THE TROPICAL MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (TMAPS) PROGRAM IN AMERICAN SAMOA: 2017 REPORT

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30 September 2017

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Samoan Shrikebill, TMAPS Station NPAS - Laufuti Stream, Ta'u Island, 4 February 2017

Suggested citation:

Pyle, P., K. Kayano, A. Doyle, S. Fitz-William, A. Grupenhoff, A. J. Pate, F. Tousley, C. Weissburg, D. Kaschube, and L. Helton. 2017. The Tropical Monitoring Avian Productivity and Survivorship (TMAPS) Program in American Samoa: 2017 Report. The Institute for Bird Populations, Point Reyes Station, CA.

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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 an Endangered Species 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 2017 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 2014-2017 seasons and Ofu and Olosega islands for the 2016-2017 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 and indices of population size (capture rates) and productivity for these 18 stations operated on Tutuila, Ta'u, and Ofu-Olosega during the 2017 season. Using standardized data from the 2014-2017 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 2017 season, we recorded 156 captures on Tutuila, 343 captures on Ta'u, and 293 captures on Ofu-Olosega, totaling 792 captures overall, of 12 bird species. Using a standard capture-rate index (individual adults per 600 net-hours), estimated population sizes for all species pooled increased by 32% between the 2016 and 2017 seasons on Tutuila (from 17.66 to 23.24 adults per 600 net-hours), they were comparable on Ta'u 2017 (53.13 during the 2016 season and 51.05 in 2017 season), and they dropped by 25% on Ofu-Olosega (54.95 to 41.42, respectively). On both Tutuila and Ta'u, population sizes during the 2017 season were slightly lower than the mean values from the 2014-2017 seasons. Reproductive index for all species pooled was comparable between the two years on Tutuila (0.22 in 2016 and 0.19 in 2017), it increased by 48% on Ta'u (0.23 to 0.34) and it was comparable on Ofu-Olosega (0.28 and 0.29). These reproductive indices are generally quite low compared to equivalent values among North American landbirds. The 2017 productivity values were slightly lower than the four-season (2014-2017) mean on Tutuila but higher than the four-season mean on Ta'u. These values indicate how between-year landbird population dynamics can vary from island to island and from year to year.

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 in both time-series analyses, whereas productivity was highest in the lowland forests and lower in coastal habitats and upland forests. Among species, Tongan Ground Dove, Pacific Kingfisher, and Samoan Starling showed higher adult capture rates in coastal habitats, Samoan Shrikebill, Polynesian Starling, and possibly Crimson-crowned Fruit Dove showed higher rates in upland forests, and Polynesian Wattled-Honeyeater was found at fairly comparable high densities in all forest types. Productivity showed different patterns than population abundance within species: Tongan Ground Dove showed higher productivity in coastal habitats, Crimson-crowned Fruit Dove showed higher productivity in upland forest, Pacific Kingfisher and Polynesian Wattled-Honeyeater showed higher productivity in lowland forests, and Samoan Shrikebill and the two starlings appeared to show comparable productivity among 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.

We have now gained enough data to calculate more-precise estimates of population trends, productivity, and survival for five native Samoan landbird species. Among the three islands, Pacific Kingfisher and Pacific Wattled-Honeyeater consistently showed population declines, Polynesian Starling populations appeared to be stable on Tutuila and Ofu-Olosega but showed significant increases on Ta'u, and Samoan Shrikebill and Samoan Starling appeared to show stable populations on all island groups on which they occurred. These variable responses further show how species population dynamics can vary among the island groups, although the consistent declines for Pacific Kingfisher and Wattled-Honeyeater, both species found commonly in coastal habitats, may be cause for some concern.

With the exception of the two starling species on Tutuila, annual survival estimates were high for American Samoan landbirds, with values ranging from 0.724 (Samoan Starling on Ofu-Olosega) to 0.961 (Samoan Shrikebill on Ofu-Olosega). By comparison, annual survival for most North American landbirds of comparable size range from about 0.5 to 0.6. Overall it appears that American Samoan landbirds may maintain population stability through relatively high survival and low productivity, a relatively 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 in North America.

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 hope that one or two more years of data will enable us not only to increase the precision of our estimates but to calculate lambda and survivorship for at least three additional target species, Tongan Ground Dove, Crimson-collared Fruit Dove, and Blue-crowned Lorikeet.

Our capture of 17 Tongan Ground Doves and one recapture during the 2016 season and 11 captures and two recaptures during the 2016 season, has enabled us to confirm age and sex criteria for this species in American Samoa and has provided critical information on breeding condition, biometrics, and weights, which will allow us to undertake further studies on this population during future seasons. For all 13 captures during the 2017 season we collected feather, blood, and swab samples from Tongan Ground Doves to investigate genetic differentiation, pathogens, and diet. In ensuing years, we plan to continue to collect these samples and also to initiate a separate study using playback experimentation to help monitor populations, and to apply tracking devices in order to better understand home-range sizes, movement patterns, population size, and nesting behavior. This information will be applied to the management of this population, which was listed under the USFWS Endangered Species Act in September 2016 (Rosa 2007; USFWS 2015, 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, 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). 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, 2014, 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, 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; (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 2016-2017 season (hereafter, e.g., "2017 season" refers to November 2016 - March 2017), has expanded to include Ta'u Island for each of the 2014-2017 seasons, and expanded again to Ofu and Olosega islands for the 2016 and 2017 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, 2014a, 2015a, 2016b). 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. (2016a) and a final field manual was produced and published in 2017 (Pyle 2017).

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 these 18 stations operated on Tutuila, Ta'u, and Ofu-Olosega during the 2017 season. Using standardized data from the 2014-2017 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. 2014a). These final six stations (Vatia, Tula, Amalua, Mount Alava, Malota, and Malaeloa) were then operated during each of the 2014-2017 seasons. 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 2017 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. 2014a, 2015a, 2016b). The locations of these six stations are shown in Figure 2, and descriptions and a summary of effort for each station during the 2017 season are given in Table 2. In November 2016, 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 the 2016 and 2017 seasons. The locations of these six stations are shown in Figure 3, and descriptions and a summary of effort for each station during the 2017 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. Each of these 18 stations have been operated for each of the 2013-2017 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 resulted in effort varying among stations in the three island groups, from four pulses at the Tutuila stations to three pulses at the Ta'u and Ofu-Olosega stations during the 2017 season (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, resulting in further variable effort among stations, ranging from 413 to 551 net hours per station during the 2017 season (Tables 1-3). Station operation was carried out by IBP volunteer biologist technicians. In 2017 these included Doyle, Fitz-William, Grupenhoff, Pate, Tousley, and Weissburg. 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 (2017), which has resulted in changes to some common and scientific species names of landbirds from previous 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)
Red-vented Bulbul, *Pyconotus cafer*
Samoan Shrikebill, *Clytorhynchus powelli* (following Pratt 2010, who split this from Fiji Shrikebill, *C. vitiensis*)
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. (2016a, 2017). 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 et al. 2016a, 2017). 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. 2017). 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 et al. (2015b, 2017) for details. Our system was modified to reflect the molt and plumage strategies found for our captured species in American Samoa. 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. 2017).

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. 2016a, 2017). 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 p15er 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 five years of station operation on Tutuila (21 pulses during the 2013-2017 seasons), four-years of operation on Ta'u (15 pulses during the 2014-2017 seasons), and two years of operation on Ofu-Olosega (7 pulses during the 2016-2017 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 (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

A summary of captures of each species during the TMAPS 2017 season (November 2016 through March 2017) is provided for all 6 stations of each of the three island groups (all 18 stations) combined (Table 4) and for each station separately on Tutuila (Table 5), Ta'u (Table 6), and Ofu-Olosega (Table 7). Number of net-hours, a measure of effort, totaled 2918.00 on Tutuila, 2679.50 on Ta'u, and 2767.00 on Ofu-Olosega (Tables 1-3). Overall, we banded 105 birds on Tutuila, 238 birds on Ta'u, and 190 birds on Ofu-Olosega; we recaptured 46 birds on Tutuila, 99 birds each on Ta'u and Ofu-Olosega; and 5 birds on Tutuila, 6 birds on Ta'u, and 4 birds on Ofu-Olosega were released unbanded (Table 4). We therefore recorded a total of 156 captures on Tutuila, 343 captures on Ta'u, 293 captures on Ofu-Olosega, and 792 captures overall (Table 4). Overall this represents a 4.6% decrease over the 830 captures at the same stations during the 2016 season (see below regarding capture rates). Twelve species were captured during the 2017 season (see Appendix for scientific names), 8 on Tutuila, 7 on Ta'u, and 8 on Ofu-Olosega. These captures included one species, Red Junglefowl, that is a non-target species in our TMAPS Program.

The most commonly captured species on all thee islands combined were Polynesian Wattled-Honeyeater (348 captures), followed by Samoan Starling (149), Pacific Kingfisher (146), Samoan Shrikebill (68), Polynesian Starling (47), Tongan Ground Dove (13), Blue-crowned Lorikeet (9), Crimson-crowned Fruit Dove (6), Cardinal Myzomela (4), Pacific Long-tailed Cuckoo (2), Red Junglefowl (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, Buff-banded Rail, Purple Swamphen, Many-colored Fruit Dove, Pacific Imperial Pigeon, Red-vented Bulbul, Common Myna, and Jungle Myna (see Appendix for scientific names).

On Tutuila (Table 5), when all species were pooled, the highest numbers of captures were recorded at the Malota station (28 captures), followed by Mount Alava (34), Vatia (26), Amalau (24), Malaeloa (19), and Tula (15). Species richness was highest at Vatia and Mount Alava (6 species each), followed by Amalau, Malota, and Malaeloa (5 each, and Tula (3). On Ta'u (Table 6), the highest numbers of captures were recorded at Usa Nua (91), followed by NPAS - Luamaa (78), Aokuso (48), Saunoa (45), NPAS - Laufuti Stream (44), and Fala'a (37), and species richness was highest at Usa Nua (7), followed by Saunoa and Fala'a (5 each), Aokuso and NPAS - Laufuti Stream (4 each), and NPAS - Luamaa (3). On Ofu-Olosega (Table 7), the highest numbers of captures were recorded at Toaga Beach (73), followed by Sili (56), NPAS - Southeast (54), Tumu Upper (49), Tumu Lower (35), and Oge Beach (26), and species richness was highest at Tumu Lower (6), followed by NPAS - Southeast (5), Toaga Beach, Tumu Upper, and Sili (4 each), and Oge Beach (3).

