in which full demographic data can be collected. Our goal is to continue to operate six stations on each of the three island groups during November-March of each season in coming years, to further understand year-to-year and inter-island-group dynamics, and to examine these dynamics using a community-based approach. We can then begin applying results of these analyses to inform land-management recommendations for habitat conservation or restoration. The need for such approaches is pressing given the many potential threats to the persistence of Pacific insular populations such as habitat loss, avian disease, and exotic predators such as brown treesnake (*Boiga irregularis*), which has reduced or eliminated many landbirds on Guam in the Mariana Islands (Frits and Rhodda 1998). We look forward to continuing this important work in the coming years.

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Table 1. Summary of the TMAPS program and habitat designations on the island of Tutuila, American Samoa (AMSA) during the 2018 season.

Station					November 2018 – March 2018 operation		
Name	Code	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	Total number of net-hours	No. of pulses	Inclusive dates
Vatia	VATI	Mixed, old-growth and secondary lowland tropical forest on a hillside with banana and coconut plantation at base. *Lowland Forest*	14°14'41"S, 170°40'35"W	135	276.67	3	1/20/18 - 3/17/18
Tula	TULA	Primary forest on steep ridge with mature *Callophylum* and *Dysoxylum* trees. *Upland Forest*	14°14'58"S, 170°34'35"W	380	466.00	4	12/22/17 - 03/07/18
Amalau	AMAL	Mixed, old-growth and secondary lowland tropical forest; some plantation. *Coastal Habitat*	14°15'19"S, 170°39'32"W	35	259.00	2	12/14/17 - 01/11/18
Mount Alava	MTAL	Old-growth steep-slope, tropical forest; some secondary forest and plantation. *Upland Forest*	14°17'05"S, 170°42'46"W	215	405.00	4	12/19/17 – 03/05/18
Malota	MALO	Ridge-spine, natural tropical forest. *Lowland Forest*	14°18'17"S, 170°49'11"W	144	470.33	3	12/11/17 – 03/02/18
Malaeloa	MALA	Old-growth moderate-slope, lowland tropical evergreen forest; ephemeral wetlands. *Coastal Habitat*	14°19'50"S, 170°46'26"W	43	616.17	4	12/05/17 – 02/28/18
ALL STATIONS					2493.17	4	12/05/17 – 03/17/18

Table 2. Summary of the TMAPS program and habitat designations on the island of Ta’u, American Samoa (AMSA) during the 2018 season.

Station					November 2017 – March 2018 operation		
Name	Code	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	Total number of net-hours	No. of pulses	Inclusive dates
Aokuso	AOKU	Agriculturally managed secondary forest bordering herbaceous sand strand *Coastal Habitat*	14°12'49"S, 169°27'13"W	43	318.00	3	1/22/18 – 03/08/18
Saunoa	SNOA	Agriculturally managed land with some moderate-slope secondary forest alongside clearcut plantation. *Upland Forest*	14°13'11"S, 169°30'14"W	435	493.67	3	12/29/17 – 03/02/18
Usu Nua	USUN	Agriculturally managed secondary forest. *Lowland Forest*	14°13'59"S, 169°30'39"W	210			not operated this season
Fala’a	FALA	Gentle-slope mature lowland secondary forest. *Lowland Forest*	14°14'49"S, 169°29'59"W	424	383.33	3	01/04/18 – 03/06/18
NPAS - Laufuti Stream	LAUF	Gentle-slope mature lowland secondary forest. *Upland Forest*	14°14'54"S, 169°26'31"W	835			not operated this season
NPAS- Luamaa	LUAM	Coral rubble lowland littoral forest. *Coastal Habitat*	14°15'24"S, 169°25'28"W	8			not operated this season
ALL STATIONS					1195.00	3	12/29/17 – 03/08/18

Table 3. Summary of the TMAPS program and habitat designations on the islands of Ofu-Olosega, American Samoa (AMSA) during the 2018 season.

Station		Major Habitat Type	Latitude-longitude	Avg Elev. (m)	November 2017 – March 2018 operation: Total number of net-hours	No. of pulses	Inclusive dates
Ofu Island							
Tumu Lower	TUML	Agriculturally managed lowland forest. *Lowland Forest*	14°10'05"S, 169°40'32"W	94	390.67	3	01/22/18 – 03/13/18
National Park Southeast	NPSE	Coastal lowland forest bordering sand strand. *Coastal Habitat*	14°10'15"S, 169°38'42"W	5	417.67	3	01/18/18 – 03/10/18
Toaga Beach	TOAG	Coastal lowland forest, bordering sand strand and talus slope. *Coastal Habitat*	14°10'34"S, 169°39'14"W	13	324.00	3	01/25/18 – 03/15/18
Tumu Upper	TUMU	Disturbed montane forest; microwave station at summit. *Upland Forest*	14°10'34"S, 169°39'36"W	477	356.00	3	01/15/18 – 03/06/18
Olosega Island							
Sili	SILI	Reclaimed old village site; coral rubble lowland littoral forest. *Coastal Habitat*	14°09'43"S, 169°37'05"W	12	410.00	3	01/29/18 – 03/17/18
Oge Beach	OGEB	Montane rain forest with low canopy, few saplings, and moderate to heavy ground cover. *Lowland Forest*	14°11'15"S, 169°36'50"W	144	424.00	3	01/02/18 – 03/03/18
ALL STATIONS					2322.33	3	01/02/18 – 03/17/18

Table 4. Summary of combined results for all 15 American Samoan TMAPS stations operated during the 2018 season, December 2017 through March 2018.

	Island of Tutuila (6 stations)						Island of Ta'u (3 stations)						Island of Ofu-Olosega (6 stations)					
	Birds captured			Birds/600 net-hours			Birds captured			Birds/600 net-hours			Birds captured			Birds/600 net-Hours		
Species[1]	Newly banded	Un-band	Recap-tured	Adult	Young	Repr. Index	Newly banded	Un-band	Recap-tured	Adult	Young	Repr. Index	Newly banded	Un-band	Recap-tured	Adult	Young	Repr. Index
Buff-banded Rail														1				
Tongan Ground Dove													6		1	1.6	0.3	0.17
Crimson-crowned Fruit Dove	2			0.5	0.0	0.00	1			0.5	0.0	0.00	2			0.5	0.0	0.00
Pacific Imperial Pigeon														1				
Pacific Long-tailed Cuckoo														1				
White-rumped Swiftlet								1										
Pacific Kingfisher	14		15	3.6	1.9	0.53	2		2	1.5	0.0	0.00	27		30	8.3	2.6	0.31
Blue-crowned Lorikeet							2			0.5	0.5	1.00						
Polynesian Wattled-Honeyeater	53		10	13.5	1.4	0.11	42	2	20	25.6	4.0	0.16	99	3	47	26.4	7.0	0.27
Samoan Shrikebill							8		4	4.0	1.0	0.25	14		5	3.4	1.0	0.31
Polynesian Starling	4			0.7	0.2	0.33	6			2.0	1.0	0.50	1			0.3	0.0	0.00
Samoan Starling	8		1	1.9	0.2	0.13	20	1	4	7.0	3.5	0.50	25	3	6	5.4	1.8	0.33
Jungle Myna		5																
All Species Pooled	81	8	26	20.2	3.9	0.19	81	4	30	41.2	10.0	0.24	174	9	89	47.5	12.7	0.28
Total Number of Captures		115						115						272				
Number of Species	5	2	3	5	4		7	3	4	7	5		7	5	5	7	5	
Total Number of Species		7			5			8			7			10			7	

[1] Scientific names given in Appendix I.

Table 5. Capture summary for the six individual TMAPS stations operated on the island of **Tutuila**, American Samoa (AMSA) during the 2018 season, December 2017 through March 2018. N = Newly banded, U = Unbanded, R = Recaptures of banded birds.

	Vatia			Tula			Amalau			Mount Alava			Malota			Malaeloa		
Species[1]	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Crimson-crowned Fruit Dove	1						1											
Pacific Kingfisher	2			5		7			3	1		1	4		4	2		
Polynes. Wattled-Honeyeater	7		1	14		3			1	10			14		3	8		2
Red-vented Bulbul																	3	
Polynesian Starling													2			2		
Samoan Starling	2						1		1	1			4					
Jungle Myna														2			3	
All Species Pooled	12	0	1	19	0	10	2	0	5	12	0	1	24	2	7	12	6	2
Total Number of Captures		13			29			7			13			33			20	
Number of Species	4	0	1	2	0	2	2	0	3	3	0	1	4	1	2	3	2	1
Total Number of Species		4			2			4			3			5			5	

[1] Scientific names given in Appendix I.

Table 6. Capture summary for the three individual TMAPS stations operated on the island of **Ta’u**, American Samoa (AMSA) during the 2018 season, December 2017 through March 2018. N = Newly banded, U = Unbanded, R = Recaptures of banded birds.

	Aokuso			Saunoa			Fala’a		
Species[1]	N	U	R	N	U	R	N	U	R
White-rumped Swiftlet								1	
Crimson-crowned Fruit Dove				1					
Pacific Kingfisher			1	1		1	1		
Samoan Starling	15	1	3	5		1			
Polynesian Starling	1			4			1		
Polynesian Wattled-Honeyeater	15		6	13	1	9	14	1	5
Blue-crowned Lorikeet				2					
Samoan Shrikebill				3		1	5		3
All Species Pooled	31	1	10	29	1	12	21	2	8
Total Number of Captures		42			42			31	
Number of Species	3	1	3	7	1	4	4	2	2
Total Number of Species		4			7			5	

[1] Scientific names given in Appendix I.

Table 7. Capture summary for the six individual TMAPS stations operated on the island of **Ofu-Olosega**, American Samoa (AMSA) during the 2018 season, January 2018 through March 2018. N = Newly banded, U = Unbanded, R = Recaptures of banded birds.

	Ofu Island												Olosega Island					
	Tumu Lower			NPAS Southeast			Toaga Beach			Tumu Upper			Sili			Oge Beach		
Species[1]	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Crimson-crowned Fruit Dove										2								
Pacific Kingfisher	8		1	8		20	4		2				2		2	5		5
Samoan Starling	4	1	2		1	1	10	1	2				8		1	3		
Polynesian Starling										1								
Polynes. Wattled-Honeyeater	23	1	7	14	1	5	9		7	16		13	19		10	18	1	5
Pacific Long-tailed Cuckoo		1																
Pacific Imperial Pigeon								1										
Tongan Ground Dove	1						2						1		1	2		
Buff-banded Rail														1				
Samoan Shrikebill	1			2			2			9		5						
All Species Pooled	37	3	10	24	2	26	27	2	11	28		18	30	1	14	28	1	10
Total Number of Captures		50			52			40			46			45			39	
Number of Species	5	3	3	3	2	3	5	2	3	4		2	4	1	4	4	1	2
Total Number of Species		6			4			6			4			5			4	

[1] Scientific names given in Appendix I.

Table 8. Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the six individual MAPS stations operated on the island of **Tutuila**, American Samoa (AMSA) during the 2018 season, December 2017 through March 2018.