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 (23.2 adults per 600 net-hours), higher on Ofu-Olosega (41.4), and yet higher on Ta'u (51.3). Captures of young birds were lowest on Tutuila (4.3), followed by Ofu-Olosega (12.1), and Ta'u (17.5). Reproductive success was also lowest on Tutuila (0.19 young per adult), followed by Ofu-Olosega (0.29), and Ta'u (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 Mount Alava (37.3 adults per 600 net-hours), followed by Malota (28.3), Vatia (27.3), Malaeloa (19.4), Amalau (16.9), and Tula (10.8). Captures of young on Tutuila showed a different order among stations, being highest at Amalau (7.9 young per 600 net-hours), followed by Malota (6.5), Tula (5.4), Vatia (4.3), Mount Alava (1.3), and Malaeloa, which captured no young birds (0.0). Reproductive index showed more variation among stations, being highest at Tula (0.50 young/adult), followed by Amalau (0.47), Malota (0.23), Vatia (0.16), Mount Alava (0.04) and Malaeloa (0.00).

On Ta'u (Table 9), adult capture rates were highest at Usu Nua (68.5 adults per 600 net-hours), followed by NPAS - Luamaa (66.2), Aokuso (47.8), NPAS - Laufuti Stream (43.8), Fala'a (40.7), and Saunoa (37.8). Following Usa Nua (38.8 young per 600 net-hours), capture rates of young again followed a different order than those of adults, being highest at Saunoa (19.5), followed by Aokuso (17.4), Fa'ala (13.1), NPAS - Laufuti Stream (8.2), and NPAS - Luamaa (7.4). As such, reproductive index showed a different variation following Usa Nua (0.32 young per adult), being highest at Saunoa (0.52), followed by Aokuso (0.36), Fa'ala (0.32), and NPAS - Laufuti Stream and Luamaa (0.19 each).

On Ofu-Olosega (Table 10), adult capture rates were highest at Toaga Beach (67.2 adults per 600 net-hours), followed by Tumu Upper (45.5), NPAS - Southeast (42.5), Sili (38.9), Tumu Lower (36.8), and Oge Beach (19.1). Capture rates of young were highest at Sili (24.7 young per 600 net-hours), followed by Toaga Beach (16.1), NPAS - Southeast (11.3), Oge Beach (8.9), Tumu Upper (8.3), and Tumu Lower (3.8). Reproductive index was highest at Oge Beach (0.47 young per adult), followed by Sili (0.40), NPAS - Southeast (0.27), Toaga Beach (0.24), Tumu Upper (0.18), and Tumu Lower (0.10).

To compare overall capture rates between 2016 and 2017 and among all three island groups, we present estimates of adult population size and reproductive success during each of the 2016 and 2017 seasons individually and for all seasons since 2014 pooled on each island (Table 11). On Tutuila, adult population size increased by 32% between 2016 and 2017 (from 17.66 to 23.24 adults per 600 net-hours) but the 2017 value was still lower than the mean for 2014-2017 (24.60). Reproductive success was comparable between 2016 (0.22 young/adult) and 2017 (0.19), both slightly lower than the mean for 2014-2017 (0.23). Much of this variation appeared to be driven by that of Polynesian Wattled-Honeyeater, the most commonly captured species, which showed both population-size and productivity values reflecting these patterns. Most of the remaining target species also showed higher population sizes in 2017 than in 2016, but showed mixed differences between these two years in productivity (Table 11).

On Ta'u, adult population size was comparable between 2016 and 2017 (53.13 and 51.05 adults per 600 net hours, respectively) but reproductive index increased by 48% between the two years, from 0.23 to 0.34 young/adult (Table 11). Population sizes during the two years were slightly lower than that of the 2014-2017 mean (58.60 adults/600 net-hours) while the mean reproductive success for 2014-2017 (0.25) was comparable to the lower value of 2016. Among species, notable departures from this pattern were for population size in Samoan Starling (much higher in 2016 than in 2017) and Polynesian Starling (much lower in 2016 than in 2017), and for reproductive success of most species, being lower in 2017 than in 2016. Instead, the overall increase between the two years was driven primarily by substantial increases between 2016 and 2017 in the two starlings, by 154% in Samoan Starling and 196% in Polynesian Starling.

On Ofu-Olosega, adult population size dropped substantially between 2016 and 2017 (by 25%, from 54.95 to 41.42 adults per 600 net hours) while reproductive index showed virtually no change, 0.28 and 0.29 young/adult, respectively (Table 11). Most species showed lower population-size indices in 2017 than in 2016, with the exception of Tongan Ground-Dove (comparable values) and Samoan Shrikebill (58% increase between these two years). Although there was little overall difference in productivity between the two years there was substantial variation among species. Tongan Ground Dove, Samoan Shrikebill and Polynesian Starling showed substantial decreases between the two years while Pacific Kingfisher and Samoan Starling showed substantial increases (Table 11).

As noted above, adult capture rates for all species pooled during the four seasons combined (2014-2017) were much lower on Tutuila (20.09 adults per 600 net-hours) than they were on Ta'u (53.55) (Table 11). Reproductive index during these four years combined was comparable, being 0.23 young/adult on Tutuila and 0.25 on Ta'u. Although data from Ofu-Olosega were only collected in 2016-2017, a comparison of all values in Table 11 indicates that population sizes at the six stations (48.19 adults/600 net-hours) are closer to those of Ta'u whereas productivity values (0.29 young/adult) were higher on these islands than on both Tutuila and Ta'u.

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, Polynesian Wattled-Honeyeater, Samoan Shrikebill, and Samoan Starling showing higher rates on Ta'u, and Pacific Kingfisher showing higher rates on Ofu-Olosega. 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. Interestingly, three species, Crimson-crowned Fruit Dove, Pacific Kingfisher, and Polynesian Wattled-Honeyeater showed higher or comparably high productivity on Tutuila than on the other two islands; three species, Polynesian Wattled-Honeyeater, Samoan Shrikebill, and Samoan Starling showed higher or comparably high productivity on Ofu-Olosega than on the other two islands, and only one species, Polynesian Starling, showed higher productivity on Ta'u than on the other two islands.

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 2014-2017 seasons from 12 stations on Tutuila and Ta'u and using data collected during the 2016-2017 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 2014-2017 seasons and they were higher in the coastal habitats than in the higher-elevation habitats on all three island groups during the 2016-2017 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 the opposite pattern, generally being found at higher abundances in upland forests and lower abundances in coastal habitats. Blue-crowned Lorikeet may be found less abundantly in lowland forests than the other two habitat types, whereas Cardinal Myzomelas may be found most commonly in lowland forests on Tutuila; however, in both cases sample sizes may be too low to assess habitat preferences for these species unequivocally. Finally, Polynesian Wattled-Honeyeaters appeared to be found at fairly 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 and Blue-crowned Lorikeet showed higher productivity in coastal habitats than in the forested habitats. The remaining three species with productivity data, Samoan Shrikebill and the two starlings, appeared to show mixed results, suggesting that productivity might be comparable within all three habitat types.

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 2013-2017 seasons on all three island-groups (2013-2017 seasons on Tutuila, 2014-2017 seasons on Ta'u, and 2016-2017 seasons on Ofu-Olosega) 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), whereas significance of the changes can be assessed by whether or not confidence intervals cross 1.0 in Figure 4A. Among the three islands, Pacific Kingfisher and Pacific Wattled-Honeyeater consistently showed population declines, those of the kingfisher being near-significant on all three island groups and those of the honeyeater being non-significant on Tutuila but near-significant on Ta'u and significant on Ofu-Olosega. Polynesian Starling populations appeared to be stable on Tutuila and Ofu-Olosega but showed significant increases on Ta'u. The other two species for which estimates could be derived, Samoan Shrikebill and Samoan Starling, appeared to show stable populations on all island groups on which they occurred. The larger standard error bars for Ofu-Olosega for each species reflect the fewer pulses of data over the two seasons (7) than on Tutuila (21) and Ta'u (15).

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. With the exception of the two starling species on Tutuila, annual (yearly) survival estimates were relatively high, with values ranging from 0.724 (Samoan Starling on Ofu-Olosega) to 0.961 (Samoan Shrikebill on Ofu-Olosega). By contrast, annual adult survivorship for Polynesian Starling (0.436) and Samoan Starling (0.367) on Tutuila were markedly lower. The standard errors for the monthly survival estimates (Table 13) and confidence intervals for the yearly estimates (Fig. 4B) were lower for Pacific Kingfisher and Polynesian Wattled-Honeyeater, indicating good precision to these estimates, whereas they were higher for the other three species, indicating that more data may be needed to enable higher confidence in the estimates. These precision values were also generally lower for Tutuila and Ta'u, than for Ofu-Olosega, again likely related to the fewer number of pulses from these islands. Recapture probabilities ranged from a low of 0.072 (Pacific Wattled- Honeyeater on Ta'u) to a high of 0.274 (Samoan Shrikebill on Ofu-Olosega), and proportion of residents ranged from a low of 0.013 (Samoan Starling on Tutuila) to a high of 1.000 (Polynesian Wattled-Honeyeater on Tutuila). Compared to data from North American MAPS stations (DeSante et al. 2015), these are generally low but reasonable recapture probabilities and, with the exception of the low values for Samoan Starling on Tutuila and Ofu-Olosega, reasonable estimates for proportion of residents.