	Vatia			Tula			Amalau			Mount Alava			Malota			Malaeloa		
Species[1]	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.
Crimson-crowned Fruit Dove	2.2	0.0	0.00				2.3	0.0	0.00									
Pacific Kingfisher	2.2	2.2	1.00	5.1	3.9	0.75	4.6	0.0	0.00	1.5	1.5	1.00	6.4	3.8	0.60	1.9	0.0	0.00
Polynes. Wattled-Honeyeater	13.0	4.3	0.33	20.6	1.3	0.06	2.3	0.0	0.00	13.3	1.5	0.11	19.1	1.3	0.07	8.8	1.0	0.11
Polynesian Starling													1.3	1.3	1.00	1.9	0.0	0.00
Samoan Starling	4.3	0.0	0.00				4.6	0.0	0.00	1.5	0.0	0.00	3.8	1.3	0.33			
All Species Pooled	21.7	6.5	0.30	25.8	5.1	0.20	13.9	0.0	0.00	16.3	3.0	0.18	30.6	7.7	0.25	12.7	1.0	0.08
Number of Species	4	2		2	2		4	0		3	2		4	4		3	1	
Total Number of Species		4			2			4			3			4			3	

[1] Scientific names given in Appendix I.

Table 9. Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the three individual MAPS stations operated on the island of **Ta'u**, American Samoa (AMSA) during the 2018 season, December 2017 through March 2018.

	Aokuso			Saunoa			Fala'a		
Species[1]	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.
Crimson-crowned Fruit Dove				1.2	0.0	0.00			
Pacific Kingfisher	1.9	0.0	0.00	1.2	0.0	0.00	1.6	0.0	0.00
Blue-crowned Lorikeet				1.2	1.2	1.00			
Polynes. Wattled-Honeyeater	34.0	3.8	0.11	21.9	3.6	0.17	23.5	4.7	0.20
Samoan Shrikebill				2.4	1.2	0.50	9.4	1.6	0.17
Polynesian Starling	1.9	0.0	0.00	2.4	2.4	1.00	1.6	0.0	0.00
Samoan Starling	17.0	11.3	0.67	6.1	1.2	0.20			
All Species Pooled	54.7	15.1	0.28	36.5	9.7	0.27	36.0	6.3	0.17
Number of Species	4	2		7	5		4	2	
Total Number of Species		4			7			4	

[1] Scientific names given in Appendix I.

Table 10. Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the six individual MAPS stations operated on the island of **Ofu-Olosega**, American Samoa (AMSA) during the 2018 season, January 2018 through March 2018.

	Ofu Island												Olosega Island					
	Tumu Lower			NPAS - Southeast			Toaga Beach			Tumu Upper			Sili			Oge Beach		
Species[1]	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.	Ad.	Yg.	Rep. Ind.
Tongan Ground Dove	1.5	0.0	0.00				3.7	0.0	0.00				2.9	0.0	0.00	1.4	1.4	1.00
Crimson-crowned Fruit Dove										3.4	0.0	0.00						
Pacific Kingfisher	7.7	6.1	0.80	20.1	5.7	0.29	7.4	1.9	0.25				5.9	0.0	0.00	7.1	1.4	0.20
Blue-crowned Lorikeet																		
Polynes. Wattled-Honeyeater	32.3	7.7	0.24	17.2	5.7	0.33	18.5	5.6	0.30	37.1	6.7	0.18	29.3	8.8	0.30	24.1	7.1	0.29
Samoan Shrikebill	1.5	0.0	0.00	0.0	2.9	und.[2]	1.9	1.9	1.00	18.5	1.7	0.09						
Polynesian Starling										1.7	0.0	0.00						
Samoan Starling	4.6	3.1	0.67	1.4	0.0	0.00	16.7	3.7	0.22				8.8	2.9	0.33	2.8	1.4	0.50
All Species Pooled	47.6	16.9	0.36	38.8	14.4	0.37	48.1	13.0	0.27	60.7	8.4	0.14	46.8	11.7	0.25	35.4	11.3	0.32
Number of Species	5	3		3	3		5	4		4	2		4	2		4	4	
Total Number of Species		5			4			5			4			4			4	

[1] Scientific names given in Appendix I.
[2] Reproductive index (young/adult) is undefined because no adults of this species were captured at this station in this year.

Table 11. Mean numbers of aged individual birds captured per 600 net-hours and reproductive index for MAPS stations pooled on each of the Islands of Tutuila (six stations) and Ta'u (the three stations operated in 2018), American Samoa, from November - March, during each of the seasons 2017 and 2018 and all five seasons, 2014-2018 combined. Comparable values are also shown for Ofu-Olosega, but for only the three seasons (2016-2018) in which stations were run on these islands.

	Island of Tutuila						Island of Ta'u[1]						Island of Ofu-Olosega					
	2017		2018		Mean 2014 – 2018		2017		2018		Mean 2014 - 2018		2017		2018		Mean 2016 – 2018	
Species[2]	Adult/ 600nh	RI	Adult/ 600nh	RI	Adult/ 600nh	RI	Adult/ 600nh	RI	Adult/ 600nh	RI	Adult/ 600nh	RI	Adult/ 600nh	RI	Adult/ 600nh	RI	Adult/ 600nh	RI
Tongan Ground Dove													2.17	0.30	1.55	0.26	1.90	0.34
Many-colored Fruit Dove					0.08	0.00												
Crimson-cr. Fruit Dove	0.82	0.25	0.48	0.05	0.78	0.18			0.50	0.00	0.51	0.00	0.22	0.00	0.52	0.00	0.42	0.00
Pacific Long-tailed Cuckoo					0.00	und.[3]							0.22	0.00	0.22	0.00	0.07	0.00
White-rumped Swiftlet					0.00	und.[3]												
Pacific Kingfisher	3.91	0.68	3.61	0.53	3.00	0.57	3.26	0.43	1.51	0.00	3.27	0.28	7.16	0.46	8.27	0.31	7.89	0.38
Blue-crowned Lorikeet							2.33	0.20	0.50	1.00	1.88	0.27						
Cardinal Myzomela	0.41	0.00	0.00	——	0.21	0.00												
Polyn. Wattled-Honeyeater	13.99	0.07	13.48	0.11	12.59	0.14	20.97	0.02	25.61	0.16	25.11	0.11	19.95	0.12	26.35	0.27	25.19	0.19
Samoan Shrikebill							5.13	0.64	4.02	0.25	4.19	0.55	3.69	0.47	3.36	0.31	3.19	0.55
Red-vented Bulbul					0.00	und.[3]												
Polynesian Starling	1.65	0.13	0.72	0.33	1.27	0.28	0.93	5.00	2.01	0.50	0.93	1.88	0.43	0.00	0.26	0.00	0.41	0.22
Samoan Starling	2.47	0.08	1.93	0.13	1.99	0.31	8.39	0.83	7.03	0.50	11.16	0.49	7.59	0.54	5.43	0.33	8.05	0.43
Jungle Myna					0.08	0.00												
Common Myna					0.05	0.00												
All Species Pooled	23.25	0.19	20.22	0.19	20.05	0.23	41.01	0.42	41.18	0.24	47.06	0.28	41.42	0.29	45.73	0.28	47.13	0.29

[1] Ta'u comparisons only include data from stations Aokuso, Saunoa, and Fala'a, those operated during the 2018 season
[1] Scientific names given in Appendix I.
[2] Reproductive index (young/adult) is undefined because no adults of this species were captured at this station in this year.

Table 12. Mean numbers of adults captured per 600 net-hours and reproductive index (young/adult) for 12 stations on Tutuila and Ta'u (2014-2018 seasons) and 18 stations on all three islands (2016-2018 seasons) by habitat type on American Samoa, for nine native Samoan landbirds and all landbird species pooled.

	Mean 2014-2018, Tutuila and Ta'u						Mean 2016-2018, all three islands					
	Coastal Habitat		Lowland Forest		Upland Forest		Coastal Habitat		Lowland Forest		Upland Forest	
Species[1]	Adult/ 600nh	RI	Adult/ 600nh	RI	Adult/ 600nh	RI	Adult/ 600nh	RI	Adult/ 600nh	RI	Adult/ 600nh	RI
Tongan Ground Dove							1.23	0.35	0.67	0.17		
Crimson-crwnd. Fruit Dove	0.29	0.00	0.77	0.04	0.76	0.20	0.32	0.00	0.49	0.00	0.63	0.17
Pacific Kingfisher	4.91	0.28	2.93	0.96	2.88	0.42	7.63	0.36	4.31	0.65	2.60	0.49
Blue-crowned Lorikeet	0.61	0.33	0.12	0.00	0.67	0.25	0.36	0.17	0.00	——	0.49	0.33
Cardinal Myzomela	0.00	——	0.28	0.00	0.08	0.00	0.00	——	0.23	0.00	0.10	0.00
Polyn. Wattled-Honeyeater	20.63	0.11	22.07	0.17	18.69	0.09	21.61	0.16	22.23	0.16	21.14	0.09
Samoan Shrikebill	0.00	——	2.98	0.48	2.10	0.61	0.15	2.00	1.77	0.90	5.75	0.44
Polynesian Starling	0.80	0.17	1.96	0.59	1.38	0.56	0.55	0.11	1.11	0.67	1.81	0.87
Samoan Starling	7.73	0.45	6.23	0.38	3.47	0.24	9.22	0.43	5.67	0.38	2.87	0.38
All Species Pooled	35.05	0.21	37.50	0.29	30.26	0.21	41.12	0.26	36.54	0.30	35.49	0.24

[1] Scientific names given in Appendix I.

[2] Coastal Tropical Forest includes the stations: AMAL, MALA, AOKU, LUAM*, NPSE, TOAG, SILI; Lowland Tropical Forest includes the stations: VATI, MALO, USUN*, FALA, TUML, OGEB; Upland Tropical Forest includes the stations: TULA, MTAL, SNOA, LAUF*, TUMU. * These three stations were not operated in 2018 but the data collected at these stations contributed to the means for the other years.

Table 13. Monthly estimates of population change, adult survival, recapture probability, and proportion of residents using a time-constant, transient model for five species. Yearly estimates for adult survival probability, extrapolated from monthly estimates, are also presented for all five species. All currently operating stations were included in the calculations of monthly estimates (26 pulses overall), including 25 pulses on Tutuila during the 2013-2018 seasons, 18 pulses on Ta'u during the 2014-2018 seasons, and 10 pulses on Ofu-Olosega during the 2016-2018 seasons[1].