DISCUSSION

During the 2017 season, we recorded 156 captures on Tutuila, 343 captures on Ta'u, and 293 captures on Ofu-Olosega, totaling 792 captures overall, of 12 bird species. This represents a 4.6% decrease over the 830 captures at the same stations during the 2016 season; however, some of this decrease in captures was due to fewer net-hours on Ofu-Olosega (2767 during the 2017 season vs. 3341 during the 2016 season), the island group with the highest capture rates during the 2016 season, due to logistical and weather-related considerations. Using a standard capture-rate index (individual adults per 600 net-hours), estimated population sizes for all species pooled increased by 32% between the 2016 and 2017 seasons on Tutuila (from 17.66 to 23.24 adults per 600 net-hours), they were comparable on Ta'u 2017 (53.13 during the 2016 season and 51.05 in 2017 season), and they dropped by 25% on Ofu-Olosega (54.95 to 41.42, respectively). On both Tutuila and Ta'u, population sizes during the 2017 season were slightly lower than the mean values from the 2014-2017 seasons. Reproductive index, measured as number of individual young birds divided by the number of individual adults captured, for all species pooled, was comparable between the two years on Tutuila (0.22 in 2016 and 0.19 in 2017), it increased by 48% on Ta'u (0.23 to 0.34) and it was comparable on Ofu-Olosega (0.28 and 0.29, respectively). These reproductive indices are generally quite low compared to equivalent values among North American landbirds (DeSante et al. 2015). The 2017 productivity values were slightly lower than the four-season (2014-2017) mean on Tutuila but higher than the four-season mean on Ta'u.

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, most of the species followed the overall between-season differences in population size and productivity noted above; however, on Ta'u, population sizes of Polynesian Starling (much higher during the 2017 season) and Samoan Starling (much lower during the 2017season) departed from the change in all species pooled, and the overall increase in productivity between the two years was driven by substantial increases in the two starlings which departed from the overall pattern. On Ofu-Olosega, furthermore, population size changes of Samoan Shrikebill departed from those of other species (increasing by 58% between the two seasons) and there was substantial variation in productivity among species. Our data thus indicate that landbird dynamics are clearly complex and operate on both an island-specific and a species-specific basis.

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 in both time-series analyses, whereas productivity was highest in the lowland forests and lower in coastal habitats and upland forests. Native Samoan species showed differing habitat preferences for breeding adults, with Tongan Ground Dove, Pacific Kingfisher, and Samoan Starling favoring coastal habitats, Samoan Shrikebill, Polynesian Starling, and possibly Crimson-crowned Fruit Dove favoring upland forests, and Polynesian Wattled-Honeyeater found at fairly 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: Tongan Ground Dove showed higher productivity in coastal habitats, Crimson-crowned Fruit Dove showed higher productivity in upland forest, Pacific Kingfisher and Polynesian Wattled-Honeyeater showed higher productivity in lowland forests, and Samoan Shrikebill and the two starlings appeared to show comparable productivity among 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 nonnatal 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 more-precise estimates of population trends, productivity, and survival for five native Samoan landbird species. 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 2014-2017 seasons were estimatedon all island-groups in which these five species occur. Among the three islands, Pacific Kingfisher and Pacific Wattled-Honeyeater consistently showed population declines, those of the kingfisher being near-significant on all three island groups and those of the honeyeater being near-significant or significant on Ta'u and Ofu-Olosega. Polynesian Starling populations appeared to be stable on Tutuila and Ofu-Olosega but showed significant increases on Ta'u over the four-year period of data collection there, and Samoan Shrikebill and Samoan Starling appeared to show stable populations on all island groups on which they occurred. These variable responses again show how species population dynamics can vary among the island groups, although the consistent declines for Pacific Kingfisher and Wattled-Honeyeater, both species found commonly in coastal habitats, may be cause for some concern.

With the exception of the two starling species on Tutuila, annual survival estimates were high for American Samoan landbirds, with values ranging from 0.724 (Samoan Starling on Ofu-Olosega) to 0.961 (Samoan Shrikebill on Ofu-Olosega). By comparison, annual survival for most North American landbirds of comparable size range from about 0.5 to 0.6 (DeSante et al. 2015). Annual adult survivorship for Polynesian Starling (0.436) and Samoan Starling (0.367) on Tutuila were markedly lower than that of the other species/island combinations; however, the standard errors and confidence intervals for the yearly estimates for these starlings were high, indicating that more data may be needed to enable higher confidence in the estimates. Overall it appears that American Samoan landbirds may maintain population stability through relatively high survival and low productivity, a relatively 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 in North America.

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 hope that one or two more years of data will enable us not only to increase the precision of our estimates but to calculate lambda and survivorship for at least three additional target species, Tongan Ground Dove, Crimson-collared Fruit Dove, and Blue-crowned Lorikeet. In the meantime, we can at least start examining population dynamics among our five target species.

Pacific Kingfisher. Our data from the 2014-2017 seasons clearly indicate that Pacific Kingfishers are found most commonly in lowland coastal habitats and decrease in abundance with increasing elevation. Productivity showed a slightly different pattern, being higher in lowland forests than in coastal habitats or upland forests. Recapture data indicate that populations are declining on all three island groups, with declines being marginally significant. Declines could be related to the preference of this species for coastal habitats, which may be more impacted in American Samoa than lowland and upland forested habitats. Both productivity and survivorship showed similar differences among the three island groups, each being lowest on Ta'u and highest on Tutuila. Thus, poorer demographics may be related to the decline on Ta'u, but more data will be needed to understand reasons for declines on Tutuila and Ofu-Olosega, where both productivity and survival were comparably high.

Polynesian Wattled-Honeyeater. This is by far the most commonly captured species in our TMAPS data set and it appears to be equally common among all habitat types and elevations, and among all three island groups. Productivity appears to be slightly higher in lowland forests than in coastal habitats and upland forests, although this difference could also represent post-juvenile dispersal into lowland forests for habitat or nutritional reasons. Recapture data indicate that populations are declining on all three island groups, with declines being non-significant on Tutuila, nearly significant on Ta'u, and significant in Ofu-Olosega. Declines could be related, in part, to the preference of this species for coastal habitats, which may be more impacted in American Samoa than lowland and upland forested habitats. Productivity indices are very low in this species, whereas survivorship is quite high in relation to other landbirds, indicating a K-selected demographic strategy. The fact that this species is declining could indicate that productivity is too low, and we hope to examine this further with more years of data which, for example, may enable us to assess yearling proportions within these populations.

Samoan Shrikebill. Our data clearly indicate that Samoan Shrikebills are found most commonly in upland forested habitats and decrease in abundance with decreasing elevation. Productivity appeared to be similar among all three habitat types. Populations appeared to be more-or-less stable on both Ta'u and Ofu-Olosega, although confidence intervals at the latter location were high, indicating that more data may be needed to fully assess population trends of this species there. Both productivity and survivorship were relatively high on both island groups, indicating that this species appears to be in good shape, demographically.

Polynesian Starling. This species was captured most commonly in upland forested habitats and decreased in abundance with decreasing elevation, whereas productivity appeared to be similar among all three habitat types. Recapture data indicate that populations are declining slightly and non-significantly on Tutuila and Ofu-Olosega whereas they are increasing significantly on Ta'u. Both productivity and survivorship were higher on Ta'u than in the other groups, which explains the increased population trend there. The relatively low survivorship on Tutuila could factor into the decline there, although more precision to this estimate, both here and on Ofu-Olosega, will be needed to further assess causal factors for demographic trends in this species.

Samoan Starling. Samoan Starlings are found most commonly in lowland coastal habitats and decrease in abundance with increasing elevation. Productivity appeared to be similar in all three habitat types. Recapture data indicate stable populations on all three island groups. Productivity and survivorship each appeared adequate on Ta'u and Ofu-Olosega but each was low on Tutuila; more precision to this estimate may be needed to confirm the low survivorship value there.

Overall, however, it appears that populations of Samoan Starlings are healthy in American Samoa.

The establishment and operation of six new stations on Ofu-Olosega during the 2016-2017 seasons 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 and 11 captures and two recaptures during the 2016 season has enabled us to confirm age and sex criteria for this species in American Samoa (Pyle et al. 2016a, 2017), and has provided critical information on breeding condition, biometrics, and weights, which will allow us to undertake further studies on this population during future seasons. For all 13 captures during the 2017 season we collected feather, blood, and swab samples from Tongan Ground Doves to investigate genetic differentiation, pathogens, and diet. In ensuing years, we plan to continue to collect these samples and also to initiate a separate study using playback experimentation to help monitor populations, and to apply tracking devices in order to better understand home-range sizes, movement patterns, population size, and nesting behavior. This information will be applied to the management of this population, which was listed under the USFWS Endangered Species Act in September 2016 (Rosa 2007; USFWS 2015, 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, 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 Marianas Islands (Frits and Rhodda 1998). We look forward to continuing this important work in the coming years.

ACKNOWLEDGMENTS

We are extremely grateful to Samoan landowners for granting us permission to establish TMAPS stations on their lands. On Tutuila these were Alo Pete Steffany, Utu Ron, Wesley Tulefano, Easter Tom Bruce and the Asi family, Fuimaono Asuemu, the Lauti family, the Gurr family, and the Tula family. On Ta'u these were Sau and Usu Nua, the Saunoa family, the Fala'a family, Aokuso, Tei, and the National Park of American Samoa. On Ofu-Olosega these were the Lata family, Peter Ili and family, Misaalefua family, and the National Park of American Samoa.

We thank the U.S. Fish and Wildlife Service (USFWS) for providing funding through Wildlife Restoration (WSFR) Grants to American Samoa; Ruth Utzurrum of USFWS, Honolulu, assisted us by reviewing and making suggestions for improvements to grant proposals for both initial and continuing field work. Shelly Kremer was instrumental in instigating funding for TMAPS in the

Pacific, including American Samoa, and Lainie Zarones and Nicole Arcilla, formerly of DWMR in American Samoa, helped us secure funding for data collection in 2012-2014. We also thank Annie Marshall and Colleen Henson of the USFWS, Honolulu, for help procuring Endangered Species Act Permit (TE-08598C-0) for our work with the Tongan Ground Dove.

We thank former DMWR Director Ray Tulafono for approving and facilitating the work during 2012-2013 and current DMWR Director Ruth Matagi-Tofiga and Deputy Director Selaina Vaitautolu-Tuimavave for approving the work for the 2014-2017 seasons. We are indebted to local biologists and guides, Siaifoi Faaumu and Matthew Toilolo of DWMR, Panini Seafa and Meli on Ta'u, and John Utuga and Ricky Miasaalefua on Ofu-Olosega, for help with field work and land access. We thank other DWMR staff members, including Ailao Tualaulelei, Mark MacDonald, and especially Adam Miles for help with funding and logistics, and Carlo Caruso, Tavita Togia, Sean Eagan, James Bacon, Kiolona Atanoa, and Loia Tagoni, of the National Park of American Samoa, for assistance and permission to conduct research on lands they manage. IBP field biologists who took part during the first four years of the TMAPS Program, in addition to Kayano and Pate, were Alfredo Arcilla Jr., Rudy Badia, Adrienne Doyle, Emily Jeffreys, Sam Jones, Daniel Lipp, Vicki Morgan, Robinson Seumanutafa Mulitalo, Colleen Nell, Jessie Reese, Zachary Robinson, Marie Soderbergh, Chris Taft, Joshua Tigilau, Keegan Tranquillo, Salefu Tuvalu, Nathan Weyant, and Bobby Wilcox. We thank Rodney Siegel of IBP for administrative and technical support. This is Contribution No. 569 of The Institute for Bird Populations.

LITERATURE CITED

Bart, J. 2005. Monitoring the abundance of bird populations. Auk 122:15-25.

DeSante, D.F. 1992. Monitoring Avian Productivity and Survivorship (MAPS): a sharp, rather than blunt, tool for monitoring and assessing landbird populations. Pages 511-521 *in* D. R. McCullough and R. H. Barrett, editors. Wildlife 2001: Populations. Elsevier Applied Science, London, UK. PDF

DeSante, D.F. and T.L. George. 1994. Population trends in the landbirds of western North America. Pages 173-190 *in* J. R. Jehl, Jr. and N. K. Johnson (eds.), A century of avifaunal change in North America, Studies in Avian Biology No 15, Cooper Ornithological Society. PDF

DeSante, D.F., and D.R. Kaschube. 2007. The Monitoring Avian Productivity and Survivorship (MAPS) Program 2002 and 2003 Report. Bird Populations 8:46-115. PDF

DeSante, D.F., M.P. Nott, and D.R. O'Grady. 2001. Identifying the proximate demographic cause(s) of population change by modeling spatial variation in productivity, survivorship, and population trends. Ardea 89:185-207. PDF

DeSante, D.F., M.P. Nott, and D.R. Kaschube. 2005. Monitoring, modeling, and management: Why base avian monitoring on vital rates and how should it be done? Pages 795-804 *in* C. J. Ralph and T. D. Rich, editors. Bird Conservation Implementation and Integration in the Americas. U.S. Forest Service General Technical Report PSW-GTR-191. PDF

DeSante, D.F., K.M. Burton, P. Velez, and D. Froehlich. 2017. MAPS Manual. The Institute for Bird Populations, Point Reyes Station, CA. PDF

DeSante, D. F., D. R. Kaschube, and J. F. Saracco. 2015. Vital rates of North American landbirds. www.VitalRatesOfNorthAmericanLandbirds.org: The Institute for Bird Populations, Point Reyes Station, CA.

Fritts, T.H, and G.H. Rodda. 1998. The role of introduced species in the degradation of island ecosystems: A case history of Guam. Annual Review of Ecology and Systematics 29:113-140.

Gregory R.D., A.J. van Strien, P. Vorisek, A.W. Gmelig Meyling, D.G. Noble, R.P.B. Foppen, and D.W. Gibbons. 2005. Developing indicators for European birds. Philosophical Transactions of the Royal Society London B 360: 269-288.

Gill, F., and D. Donsker (eds). 2016. IOC World Bird List (v 6.3). doi : 10.14344/IOC.ML.6.3. [Accessed 1 September 2016].

Handel, C. M., L. M. Pajot, S. L. Talbot, and G. K. Sage. 2006. Use of buccal swabs for sampling DNA from nestling and adult birds. Wildlife Society Bulletin 34:1094-1100.

Hines, J.E., W.L. Kendall, and J.D. Nichols. 2003. On the use of the robust design with transient capture-recapture models. Auk 120:1151-1158.

Holmes, R.T. 2007. Understanding population change in migratory songbirds: long-term and experimental studies of Neotropical migrants in breeding and wintering areas. Ibis 149:2-13.

Hutto, R.L. 1998. Using landbirds as an indicator species group. Pages 75-92 *in* J. M. Marzluff and R. Sallabanks, editors. Avian Conservation: Research and Management. Island Press, Washington, D.C., USA.

Johnson, E.I., J.D. Wolfe, T.B. Ryder, and P. Pyle. 2011. Modifications to a molt-based ageing system proposed by Wolfe et al. (2010). Journal of Field Ornithology 82:421-423. PDF

Junda, J., A.L. Crary, and P. Pyle. 2012. Two modes of primary replacement during prebasic molt of Rufous Fantails *Rhipidura rufifrons*. Wilson Journal of Ornithology 124:680-685. PDF

Keeler, S. P., P. J. Ferro, J. D. Brown, X. Fang, J. El-Attrache, R. Poulson, M. W. Jackwood. and D. E. Stallknecht 2012. Use of FTA ® Sampling Cards for Molecular Detection of Avian Influenza Virus in Wild Birds. Avian Diseases 56:200-207.

Laake, J. and E. Rexstad. 2008. RMark: an alternative approach to building linear models in MARK. Pp. C1-C114 in Program MARK: a Gentle Introduction, 6th Ed. (E. Cooch and G. White, eds.) http://www.phidot.org/software/mark/docs/book/

Morrison, M.J. 1986. Bird populations as indicators of environmental change. Current Ornithology 3:429-451.

Noon, B.R. and J.R. Sauer. 1992. Population models for passerine birds: structure parameterization, and analysis. Pages 441-464 in D. C. McCullough and R. H. Barrett (eds.), Wildlife 2001: Populations. Elsevier Applied Science, London.

Nott, M.P., and D.F. DeSante. 2002. Demographic monitoring and the identification of transient in mark-recapture models. Pp. 727-736 *in:* J.M. Scott, P. Heglund, et al. (eds.), Predicting Species Occurrences: Issues of Scale and Accuracy, Island Press, New York. PDF

Nott, P., D.F. DeSante, and N. Michel. 2003. Monitoring Avian Productivity and Survivorship (MAPS) Habitat Structure Assessment (HSA) Protocol: describing vertical and horizontal spatial habitat patterns at MAPS stations. The Institute for Bird Populations, Point Reyes Staion, California. PDF

Owen, J.C. Collecting, processing, and storing avian blood samples: a review. Journal of Field Ornithology 82:339-354.

Peach, W.J., S.R. Baillie, and S.T. Buckland. 2004. Current practices in the British Trust for Ornithology Constant Effort Sites scheme and comparisons with temporal changes in mist-net captures with changes in spot-mapping counts a the extensive scale. Studies in Avian Biology 29:46-56.

Peach, W.J., S.T. Buckland, and S.R. Baillie. 1996. The use of constant effort mist-netting to measure between-year changes in the abundance and productivity of common passerines. Bird Study 43:142-156.

Pradel, R. 1996. Utilization of capture-mark-recapture for the study of recruitment and population growth rate. Biometrics 52:703- 709.

Pradel, R., J. Hines, J.-D. Lebreton, and J.D. Nichols. 1997. Estimating survival probabilities and proportions of 'transients' using capture-recapture data. Biometrics 53:60-72.

Pratt, H. D. 2010. Revisiting species and subspecies of island birds for a better assessment of biodiversity. Ornithological Monographs 67:79–89.

Pyle, P. 2014a. Updated manual for ageing and sexing landbirds of American Samoa. The Institute for Bird Populations, Point Reyes Station, CA. PDF

Pyle, P. 2014b. Applying "WRP" molt and age codes at TMAPS stations: a case study based on American Samoan landbirds. MAPS Chat 14:1-6. PDF

Pyle, P., N. S. Dauphine, D. Lipp, R. Badia, R. Taylor, and E. Rowan. 2012. The Tropical Monitoring Avian Productivity and Survivorship (TMAPS) Program in American Samoa: 2012 Report. The Institute for Bird Populations, Point Reyes Station, CA. PDF

Pyle, P., N. S. Dauphine, K. Tranquillo, C. Nell, E Jeffreys, D. Kaschube, R. Taylor, and E. Rowan. 2013. The Tropical Monitoring Avian Productivity and Survivorship (TMAPS) Program in American Samoa: 2013 Report. The Institute for Bird Populations, Point Reyes Station, CA. PDF

Pyle, P., N.S. Arcillo, K. Tranquillo, K. Kayano, A. Doyle, S. Jones, D. Kaschube, R. Taylor, and E. Rowan. 2014. The Tropical Monitoring Avian Productivity and Survivorship (TMAPS) Program in American Samoa: 2014 report. The Institute for Bird Populations, Point Reyes Station, CA. PDF

Pyle, P., K. Kayano, J. Reese, V. Morgan, R. S. Mulitalo, J. Tigilau, S. Tuvalu, D. Kaschube, R. Taylor, and L. Helton. 2015a. The Tropical Monitoring Avian Productivity and Survivorship (TMAPS) Program in American Samoa: 2015 Report. The Institute for Bird Populations, Point Reyes Station, CA. PDF

Pyle, P., A. Engilis Jr., and D.A. Kelt. 2015b. Manual for ageing and sexing landbirds of Bosque Fray Jorge National Park and North-central Chile, with notes on occurrence and breeding seasonality. Special Publications of the Louisiana State University. PDF

Pyle, P, K. Tranquillo, K. Kayano, and N. Arcilla. 2016a. Molt patterns, age criteria, and molt-breeding overlap in Ameican Samoan landbirds. Wilson Journal of Ornithology 128:59-69. PDF

Pyle, P., K. Kayano, K. Murphy, A. J. Pate, M. Soderbergh, C. Taft, N. Weyandt, B. Wilcox, D. Kaschube, and L. Helton. 2016b. The Tropical Monitoring Avian Productivity and Survivorship (TMAPS) Program in American Samoa: 2016 Report. The Institute for Bird Populations, Point Reyes Station, CA. PDF

Pyle, P, K. Tranquillo, K. Kayano, K. Murphy, B. Wilcox, and N. Arcilla. 2017. Manual for ageing and sexing landbirds of American Samoa, with notes on molt and breeding seasonality. Special Publications of the Institute for Bird Populations, Point Reyes Station, CA. PDF

R Development Core Team. 2017. R: a language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria. http://www.R-project.org/

Radley, P., A.L. Crary, J. Bradley, C. Carter, and P. Pyle. 2011. Molt patterns, biometrics, and age and gender classification of landbirds on Saipan, Northern Mariana Islands. Wilson Journal of Ornithology 123:588-594. PDF

Ralph, C. P., S. E. Nagata, and C. J. Ralph. 1985. Analysis of droppings to describe diets of small birds. Journal of Field Ornithology 56:165-174.