		No.	No.	No. btwn-yr	Lambda[6] (population change)		Survival probability[7]			Recapture probability[8]		Proportion of residents[9]	
Species[2]	Island	stn.[3]	indv.[4]	recap.[5]	λ	SE(λ)	Monthly φ	SE(φ)	Yearly φ	*p*	SE(*p*)	τ	SE(τ)
Pacific Kingfisher	Tutuila	6	64	36	0.992	(0.004)	0.971	(0.007)	0.704	0.188	(0.037)	0.664	(0.107)
	Ta'u	6	60	48	0.991	(0.004)	0.970	(0.007)	0.693	0.219	(0.033)	0.730	(0.086)
	Ofu-Olosega	6	86	58	0.991	(0.004)	0.972	(0.008)	0.711	0.219	(0.031)	0.734	(0.082)
P. Wattled-Honeyeater	Tutuila	6	282	59	0.999	(0.003)	0.984	(0.006)	0.822	0.033	(0.007)	0.948	(0.051)
	Ta'u	6	487	140	0.998	(0.002)	0.981	(0.005)	0.791	0.070	(0.009)	0.886	(0.041)
	Ofu-Olosega	6	301	91	0.996	(0.004)	0.982	(0.006)	0.803	0.092	(0.012)	0.908	(0.031)
Samoan Shrikebill	Ta'u	4	52	27	1.062	(0.027)	0.989	(0.016)	0.871	0.076	(0.024)	0.853	(0.158)
	Ofu-Olosega	4	36	17	1.060	(0.014)	0.982	(0.028)	0.800	0.054	(0.040)	0.926	(0.144)
Polynesian Starling	Tutuila*	5	35	4	1.011	(0.011)	0.971	(0.044)	0.699	0.029	(0.028)	0.640	(0.384)
	Ta'u*	5	27	2	1.029	(0.013)	0.996	(0.016)	0.948	0.026	(0.026)	0.728	(0.327)
Samoan Starling	Tutuila*	5	53	2	1.002	(0.007)	0.958	(0.044)	0.600	0.012	(0.017)	0.899	(0.178)
	Ta'u	6	180	29	0.996	(0.004)	0.974	(0.012)	0.725	0.061	(0.018)	0.696	(0.110)
	Ofu-Olosega	6	112	15	0.974	(0.010)	0.967	(0.018)	0.666	0.086	(0.043)	0.639	(0.158)

[1] Only data collected during the core breeding season (November-March) were included.

[2] Species included are those for which there were (a) at least two between-year recaptures recorded from all stations pooled, (b) survival and recapture probabilities were neither 1.000 nor 0.000, and (c) the standard errors for population change and survival probabilities were less than the estimate.

[3] Number of stations at which at least one adult individual of the species was captured.

[4] Number of adult individuals captured (i.e., number of capture histories).

[5] Total number of between-pulse-recaptures (excluding recaptures within pulses).

Table 13. Continued.

[7] Survival probability (φ) presented as the maximum likelihood estimate (standard error of the estimate). Defined as the probability of an adult bird surviving to and returning in a particular pulse to the area where it was present in the previous pulse. The estimated monthly probability (Monthly φ) and the standard error of the estimate (Monthly SE(φ)) are presented as well as the estimated yearly probability extrapolated as Monthly φ *^12.*

[8] Recapture probability (p) presented as the maximum likelihood estimate (standard error of the estimate). Defined as the conditional probability of recapturing an adult bird at least once in a particular pulse, given that it did survive and return to the area where it was present in the previous pulse. The estimated probability (p) and the standard error of the estimate (SE(p)) are presented.

[9] Proportion of residents (τ). The estimated proportion of residents among those newly-banded adults based on between-pulse recapture data. The estimated proportion (τ) and standard error of the estimate (SE(τ)) are presented.

* The estimate for survival probability should be viewed with caution because it is based on fewer than five between-pulse/between-season recaptures or the estimate is very imprecise (SE(φ)≥ 0.200 or CV(φ) ≥ 50.0%)

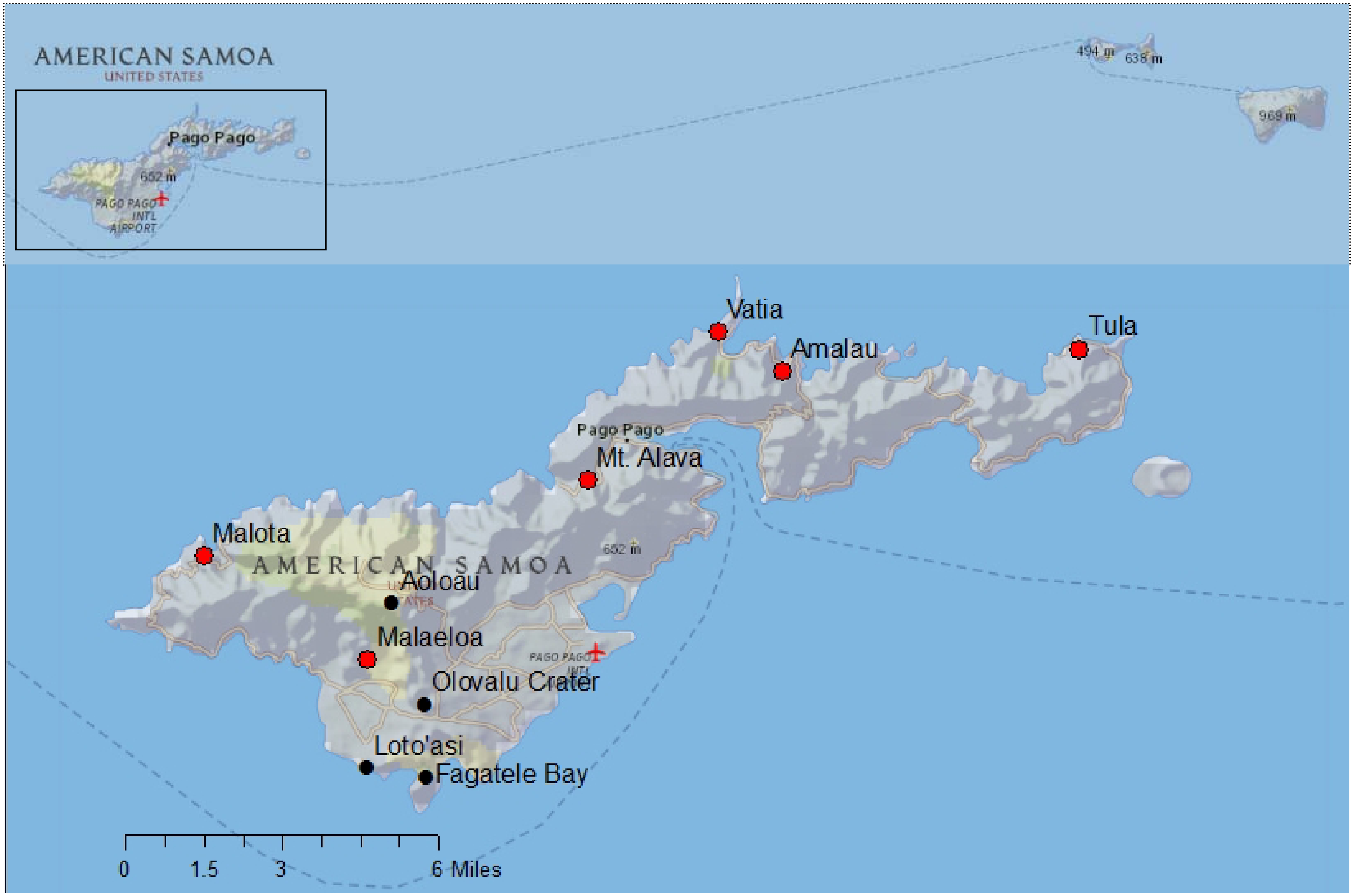

Figure 1. Locations of the ten Tropical Monitoring Avian Productivity and Survivorship (TMAPS) stations operated on Tutuila Island, American Samoa, from 2012 to 2016. Active (2016) stations are shown by red circles, non-active stations by black circles.

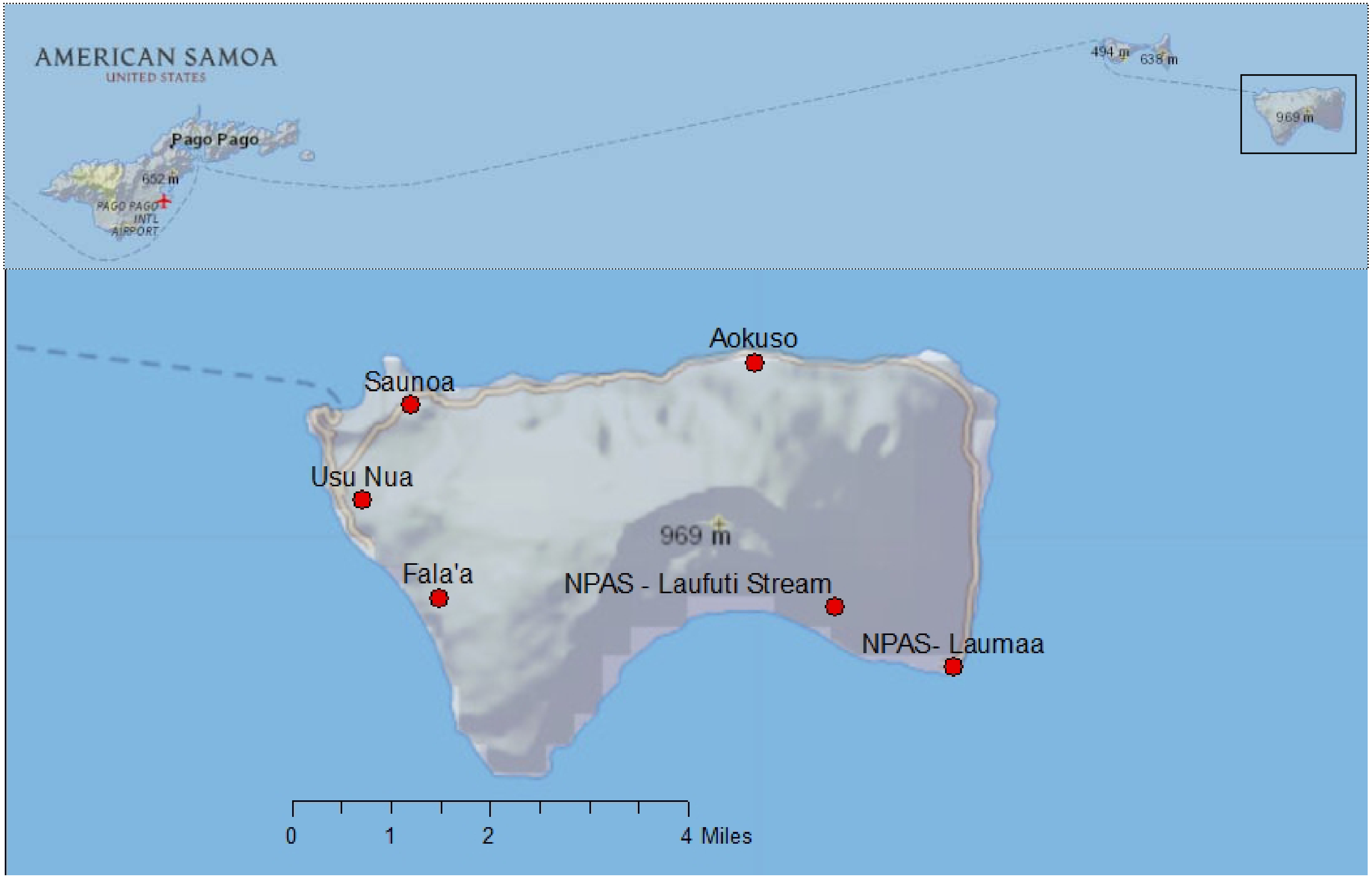

Figure 2. Locations of the six Tropical Monitoring Avian Productivity and Survivorship (TMAPS) stations operated on Ta'u island, American Samoa, during the 2014-2016 seasons.