Rosa, K. 2007. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form: *Gallicolumba stairi*, Friendly (shy) ground-dove (American Samoa Distinct Population Segment). U.S. Fish and Wildlife Service: Pacific Islands Fish and Wildlife Office.

Saracco, J.F., D.F. DeSante, and D.R. Kaschube. 2008. Assessing landbird monitoring programs and demographic causes of population trends. Journal of Wildlife Management 72:1665-1673. PDF

Saracco, J. F., D. F. DeSante, M. P. Nott, and D. R. Kaschube. 2009. Using the MAPS and MoSI programs to monitor landbirds and inform conservation. Pp. 651-658 in: T. D. Rich, C. D. Thompson, D. Demarest, and C. Arizmendi, editors, Proceedings of the Fourth International Partners in Flight Conference: Tundra to Tropics. University of Texas-Pan American Press. PDF

Saracco, J. F., J. A. Royle, D. F. DeSante, and B. A. Gardner. 2010a. Spatial modeling of survival and residency and application to the Monitoring Avian Productivity and Survivorship Program. Journal of Ornithology. On-line: doi: 10.1007/s10336-010-0565-1. PDF

Saracco, J. F., J. A. Royle, D. F. DeSante, and B. A. Gardner. 2010b. Modeling spatial variation in avian survival and residency probabilities. Ecology 91:1885-1891. PDF

Saracco, J.F., L. Helton, and P. Pyle. 2015. Seasonal demographics of landbirds on Saipan: report on the 2013-14 TMAPS program. The Institute for Bird Populations, Point Reyes Station, CA. PDF

Saracco, J.F., P. Radley, P. Pyle, E. Rowan, R. Taylor, and L. Helton. 2016. Linking vital rates of landbirds on a tropical island to rainfall and vegetation greenness. PLOS ONE 11(2):e0148570. DOI: 10.1371/journal.pone.0148570. PDF

Sauer, J. R., J. E. Hines, and J. Fallon. 2008. The North American Breeding Bird Survey, Results and Analysis 1966 - 2007. Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, MD.

Temple, S.A., and J.A. Wiens. 1989. Bird populations and environmental changes: can birds be bio-indicators? American Birds 43:260-270.

U.S. Fish and Wildlife Service. 2015. Endangered and threatened wildlife and plants; proposed endangered species status for five species from American Samoa. Federal Register Document 80 FR 61567, pages 61567-61607, Docket No. FWS-R1-ES-2015-0128 4500030113.

U.S. Fish and Wildlife Service. 2016.Endangered and threatened wildlife and plants; endangered status for five species from American Samoa; final rule. Federal Register 81 (184) pages 65466-65508, Docket No. FWS–R1–ES–2015–0128; 4500030113 (22 September 2016).

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick, 1992. The Alaska Vegetation Classification. Gen. Tech. Rep. PNW-GTR-286. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 278 p

White, G. C., and K. P. Burnham. 1999. Program MARK: survival estimation for populations of marked animals. Bird Study 46 (Supplement):120-138.

Williams, K. E., K. P. Huyvaert, and A. J. Piaggio. 2016. No filters, no fridges: a method for preservation of water samples for eDNA analysis. BMC Res Notes. 2016; 9: 298 doi: 10.1186/s13104-016-2104-5

Wolfe, J.D., T.B. Ryder, and P. Pyle. 2010. Using molt cycles to categorize age in tropical birds: An integrative system. Journal of Field Ornithology 81:186-194. PDF

Table 1. Summary of the TMAPS program and habitat designations on the island of Tutuila, American Samoa (AMSA) during the 2017 season.

Station					November 2016 – March 2017 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	417.00	4	12/27/16 - 3/22/17
Tula	TULA	Primary forest on steep ridge with mature *Callophylum* and *Dysoxylum* trees. *Upland Forest*	14°14'58"S, 170°34'35"W	380	442.67	4	12/24/16 - 03/15/17
Amalau	AMAL	Mixed, old-growth and secondary lowland tropical forest; some plantation. *Coastal Habitat*	14°15'19"S, 170°39'32"W	35	533.50	4	12/20/16 - 03/11/17
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	448.17	4	01/03/17 – 03/28/17
Malota	MALO	Ridge-spine, natural tropical forest. *Lowland Forest*	14°18'17"S, 170°49'11"W	144	550.67	4	12/08/16 – 03/04/17
Malaeloa	MALA	Old-growth moderate-slope, lowland tropical evergreen forest; ephemeral wetlands. *Coastal Habitat*	14°19'50"S, 170°46'26"W	43	526.00	4	12/15/16 – 03/08/17
ALL STATIONS					2918.00	4	12/15/16 – 03/28/17

Table 2. Summary of the TMAPS program and habitat designations on the island of Ta'u, American Samoa (AMSA) during the 2017 season.

Station					November 2016 – March 2017 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	413.83	3	12/29/16 – 02/25/17
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	460.67	3	01/12/17 – 03/11/17
Usu Nua	USUN	Agriculturally managed secondary forest. *Lowland Forest*	14°13'59"S, 169°30'39"W	210	464.33	3	01/02/17 – 03/02/17
Fala'a	FALA	Gentle-slope mature lowland secondary forest. *Lowland Forest*	14°14'49"S, 169°29'59"W	424	413.00	3	01/18/17 – 03/13/17
NPAS - Laufuti Stream	LAUF	Gentle-slope mature lowland secondary forest. *Upland Forest*	14°14'54"S, 169°26'31"W	835	438.33	3	01/05/17 – 03/04/17
NPAS- Luamaa	LUAM	Coral rubble lowland littoral forest. *Coastal Habitat*	14°15'24"S, 169°25'28"W	8	489.33	3	01/09/17 – 03/08/17
ALL STATIONS					2679.50	3	12/29/16 – 03/13/17

Table 3. Summary of the TMAPS program and habitat designations on the islands of Ofu-Olosega, American Samoa (AMSA) during the 2017 season.

Station		Major Habitat Type	Latitude-longitude	Avg Elev. (m)	November 2016 – March 2017 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	472.67	3	01/14/17 – 03/11/17
National Park Southeast	NPSE	Coastal lowland forest bordering sand strand. *Coastal Habitat*	14°10'15"S, 169°38'42"W	5	480.00	3	01/20/17 – 03/14/17
Toaga Beach	TOAG	Coastal lowland forest, bordering sand strand and talus slope. *Coastal Habitat*	14°10'34"S, 169°39'14"W	13	446.67	3	01/06/17 – 03/04/17
Tumu Upper	TUMU	Disturbed montane forest; microwave station at summit. *Upland Forest*	14°10'34"S, 169°39'36"W	477	435.33	3	12/28/16 – 02/25/17
Olosega Island							
Sili	SILI	Reclaimed old village site; coral rubble lowland littoral forest. *Coastal Habitat*	14°09'43"S, 169°37'05"W	12	462.33	3	01/10/16 – 03/07/17
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	470.00	3	12/31/16 – 03/02/17
ALL STATIONS					2767.00	3	12/28/16 – 03/14/17

Table 4. Summary of combined results for all 18 American Samoan TMAPS stations (six from each island group) operated during the 2017 season, December 2016 through March 2017.

	Island of Tutuila						Island of Ta'u						Island of Ofu-Olosega					
	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
Red Junglefowl		1																
Tongan Ground Dove													11		2	2.2	0.7	0.30
Crimson-crowned Fruit Dove	5			0.8	0.2	0.25							1			0.2	0.0	0.00
Pacific Long-tailed Cuckoo								1					1			0.2	0.0	0.00
White-rumped Swiftlet		1																
Pacific Kingfisher	24		19	3.9	2.7	0.68	20		17	4.5	1.8	0.40	33		31	7.2	3.3	0.46
Blue-crowned Lorikeet							7	2		1.1	0.4	0.40						
Cardinal Myzomela	1		3	0.4	0.0	0.00												
Polynesian Wattled-Honeyeater	53	2	24	14.0	1.0	0.07	104	1	46	29.3	1.6	0.05	75	3	40	19.9	2.4	0.12
Samoan Shrikebill							19		17	4.0	2.7	0.67	19		13	3.7	1.7	0.47
Polynesian Starling	9	1		1.6	0.2	0.13	32		2	3.4	4.3	1.27	1		2	0.4	0.0	0.00
Samoan Starling	13			2.5	0.2	0.08	56	2	17	9.0	6.7	0.75	49	1	11	7.6	4.1	0.54
All Species Pooled	105	5	46	23.2	4.3	0.19	238	6	99	51.3	17.5	0.34	190	4	99	41.4	12.1	0.29
Total Number of Captures		156						343						293				
Number of Species	6	4	3	6	5		6	4	5	6	6		8	2	6	8	5	
Total Number of Species		8			6			7			6			8			8	

[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 2017 season, December 2016 through March 2017. 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
Red Junglefowl																	1	
Crimson-crowned Fruit Dove	1			1			1			1			1					
White-rumped Swiftlet											1							
Pacific Kingfisher	4		2	2		5	7		2	3		2	8		6			2
Cardinal Myzomela	1		3															
Polynes. Wattled-Honeyeater	9			6		1	5	1	3	12		11	12		5	9	1	4
Polynesian Starling	1						3			2	1		2			1		
Samoan Starling	5						2			1			4			1		
All Species Pooled	21	0	5	9	0	6	18	1	5	19	2	13	27	0	11	11	2	6
Total Number of Captures		26			15			24			34			38			19	
Number of Species	6	0	2	3	0	2	5	1	2	5	2	2	5	0	2	3	2	2
Total Number of Species		6			3			5			6			5			5	

[1] Scientific names given in Appendix I.

Table 6. Capture summary for the six individual TMAPS stations operated on the island of **Ta'u**, American Samoa (AMSA) during the 2017 season, December 2016 through March 2017. N = Newly banded, U = Unbanded, R = Recaptures of banded birds.

	Aokuso			Saunoa			Usu Nua			Fala'a			Laufuti Stream			Luamaa		
Species[1]	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Pacific Long-tailed Cuckoo								1										
Pacific Kingfisher	4		3				5		3	3		1	3			5		10
Blue-crowned Lorikeet	4	1		2	1		1											
Polynes. Wattled-Honeyeater	14		9	8		6	30		8	9		1	14		2	29	1	20
Samoan Shrikebill						2	1		1	11		5	7		9			
Polynesian Starling				8			13			4			7		2			
Samoan Starling	8		5	15	1	2	22		6	3						8	1	4
All Species Pooled	30	1	17	33	2	10	72	1	18	30	0	7	31	0	13	42	2	34
Total Number of Captures		48			45			91			37			44			78	
Number of Species	4	1	3	4	2	3	6	1	4	5	0	3	4	0	3	3	2	3
Total Number of Species		4			5			7			5			4			3	

[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 2017 season, December 2016 through March 2017. N = Newly banded, U = Unbanded, R = Recaptures of banded birds.

	Ofu Island												Olosega Island					
	Tumu Lower			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
Tongan Ground Dove	4			3		1	2		1				2					
Crimson-crowned Fruit Dove										1								
Pacific Long-tailed Cuckoo	1																	
Pacific Kingfisher	1		1	11		14	9		6				8		5	4		5
Polynes. Wattled-Honeyeater	12	1	8	10		6	19	1	8	9		7	14		7	11	1	4
Samoan Shrikebill	1			2						16		13						
Polynesian Starling										1		2						
Samoan Starling	6			6		1	19	1	7				17		3	1		
All Species Pooled	25	1	9	32	0	22	49	2	22	27	0	22	41	0	15	16	1	9
Total Number of Captures		35			54			73			49			56			26	
Number of Species	6	1	2	5	0	4	4	2	4	4	0	3	4	0	3	3	1	2
Total Number of Species		6			5			4			4			4			3	

[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 2017 season, December 2016 through March 2017.

	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	1.4	0.0	0.00	0.0	1.4	und.[2]	1.1	0.0	0.00	1.3	0.0	0.00	1.1	0.0	0.00			
Pacific Kingfisher	2.9	2.9	1.00	2.7	2.7	1.00	2.2	6.7	3.00	4.0	1.3	0.33	8.7	2.2	0.25	2.3	0.0	0.00
Cardinal Myzomela	2.9	0.0	0.00															
Polynes. Wattled-Honeyeater	11.5	1.4	0.13	8.1	1.4	0.17	9.0	0.0	0.00	28.1	0.0	0.00	13.1	3.3	0.25	14.8	0.0	0.00
Polynesian Starling	1.4	0.0	0.00				2.2	1.1	0.50	2.7	0.0	0.00	2.2	0.0	0.00	1.1	0.0	0.00
Samoan Starling	7.2	0.0	0.00				2.2	0.0	0.00	1.3	0.0	0.00	3.3	1.1	0.33	1.1	0.0	0.00
All Species Pooled	27.3	4.3	0.16	10.8	5.4	0.50	16.9	7.9	0.47	37.5	1.3	0.04	28.3	6.5	0.23	19.4	0.0	0.00
Number of Species	6	2		2	3		5	2		5	1		5	3		4	0	
Total Number of Species		6			3			5			5			5			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 9. 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 **Ta'u**, American Samoa (AMSA) during the 2017 season, December 2016 through March 2017.

	Aokuso			Saunoa			Usu Nua			Fala'a			Laufuti Stream			Luamaa		
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.
Pacific Kingfisher	5.8	2.9	0.50				3.9	3.9	1.00	4.4	1.5	0.33	4.1	0.0	0.00	8.6	2.5	0.29
Blue-crowned Lorikeet	4.4	1.5	0.33	2.6	0.0	0.00	0.0	1.3	und.[2]									
Polynes. Wattled-Honeyeater	30.4	1.5	0.05	18.2	0.0	0.00	45.2	1.3	0.03	14.5	0.0	0.00	19.2	1.4	0.07	45.4	4.9	0.11
Samoan Shrikebill				2.6	0.0	0.00	1.3	0.0	0.00	13.1	10.2	0.78	8.2	6.8	0.83			
Polynesian Starling				0.0	10.4	und.[2]	3.9	12.9	3.33	4.4	1.5	0.33	12.3	0.0	0.00			
Samoan Starling	7.2	11.6	1.60	14.3	9.1	0.64	14.2	19.4	1.36	4.4	0.0	0.00				12.3	0.0	0.00
All Species Pooled	47.8	17.4	0.36	37.8	19.5	0.52	68.5	38.8	0.57	40.7	13.1	0.32	43.8	8.2	0.19	66.2	7.4	0.11
Number of Species	4	4		4	2		5	5		5	3		4	2		3	2	
Total Number of Species		4			5			6			5			4			3	

[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 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 2017 season, December 2016 through March 2017.

	Ofu Island												Olosega Island					
	Tumu Lower			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	3.8	1.3	0.33	5.0	0.0	0.00	2.7	1.3	0.50				1.3	1.3	1.00			
Crimson-crowned Fruit Dove										1.4	0.0	0.00						
Pacific Long-tailed Cuckoo	1.3	0.0	0.00															
Pacific Kingfisher	2.5	0.0	0.00	15.0	5.0	0.33	10.7	5.4	0.50				7.8	6.5	0.83	6.4	2.6	0.40
Polynes. Wattled-Honeyeater	21.6	1.3	0.06	17.5	1.3	0.07	26.9	5.4	0.20	19.3	0.0	0.00	22.1	1.3	0.06	12.8	5.1	0.40
Samoan Shrikebill	0.0	1.3	und.[2]	1.3	1.3	1.00				22.1	8.3	0.38						
Polynesian Starling										2.8	0.0	0.00						
Samoan Starling	7.6	0.0	0.00	3.8	3.8	1.00	26.9	4.0	0.15				7.8	15.6	2.00	0.0	1.3	und.[2]
All Species Pooled	36.8	3.8	0.10	42.5	11.3	0.27	67.2	16.1	0.24	45.5	8.3	0.18	38.9	24.7	0.63	19.1	8.9	0.47
Number of Species	5	3		5	4		4	4		4	1		4	4		2	3	
Total Number of Species		6			5			4			4			4			3	

[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 six MAPS stations pooled on each of the Islands of Tutuila and Ta'u, American Samoa, from November - March, during each of the four seasons 2014-2017 and all four seasons combined. Comparable values are also shown for Ofu-Olosega, but for only the two seasons (2016-2017) in which stations were run on these islands.

	Island of Tutuila						Island of Ta'u						Island of Ofu-Olosega					
	2016		2017		Mean 2014 - 2017		2016		2017		Mean 2014 - 2017		2016		2017		Mean 2016 - 2017	
Species[1]	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													2.16	0.42	2.17	0.30	2.16	0.36
Many-colored Fruit Dove					0.10	0.00												
Crimson-cr. Fruit Dove	0.48	0.00	0.82	0.25	0.86	0.22	0.60	0.00			0.43	0.00	0.54	0.00	0.22	0.00	0.38	0.00
Pacific Long-tailed Cuckoo					0.00	und.[2]					0.06	0.00			0.22	0.00	0.11	0.00
White-rumped Swiftlet					0.00	und.[2]												
Pacific Kingfisher	2.63	0.73	3.91	0.68	2.85	0.58	4.50	0.47	4.48	0.40	4.74	0.28	8.26	0.37	7.16	0.46	7.71	0.41
Blue-crowned Lorikeet							1.50	0.20	1.12	0.40	1.21	0.18						
Cardinal Myzomela	0.48	0.00	0.41	0.00	0.26	0.00												
Polyn. Wattled-Honeyeater	10.50	0.11	13.98	0.07	12.41	0.14	29.72	0.10	29.33	0.05	31.21	0.11	29.63	0.16	19.95	0.12	24.79	0.14
Samoan Shrikebill							3.60	0.83	4.03	0.67	3.65	0.60	2.34	1.00	3.69	0.47	3.01	0.74
Red-vented Bulbul					0.00	und.[2]												
Polynesian Starling	0.95	0.25	1.65	0.13	1.41	0.26	0.60	0.50	3.36	1.27	1.47	0.87	0.54	0.67	0.43	0.00	0.49	0.33
Samoan Starling	2.15	0.00	2.47	0.08	2.05	0.33	12.61	0.26	8.73	0.77	10.79	0.44	11.49	0.36	7.59	0.54	9.54	0.45
Jungle Myna	0.24	0.00			0.10	0.00												
Common Myna	0.24	0.00			0.06	0.00												
All Species Pooled	17.66	0.22	23.24	0.19	20.09	0.23	53.13	0.23	51.05	0.34	53.55	0.25	54.95	0.28	41.42	0.29	48.19	0.29

[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 (2014-2017 seasons) and 18 stations on all three islands (2016-2017 seasons) by habitat type on American Samoa, for nine native Samoan landbirds and all landbird species pooled.