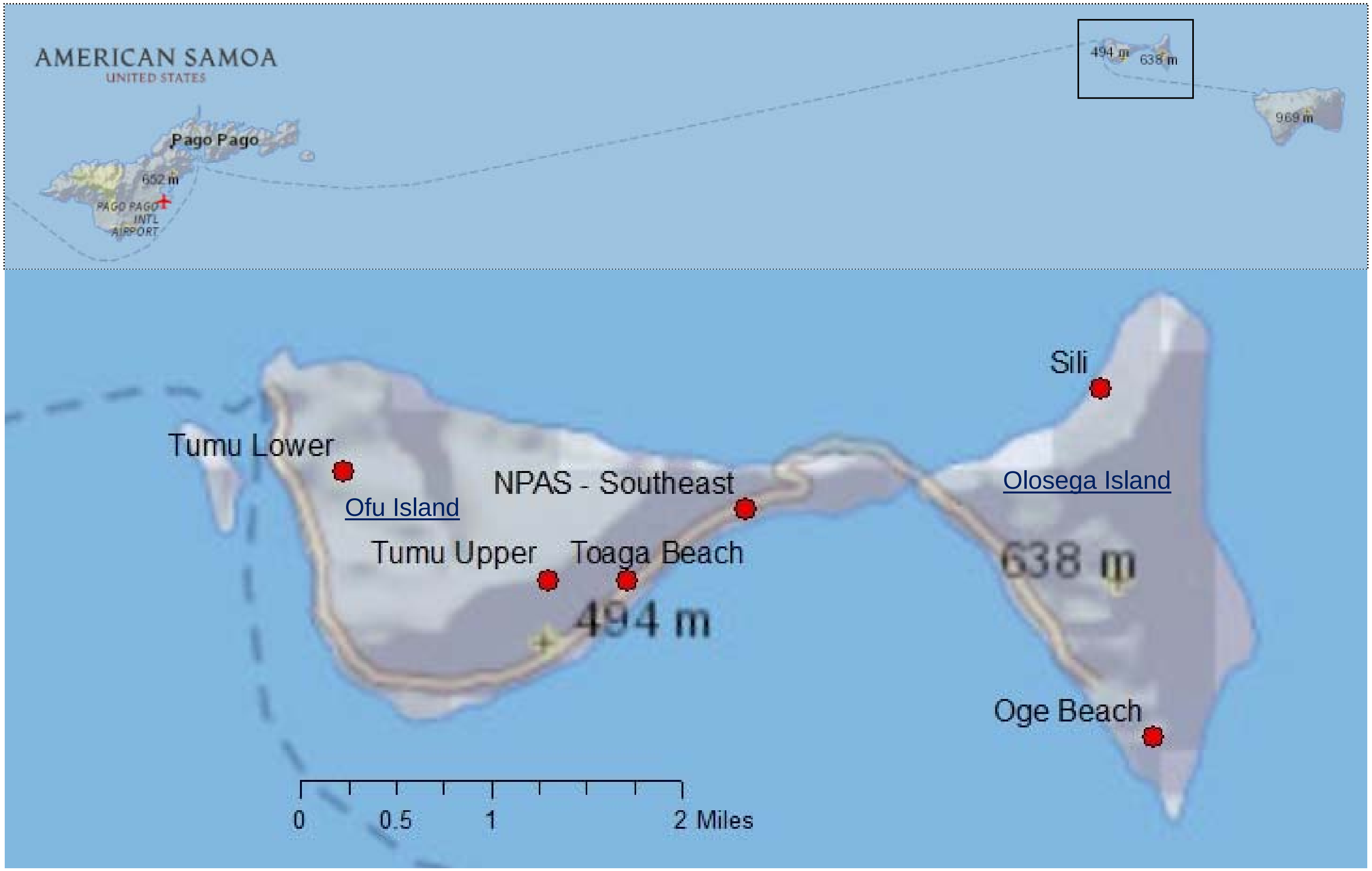

Figure 3. Locations of the six Tropical Monitoring Avian Productivity and Survivorship (TMAPS) stations operated on Ofu (left) and Olosega (right) islands, American Samoa, during the 2016 season.