	Mean 2014-2017, Tutuila and Ta'u						Mean 2016-2017, 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							1.42	0.62	0.69	0.17		
Crimson-crwnd. Fruit Dove	0.24	0.00	0.81	0.06	0.84	0.25	0.35	0.00	0.59	0.00	0.42	0.25
Pacific Kingfisher	5.51	0.35	2.74	1.06	2.94	0.36	7.99	0.44	3.84	0.72	2.85	0.40
Blue-crowned Lorikeet	0.76	0.33	0.14	0.00	0.73	0.00	0.53	0.17	0.00	——	0.57	0.00
Cardinal Myzomela	0.00	——	0.35	0.00	0.10	0.00	0.00	——	0.34	0.00	0.15	0.00
Polyn. Wattled-Honeyeater	22.19	0.12	23.19	0.16	18.73	0.08	23.53	0.12	21.92	0.14	20.53	0.05
Samoan Shrikebill	0.00	——	2.95	0.56	2.49	0.58	0.09	1.00	1.57	1.28	6.34	0.59
Polynesian Starling	0.63	0.22	2.27	0.55	1.51	0.41	0.44	0.17	1.46	0.61	2.20	0.97
Samoan Starling	8.44	0.44	7.06	0.46	3.68	0.26	10.64	0.43	6.73	0.42	3.26	0.48
All Species Pooled	37.86	0.21	39.58	0.30	31.30	0.20	45.09	0.26	37.26	0.31	36.45	0.26

[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

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 (22 pulses overall), including 21 pulses on Tutuila during the 2013-2017 seasons, 15 pulses on Ta'u during the 2014-2017 seasons, and 7 pulses on Ofu-Olosega during the 2016-2017 seasons[1].

				No. btwn-yr	Lambda[6] (population change)		Survival probability[7]			Recapture probability[8]		Proportion of residents[9]	
Species[2]	Island	No. stn.[3]	No. indv.[4]	recap.[5]	λ	SE(λ)	Monthly φ	SE(φ)	Yearly φ	p	SE(p)	τ	SE(τ)
Pacific Kingfisher	Tutuila	6	58	26	0.993	(0.005)	0.983	(0.011)	0.810	0.205	(0.035)	0.363	(0.154)
	Ta'u	6	58	47	0.992	(0.005)	0.974	(0.010)	0.728	0.222	(0.034)	0.720	(0.114)
	Ofu-Olosega	6	67	35	0.991	(0.007)	0.981	(0.015)	0.795	0.217	(0.035)	0.664	(0.116)
P. Wattled-Honeyeater	Tutuila†	6	235	49	0.999	(0.004)	0.977	(0.008)	0.753	0.037	(0.008)	1.000	(0.056)
	Ta'u	6	455	121	0.995	(0.003)	0.979	(0.006)	0.773	0.072	(0.010)	0.867	(0.045)
	Ofu-Olosega	6	229	56	0.977	(0.011)	0.986	(0.011)	0.849	0.123	(0.026)	0.714	(0.109)
Samoan Shrikebill	Ta'u	4	46	25	1.001	(0.008)	0.996	(0.010)	0.955	0.168	(0.047)	0.557	(0.156)
	Ofu-Olosega	2	26	12	1.015	(0.022)	0.997	(0.017)	0.961	0.274	(0.095)	0.283	(0.183)
Polynesian Starling	Tutuila*	5	32	4	0.995	(0.011)	0.933	(0.050)	0.436	0.090	(0.066)	0.535	(0.357)
	Ta'u*	4	24	2	1.044	(0.019)	0.988	(0.021)	0.870	0.081	(0.056)	0.721	(0.328)
	Ofu-Olosega*	1	4	1	0.988	(0.059)	0.988	(0.022)	0.862	0.097	(0.080)	0.730	(0.283)
Samoan Starling	Tutuila*	5	47	1	1.000	(0.006)	0.920	(0.108)	0.367	0.154	(0.177)	0.013	(0.035)
	Ta'u	6	164	30	0.999	(0.005)	0.988	(0.013)	0.867	0.055	(0.017)	0.752	(0.095)
	Ofu-Olosega	6	95	14	0.994	(0.012)	0.973	(0.023)	0.724	0.253	(0.081)	0.132	(0.083)

[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%)

† The estimate for survival probability, recapture probability, or both may be biased low because τ (proportion of residents) was set at 1.00.

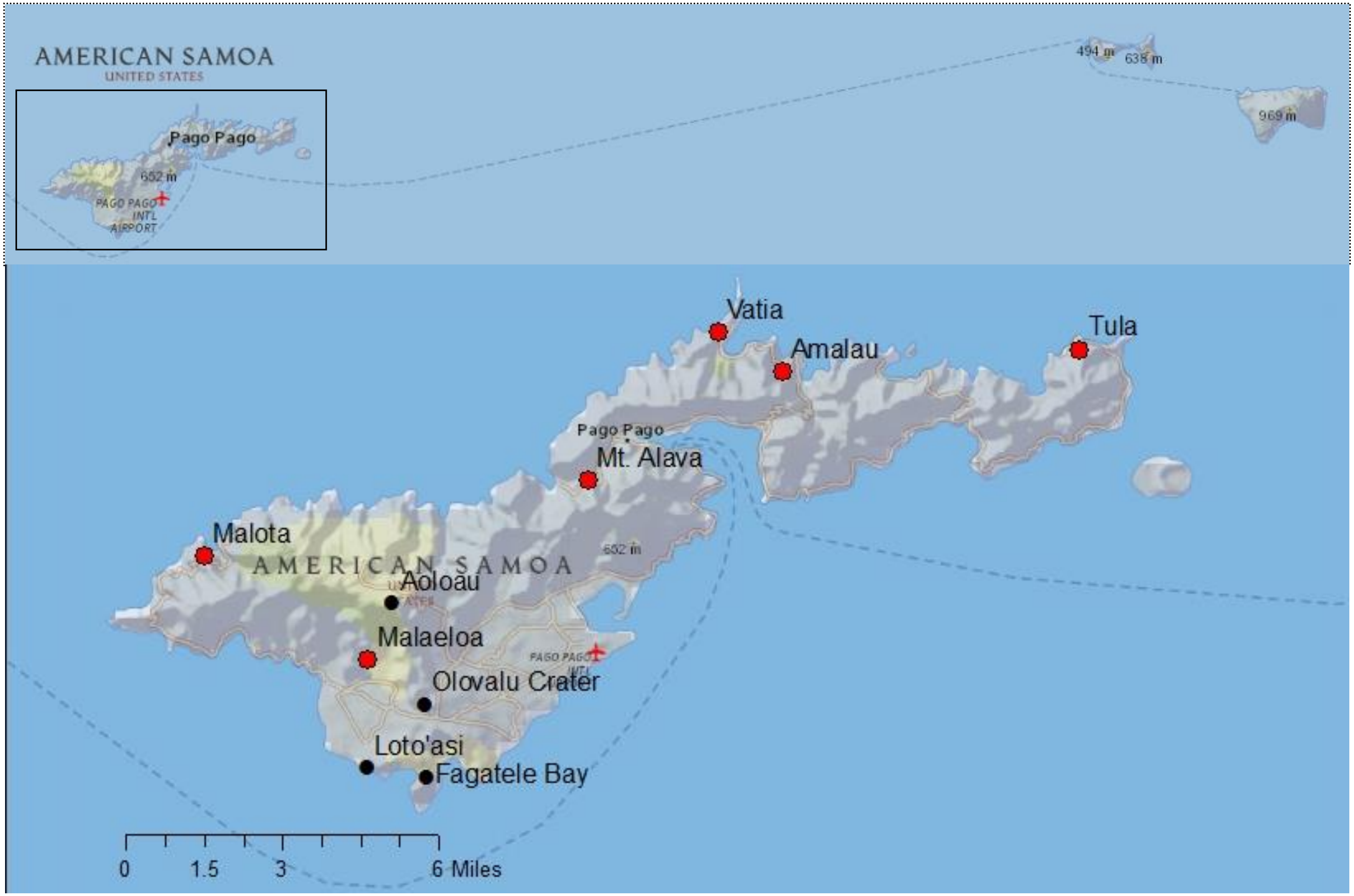

Figure 1. Locations of the ten Tropical Monitoring Avian Productivity and Survivorship (TMAPS) stations operated on Tutuila Island, American Samoa, from 2012 to 2016. Active (2016) stations are shown by red circles, non-active stations by black circles.

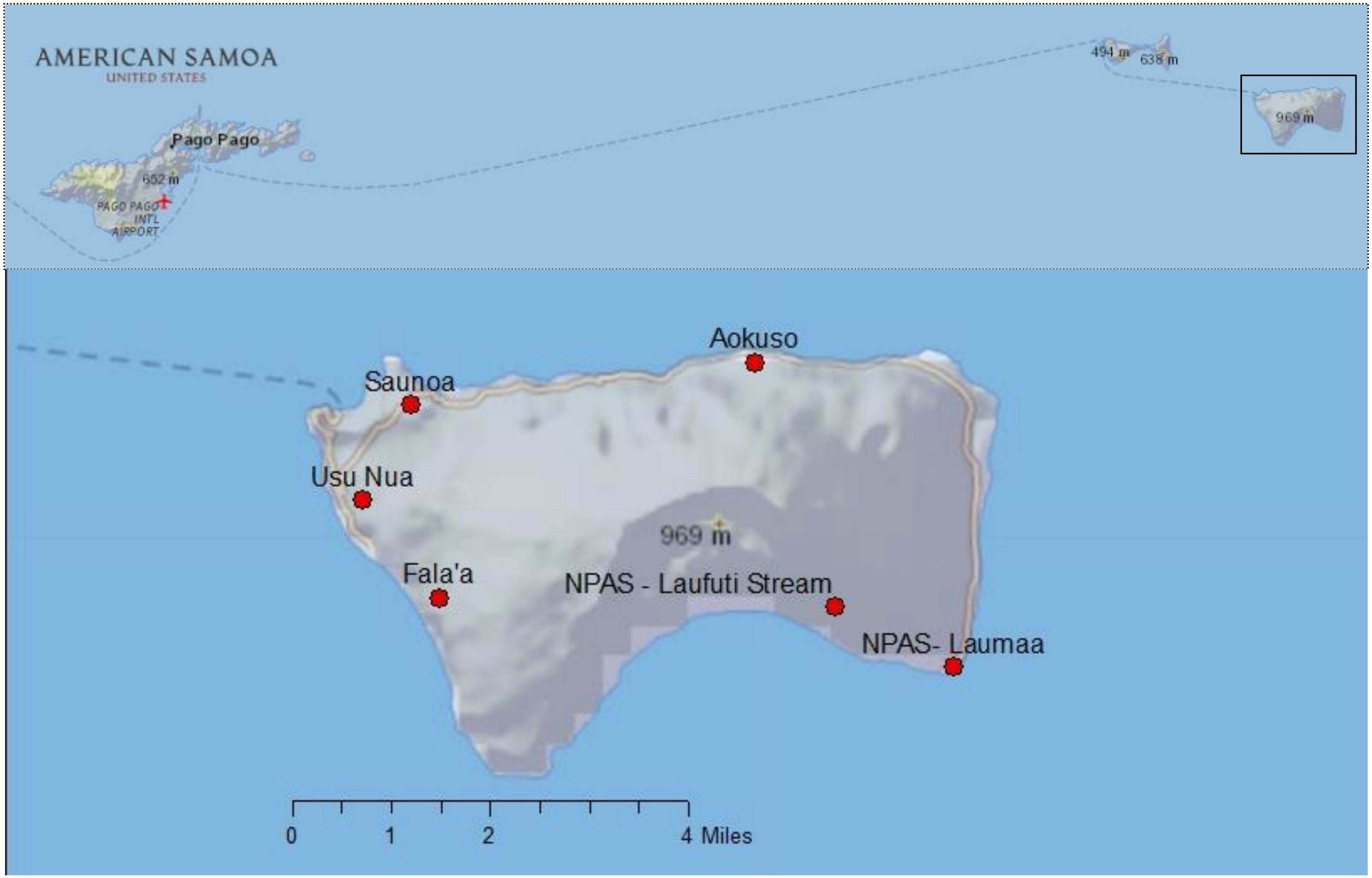

Figure 2. Locations of the six Tropical Monitoring Avian Productivity and Survivorship (TMAPS) stations operated on Ta’u island, American Samoa, during the 2014-2016 seasons.

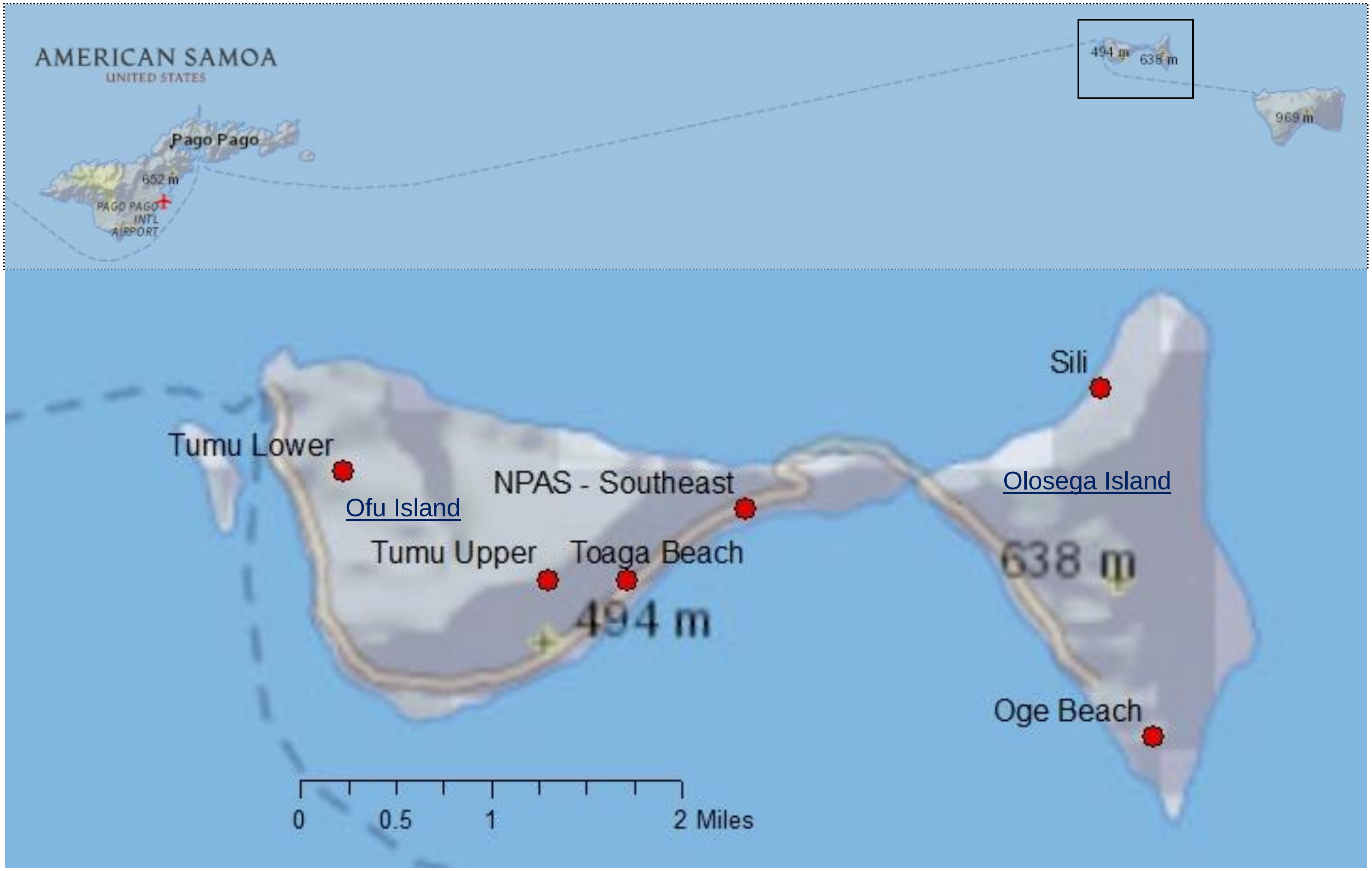

Figure 3. Locations of the six Tropical Monitoring Avian Productivity and Survivorship (TMAPS) stations operated on Ofu (left) and Olosega (right) islands, American Samoa, during the 2016 season.

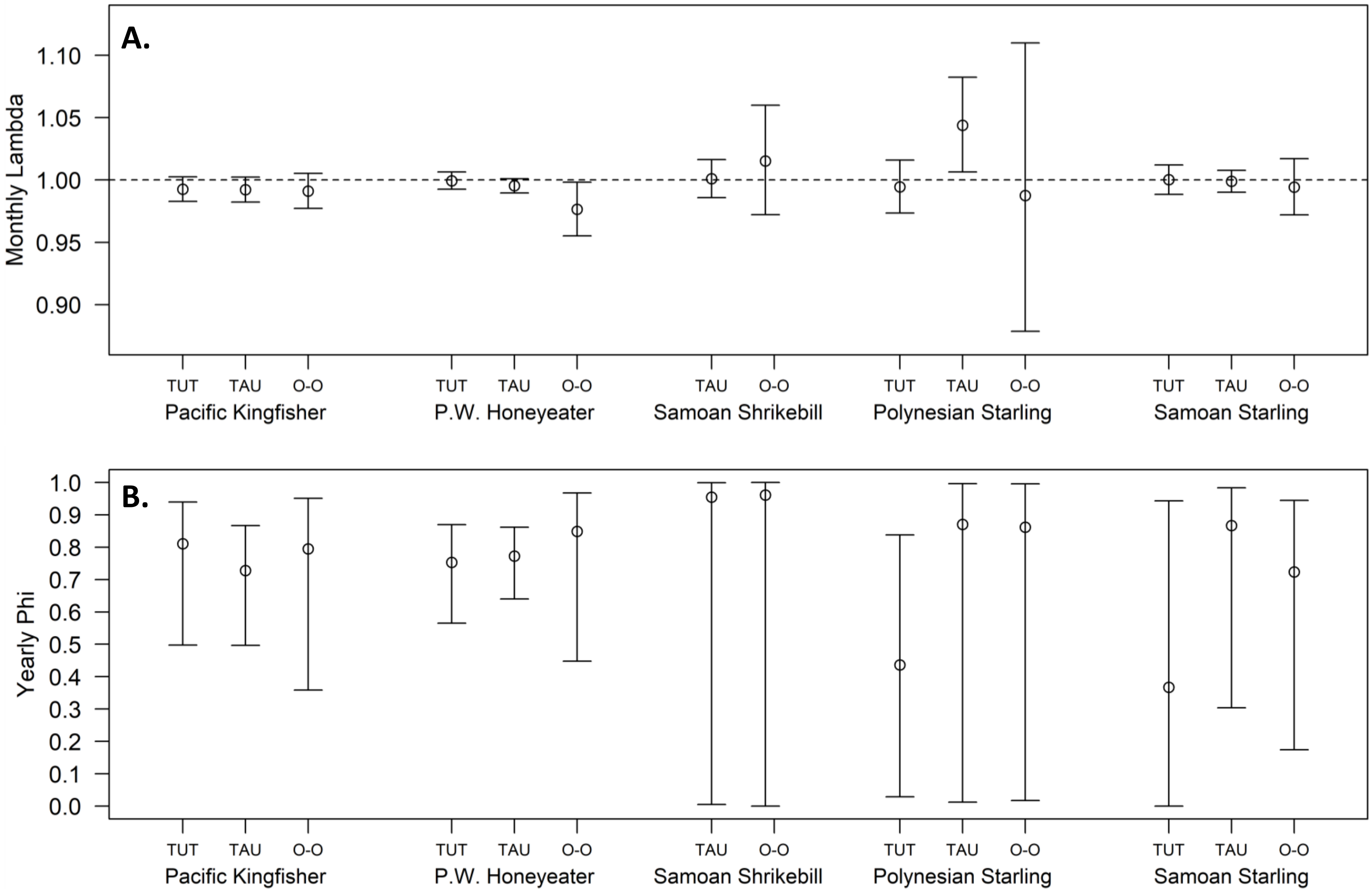

Figure 4. Monthly estimates of population change (Lambda) and adult annual survival (Phi) using a time-constant, transient model for five species. All 18 currently operating stations on the islands of Tutuila (TUT; 21 pulses), Ta'u (TAU; 15 pulses) and Ofu-Olosega (O-O; 7 pulses) were included in the 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 sace*	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													
Polynesian 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													