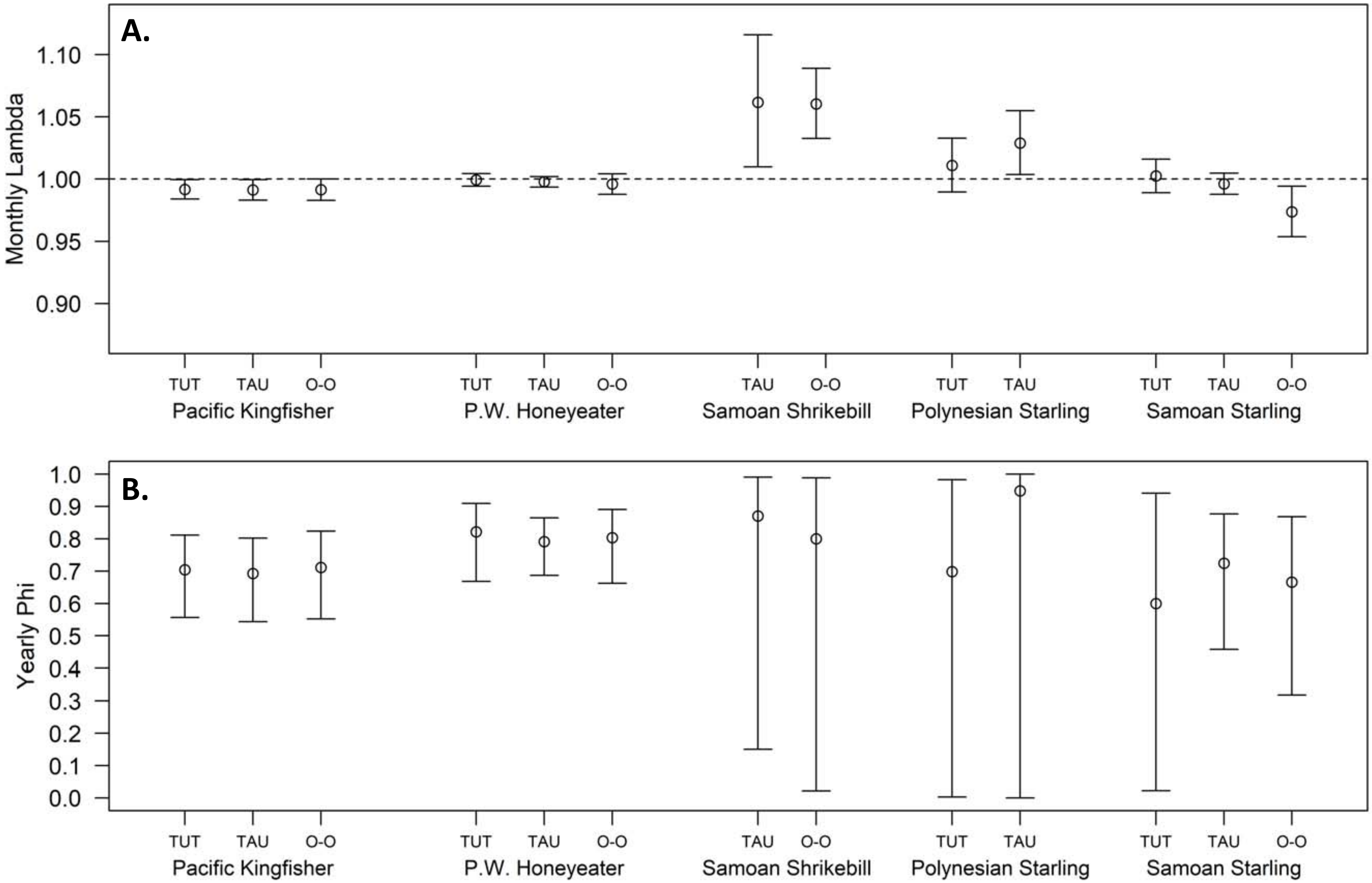

Figure 4. Monthly estimates of population change (Lambda) and adult annual survival (Phi) using a time-constant, transient model for five species. All 18 currently operating stations on the islands of Tutuila (TUT; 25 pulses), Ta'u (TAU; 18 pulses) and Ofu-Olosega (O-O; 10 pulses) were included in the calculations of the estimates.

Appendix I. Stations in which bird species (nomenclature and sequence of Gill and Donsker 2016) were banded during the American Samoa TMAPS Program during August 2012 to March 2016.

Common Name	**Scientific Name**	Vatia	Tula	Amalau	NPAS - Mt. Alava	Malota	Aoloau	Malaeloa	Olovalu Crater	Loto'asi	Fagatele Bay	Aokuso	Saunoa	Usu Nua	Fala'a	NPAS – Laufuti Stream	NPAS- Laumaa	Tumu Lower	NPAS- Southeast	Toaga Beach	Tumu Upper	Sili	Oge Beach
Red Junglefowl								X															
White-tailed Tropicbird	*Phaethon lepturus*							X															
Buff-banded Rail	*Gallirallus philippensis*			X	X							X	X										
Purple Swamphen	*Porphyrio porphyrio*			X																			
Pacific Golden-Plover	*Pluvialis fulva*												X										
White Tern	*Gygis alba*				X																		
Tongan Ground Dove	*Alopecoenas stairi*																	X	X	X		X	
Many-colored Fruit Dove	*Ptilinopus perousii*				X																		
Crimson-crowned Fruit Dove	*Ptilinopus porphyraceus*	X	X	X	X	X	X			X		X	X	X				X		X	X		
Pacific Imperial Pigeon	*Ducula pacifica*					X																X	
Pacific Long-tailed Cuckoo	*Urodynamis taitensis*		X			X									X	X		X					
White-rumped Swiftlet	*Aerodramus spodiopygius*				X	X		X					X	X									
Pacific Kingfisher	*Todiramphus sacer*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Blue-crowned Lorikeet	*Vini australis*											X	X	X									
Cardinal Myzomela	*Myzomela cardinalis*	X			X	X	X			X													
Polyn. Wattled-Honeyeater	*Foulehaio carunculata*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Samoan Shrikebill	*Clytorhynchus powelli*												X	X	X	X		X		X	X		
Red-vented Bulbul	*Pycnonotus cafer*					X	X			X	X				X								
Polynesian Starling	*Aplonis tabuensis*	X		X	X	X	X	X					X	X	X	X	X				X		
Samoan Starling	*Aplonis atrifusca*	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Common Myna	*Acridotheres tristis*				X					X	X												
Jungle Myna	*Acridotheres fuscus*					X	X	X		X													